

HUMANS WITH TAILS p.68

DEADLY GAS, CHEAP ENERGY p.64

SCIENCE ILLUSTRATED

Flying Saucers Are Real!

The Evolution of
Disk-Shaped
Aircraft p.42



CLING ON!

Our Gallery of
Amazing
Images



p.34

The Truth About Bats

They're Not Just
Bloodsuckers



p.54

Hiding in Plain Sight

Can You Find the
Camouflaged Animals?



p.48

The Luckiest Collision

NEW FINDINGS
The Moon's
Explosive Origins

p.78

The 385,000,000-Year-Old Tree





ASTRONOMY MADE SIMPLE

Who says Astronomy has to be complicated? Let a NexStar SE help you find thousands of stars, planets galaxies and more at the touch of a button! The new NexStar SE Family combines unprecedented ease of use with advanced features and incredible value. Buyer's remorse not included.



Easy as 1-2-3
SkyAlign™

- Computerized hand control with nearly 40,000 object database and motorized Altazimuth mount
- Quick release optical tube for easy no-tool setup
- StarBright XLT® enhanced coatings for maximum light transmission and clarity
- SkyAlign™ allows you to align on any three bright objects, for a fast and easy alignment process
- StarPointer™ finderscope to help with alignment and accurately locating objects
- Flash upgradeable hand control; update your telescope's operating software via the internet
- Internal battery compartment to prevent cord wrap during use
- Includes NexRemote® telescope control software, for advanced control of your telescope via computer
- "The Sky®" Planetarium software – with 10,000 object database, printable sky maps and enhanced images

NEXSTAR® SE SERIES



Align your NexStar SE telescope in minutes with our new SkyAlign technology. Just point the telescope at three bright stars and let the computer do the rest. You don't even need to know the names of the stars!



EXCLUSIVE FEATURES OF THE NEXSTAR 4SE AND 5SE

- Tripod features built-in wedge which allows ease of use for astrophotography!
- Includes a camera control feature that allows you to remotely take a series of timed exposures using your digital SLR camera.



B&H Photo – 800.947.9970 – www.bhphotovideo.com
Optics Planet – 800.504.5897 – www.opticsplanet.com
Adorama – 800.223.2500 – www.adorama.com
Scope City – 800.235.3344 – www.scopecity.com

Telescopes.com – 888.988.9876 – www.telescopes.com
Astronomics – 800.422.7876 – www.astronomics.com
Oceanside Photo and Telescope (OPT) – 800.483.6287 – www.optcorp.com
Hands on Optics – 866.726.7371 – www.handsonoptics.com



FEATURING MAKSUTOV AND SCHMIDT-CASSEGRAIN OPTICAL DESIGNS

1. SE telescopes feature Celestron's renowned optical systems and come standard with our premium StarBright® XLT Coatings.
2. Flash upgradeable hand control contains a database of nearly 40,000 celestial objects and advanced software features including SkyAlign, Identify Mode, User-definable Horizon Limits, and Precise GoTo.
3. Designed For Portability: with heaviest model only 24 lbs, spend more time observing with these lightweight and easy to set-up telescopes.
4. Heavy-duty steel tripod with accessory tray; 4SE and 5SE tripods feature a built-in wedge.



NexStar 4SE (4")	\$499.00*	NexStar 6SE (6")	\$899.00*
NexStar 5SE (5")	\$699.00*	NexStar 8SE (8")	\$1,299.00*

*Suggested retail price in U.S. dollars after mail-in rebate. Additional shipping and handling charges may apply.

Receive a \$100 rebate on the NexStar 4SE, 5SE, 6SE and 8SE. Offer good between November 1, 2008 and December 31, 2008. Visit www.celestron.com or see your dealer for complete details*.

*Some restrictions apply. Offer good for U.S. and Canada customers only.

Sky Align Technology: U.S. Patent No. 7,382,448

GRUNDIG

TIMELESS PERFORMANCE

Celebrating America's **50 years** of Space Exploration



BUZZ ALDRIN EDITION

G6 AVIATOR AM/FM/Aircraft Band/Shortwave

Portable Radio with SSB (Single Side Band)



Receives
AM Band



Receives
FM Band



Receives
Shortwave Band



Receives
Aircraft Band



Alarm
Clock



Headphone
Jack

Available at:

 **RadioShack**
Do Stuff.™

 **THE SOURCE**
BY CIRCUIT CITY™

Contents

NOVEMBER/DECEMBER 2008

AVIATION

P.42



The history of flying-saucer designs, and one craft that may actually go on sale next year.

ZOOLOGY

P.34



From their sheer diversity to how they navigate in the dark, bats are full of surprises.

PORTFOLIO

P.54



Stunning pictures of some of North America's most impressive animal camouflage.

FRONTIERS OF MEDICINE

P.72



How transgenic pigs are helping researchers uncover a cure for Alzheimer's disease.



"In the future, we'll all be able to afford strange and wonderful new flying machines that defy conventional aerodynamics."

On the cover: An artist's rendering of a flying saucer for the Delft University of Technology in the Netherlands.

GENETICS

P.68



Babies with tails, dolphins with extra flippers and other extreme oddities explained.

ALTERNATIVE ENERGY

P.64



Harnessing a dangerous buildup of gas in an African lake to produce cheap fuel.

COSMOLOGY

P.48



How our moon stands apart in the solar system, and how it helped shape Earth.

PALEOBOTANY

P.78



Geologists find the world's first trees in New York State, solving a 170-year-old mystery.

SCIENCE UPDATE p.22



BULL'S-EYE: NATURE p.10



ASK US p.27



Departments

Bull's-Eye p.8

An Earth-friendly ride, sticky fish, the world's most expensive salt, and fluorescent brain cells—all in this issue's gallery of amazing images.

Science Update p.17

Baby humpbacks speak, killer wasp tactics, stars in surprising places, a new way to spot hidden weapons, and the secret to Maya Blue.

Ask Us p.27

What colors the Northern Lights? When did childhood diseases arise? How do some plants move? Why can't water put out a grease fire?

World of Science p.84

A cool geometric diversion, the smallest (and most adorable) primates, and other fascinating nuggets of scientific knowledge.

Letters p.6

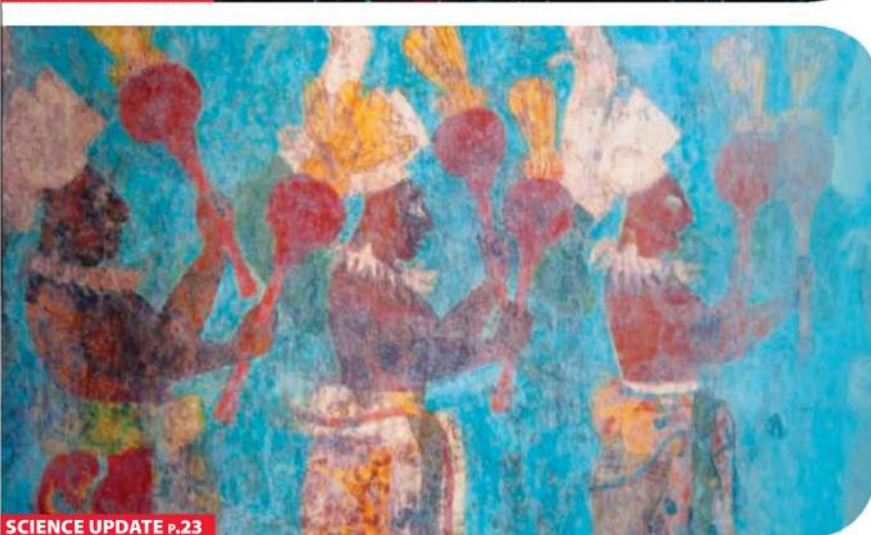
Trivia Countdown p.88

Brain Trainers p.96

WORLD OF SCIENCE p.86



SCIENCE UPDATE p.18



SCIENCE UPDATE p.23





Everyone can appreciate technologies that go from gas-friendly to gas-free.

That's why Chevy™ offers more models than Toyota or Honda with an EPA estimated 30 MPG highway or better, plus more vehicle choices today than any brand that can run on cleaner-burning, mostly renewable E85 ethanol.¹ It's also why we've introduced both Malibu® Hybrid² and Tahoe® Hybrid³ – America's first full-size hybrid SUV.⁴ And why we've put tremendous design and engineering resources in place to make Chevy Volt™⁵ – our extended-range electric vehicle – a reality. Now that's technology everyone can appreciate. Find out more at chevy.com

AN AMERICAN REVOLUTION



FUEL EFFICIENCY



BIOFUELS



HYBRID

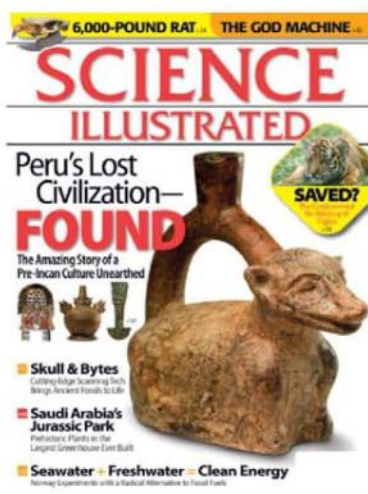


ELECTRIC



FUEL CELL

¹ E85 is 85% ethanol, 15% gasoline. For more info or to find an E85 station near you, go to chevy.com/biofuels. ² Malibu Hybrid very limited availability. ³ At participating dealers only. ⁴ Excludes other GM vehicles. ⁵ Chevy Volt not available for sale. ©2008 GM Corp. Buckle up, America!



Saving Stripes

The profile of Li Quan and her effort to save the South China tiger ["Bred to be Wild," September/October] is an unsettling account of the hope and determination needed for the survival of the subspecies. The strides Quan and her husband have made in breeding a new generation of tigers at their preserve are encouraging, though many hurdles remain. China's State Forestry Administration will need to provide enough territory for the tigers. If Quan's foundation is able to demonstrate success, this ex-situ method may become a popular manner of conservation in the future.

Aaron Kohan Chicago

Flight of Truth

Your article "Inspired by Nature" [July/August] was engaging, but the references to Leonardo da Vinci and the Wright brothers in the beginning of the piece could be misconstrued. Da Vinci assumed that man would fly as birds do, with movable wings. Although Wilbur and Orville Wright studied avian flight, the brothers ultimately realized that success lay not with biomimicry but with a fixed-wing flying machine.

Huston Paschal Raleigh, N.C.

Best Foot Forward

Thank you for the very informative article about the ancient footprints discovered in Mexico ["Footprints From Our Past," July/Aug.]. It was especially refreshing to see the various interpretations discussed. Most science articles present only the commonly accepted theory.

Jeff McKenzie West Valley, Utah

Weird Science

One of the best examples I've ever seen of science babble can be found in the "Medical Discovery!" ad for a home water machine [page 89, July/Aug.]. The single sentence "Since blood flow can easily be measured, you don't need double-blind studies..." shows such a profound lack of understanding of what constitutes scientific proof that I have no sympathy for anyone gullible enough to swallow this nonsense.

George Gjelfriend Asheville, N.C.

Corrections

In "Seawater + Freshwater = Clean Energy" [Sept./Oct.], we should have stated that, in humans, a cell membrane—not a cell wall—regulates the movement of water molecules in and out of the cell.

In "Why do some animals have whiskers?" ["Ask Us," Sept./Oct.], the last sentence, which was incomplete, should have read, "A computer collected and analyzed information and produced a precise spatial image of the object the whiskers encountered."

MAIN OFFICE

2 Park Ave., 9th Fl.
New York, NY 10016
Fax: 212-779-5108
Web: scienceillustrated.com

LETTERS

Please send letters to the editor to letters@scienceillustrated.com. We regret that we cannot answer unpublished letters. Letters may be edited for length or clarity.

NEW SUBSCRIPTIONS

Phone: 866-429-0139
Web: scienceillustrated.com/subscribe

SUBSCRIPTION INQUIRIES

Report address changes and subscription questions to:
SCIENCE ILLUSTRATED
P.O. Box 420235, Palm Coast, FL 32142-0235
Phone: 866-429-0139
Web: scienceillustrated.com/manage

SCIENCE ILLUSTRATED

Editor-in-Chief Mark Jannot

Creative Director Sam Syed

Deputy Editor Jacob Ward

Senior Associate Editor Jennifer Abbasi

Editorial Production Manager Felicia Pardo

Translator Jonathan D. Beard

Copy and Research Director Rina Bander

Copy Editors Kenyatta Matthews, Ellen Weiss

Staff Editors Lauren Aaronson, Doug Cantor, Seán Captain,

Bjorn Carey, Nicole Dyer, Seth Fletcher, Mike Haney, Martha

Harbison, Michael Moyer

Fact Checkers Brooke Borel, Melynda Fuller, Erika Villani

Editorial Assistant Amy Geppert

Contributing Art Director Patrick F. Albertson

Photo Editor Kristine LaManna

Digital Content Editor Megan Miller

Contributing Mathematician I. Martin Isaacs

Contributing Writers Henrik Bendix, Jesper Bindlev,

Tina Frederiksen, Karen Grubbe, Rolf Haugaard Nielsen, Ulla Høst,

Rasmus Kragh Jakobsen, Stine Overbye, Gorm Palmgren,

Lars Petersen, Ib Salomon, Lars Thomas

Editorial Interns Molika Ashford, Stuart Fox

Group Publisher Gregg R. Hano

Advertising Director Rich Rasor

Marketing Director Mike Gallic

Business Manager Connie Lau

Vice President, Corporate Sales and Marketing Pete Michalsky

Northeast Advertising Office: Alex DeSanctis 212-779-5129,

Chris Young 212-779-5148, Taryn Young 212-779-5030

Executive Assistant Christopher Graves

Midwest Advertising Office:

Manager John Marquardt 312-252-2838

Ad Assistant Krissy Van Rossum

Los Angeles Advertising Office:

Manager Robert Hoeck 310-227-8958

Ad Assistant Kate Gregory

Detroit Advertising Office:

Manager Edward A. Bartley 248-282-5545

Ad Assistant Diane Pahl

San Francisco Advertising Office: Jill Stankoski 415-925-6600, ext. 107

Southern Regional Advertising Office:

Manager Jason A. Alba 404-892-0760

Direct Response Sales Josh Condon 212-779-5580,

Michelle Mascioli 212-779-5007

Digital Sales Development Manager Brian Glaser

Sales Development Managers Kerri Levine, Alexis Smith

Creative Services Director Mike Iadanza

Marketing Art Director Shawn Woznicki

Promotions Manager Eshonda Caraway

Advertising Coordinator Evelyn Negron

Consumer Marketing Director Bob Cohn

Associate Directors Thomas Mathew, Lauren Rosenblatt, Andrew Schulman

Sr. Planning Manager Randall J.D. Logan

New Business Manager Cliff Sabbag

Retention Manager Gayle Fisher

Single Copy Sales Director Vicki Weston

Publicity Manager Kendra Romagnola

Human Resources Manager Kim Putman

Production Manager Betty Dong

Group Production Director Laurel Kurnides

Prepress Manager José Medina

SCIENCE ILLUSTRATED DENMARK

Editor-in-Chief Jens E. Matthiesen

International Editor Christian Baekgaard

Art Director Hanne Bo

Picture Editors Allan Baggesø, Lisbeth Brännich, Peter Eberhardt

BONNIER CORPORATION

Chairman Jonas Bonnier

Chief Executive Officer Terry Snow

Chief Operating Officer Dan Altman

Chief Financial Officer Randall Koubeck

Vice President, Consumer Marketing Bruce Miller

Vice President, Production Lisa Earlywine

Vice President, E-Media Howard Roth

Vice President, Enterprises Systems Shawn Larson

Vice President, Human Resources Cathy Hertz

Vice President, Corporate Communications Dean Turcol

Brand Director John Miller

Publishing Consultant Martin S. Walker

Corporate Counsel Jeremy Thompson

SCIENCE ILLUSTRATED is published under license agreement with Bonnier Publications. Copyright 2008 Bonnier Publications, Copenhagen, Denmark.

For customer service, please e-mail us at scienceillustratedwebcs@palmcoast.com. You can also call 866-429-0139; outside the U.S., please call 386-597-4388. Or you may write Customer Service, P.O. Box 420235, Palm Coast, FL 32142-0235.

The Rising Sun.



What is time?

What is time keeping? Does it even matter?

The Swiss wants us to think it is all about erector sets and pretense. The Jewish tricked us into thinking time started when Jesus was circumcised and the Muslims suggest it all commenced when Muhammed escaped from Mecca. What planet are these people on? Time to snap out of it. Humanity came to somehow see themselves as superior to Earth. Not so, change is needed. It is not that hard, look to the universe, it is all there. Every day is a clean sheet, begin the change now. Procrastination is no longer an acceptable excuse.

Consider this, the YES watch is the only time keeper that reconnects the natural cycles of the sun and the moon with the constant ticking of hours, minutes and seconds. At a glance you see times for sunrise, sunset and solar high noon, plus times for moonrise, moonset and lunar phase for wherever you are.

Inspired by shamans, horologists and engineers, the YES watch enables time management capabilities not found in any other timepiece. The unique day and night display combined with the one 24-hour hand offers an intuitive read of time and your place in it. The watch also alerts you to solstices, equinoxes and cross-quarter dates, and predicts time and date for the next new and full moons through the year 2099.

This one of a kind watch also gives you month, date and day, week number and day of year, plus it has a 99 minute timer, 24-hour stopwatch with laptime, 999 day countdown, future date calculator and a backlight for nighttime viewing. It has been programmed for 583 cities worldwide, but can also be set by latitude, longitude, time zone and DST. The cases are made out of stainless steel or hypo-allergenic titanium and fitted with an anti-glare sapphire crystal. The metal bracelets have locking clasps. Leather and rubber straps, instruction manual and jewelers tools are included with all models. Our ladies watch collection starts at \$395.

We offer a two year warranty and a 30 day money back guarantee. To learn more and see the entire line visit our web site. For a list of retailers or a catalog call 858 729 0703, toll-free 877 YESWATCH, or e-mail your name and address to info@yeswatch.com.

www.yeswatch.com

Zulu
U106.4 \$845



yes

*time keeping the way it
was supposed to be*



Light Bright

With more than 160,000 low-power LED lights, Santa Monica's new free Ferris wheel is already more Earth-friendly than conventionally lit Ferris wheels. Additionally, the Pacific Wheel, which took its first turn in May, is among the world's first solar-powered Ferris wheels—the original Pacific Wheel, built in 1998 with traditional lightbulbs, was *the* first. Solar panels [foreground] collect rays by day to turn and light the wheel into the night. But if the sky clouds over during your ride, don't worry: The wheel can draw backup power from conventional energy sources.









Stick to It

Colorful balloon lumpfish grip equally festive party balloons at Tokyo's new Epson Shinagawa Aqua Stadium, home to more than 20,000 sea creatures in its aquarium. Known to the Japanese as *fûsen-uo*, the *Eumicrotremus pacificus* is native to the cold waters off the island of Hokkaido in northern Japan. The fish's underside features a sucking disk that allows it to withstand heavy currents by clinging to rocks on the seafloor.

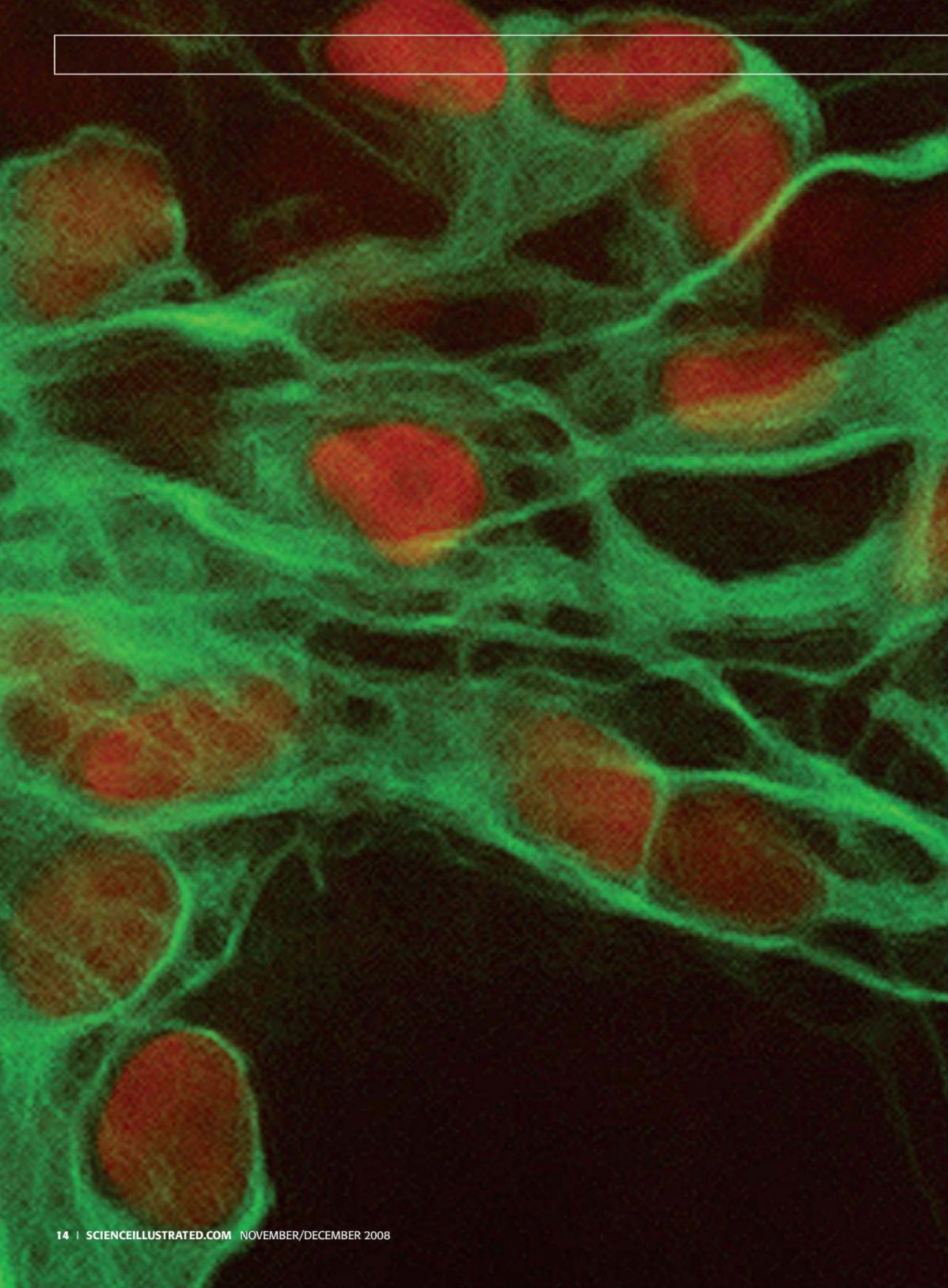






Salt of the Earth

At the Rui Simeão saltworks in southern Portugal, workers harvest high-end *flor de sal*, the “flower of salt,” prized for its sweet and creamy flavor. By far the world’s most expensive salt, *flor de sal* is produced only in Portugal and certain regions of France (where it is known as *fleur de sel*), using a technique that predates the Roman Empire. Evaporation yields salt crystals on the surface of the sea-salt bed, which are then scraped up with a traditional wooden rake. The salt is sun-dried and then packed after each day’s harvest [inset].





Homegrown Neurons

These nerve cells used to be something else. Scientists in a joint Harvard-Columbia University study began with skin cells from the forearms of patients with amyotrophic lateral sclerosis (ALS), or Lou Gehrig's disease. They reverted the cells back to stem cells, which they then grew into the types of neurons that are prone to developing the brain disease. Fluorescent dyes bind to proteins made by only certain types of cells, helping researchers track what's happening using a microscope. Green indicates nerve cells, while red specifically tags the subtype of nerve cells affected by ALS. The work offers a better understanding of the cell changes that lead to ALS, helps to screen drugs for treatment, and shows that the technology may be applicable to patients with other chronic degenerative diseases.



DISCOVER YOUR Universe

OPT has the largest selection of astronomy equipment on the planet. Whether it's an entry level computerized telescope or a complete robotic observatory, our experienced and knowledgeable sales staff can help. We've been in business for over 60 years, and helping astronomy customers since 1980!



OPT

www.optcorp.com/si

800-338-9638



P. 18
*Stars forming
in surprising
places*



P. 22
*Roach vs.
wasp? Wasp,
by a long shot*



P. 23
*The secret to
age-proof
Mayan paint*

Hydrophones Reveal Clues to Humpback Language

Scientists eavesdrop on whale noises to decode communication

*Grunts, squeals
and bubbles may
hold the secret
to humpbackese.*



BIOLOGY Adult humpback whale “songs” have fascinated scientists since their patterns were recognized four decades ago. But it’s not just the grown-ups making all the ruckus. Thanks to new technology—and good old-fashioned face time—researchers have discovered that humpback calves make sounds to communicate with their mothers.

Scientists at the Cetos Research Organization in Oakland, California, designed

a means of detecting whale sounds in the waters off Maui and Kauai, Hawaii. Researchers placed two hydrophones at different distances from a group of whales and timed the sounds. The angle of the sound waves, plus video footage, confirmed that calves were making the noises.

As for what the little ones were saying, underwater interaction with the whales shed some light. When the calves approached divers holding hydrophones, the

whales sometimes emitted a low grunt, then a squeal. Here, the calves did not swim away from the divers, and the mothers did not try to protect their young. The sounds may indicate curiosity, says Cetos director Ann Zoidis. In other cases, calves made several low grunts in a row and blew bubbles, which caused the mother to surface and lead the calves away. Grunts followed by bubbles may express something similar to alarm, Zoidis says.



FLASH! Researchers at the University of California at Davis recently discovered that two species of squirrels—the California ground squirrel and the rock squirrel—have a unique way of keeping rattlesnakes away. The squirrels chew up molted snakeskin and then lick their fur, imparting the reptile's scent onto themselves. They also pick up the snake's odor from surfaces where snakes have been resting. Researchers think this masks the squirrel's own odor, which the snakes use to hunt them.



Adding an extra copy of the SUN gene made round tomatoes grow long.

How Tomatoes Get Their Shape

Genetic engineers create surprisingly shaped fruit

BOTANY Tomatoes come in more shapes than most other fruits—oval, round, pear-shaped or even elongated like a chili pepper. Scientists may have recently found one reason for the variety: an extra copy of a gene called SUN seems to trigger elongation.

Earlier this year, crop scientists at Ohio State University found that two copies of the gene are present in elongated tomatoes, while other varieties have only one. To test their theory that SUN controls shape, the researchers cloned the gene and introduced an extra copy into wild tomato plants that typically produce round fruit,

and the resulting tomatoes were elongated. When the extra copy was removed, the fruit turned out round.

The researchers are now working on identifying other genes that contribute to tomato shape. The results may help scientists understand what controls the shape of other plants like peppers, cucumbers and gourds, says lead researcher Ester van der Knaap. Although farmers already create interesting shapes—square watermelons, for instance—using molds, they may one day plant fruit genetically designed for specific shapes to satisfy consumer appetite.



Previously undetectable stars are forming at the outskirts of galaxy M83.

Stellar Surprise

ASTRONOMY Regions in space long believed to be devoid of stars are actually teeming with them, according to new observations. A composite image of ultraviolet data from NASA's Galaxy Evolution Explorer (GALEX)—an orbiting space telescope whose mission is led by the California Institute of Technology—and radio data from the National Science Foundation's Very Large Array (VLA) in New Mexico shows early-generation stars forming at the extreme ends of M83, a galaxy 15 million light-years from Earth. Scientists previously thought that regions so far from a galaxy's center were almost devoid of the matter necessary for star formation.

The VLA, however, detected considerable matter in the form of hydrogen atoms (stars' raw ingredients) in the same area that GALEX picked up the stars. Astronomers believe that these gaseous stars may resemble those in the early universe, and the discovery may allow them to observe more hard-to-detect early-generation stars.

FROM TOP: COURTESY OHIO STATE UNIVERSITY; NASA

The Bose® QuietComfort® 2 Acoustic Noise Cancelling® Headphones.

Think of them as a peaceful getaway from the world around you. Whether it's the engine roar inside an airplane



cabin, the bustle of the city or the distractions in the office, Bose QuietComfort 2 headphones help them fade softly into the background with the flick of a switch. You can savor delicate musical

nuances without disturbing others. And when you're not listening to music, you can slip into a tranquil haven – where you can relax and enjoy peace and solitude. Clearly, these are no ordinary headphones. It's no exaggeration to say they're one of those things you have to experience to believe.

"It's as if someone behind your back reached out, found the volume control for the world, and turned it way, way, down," reports *TechnologyReview.com*. Bose QC®2 headphones incorporate patented technology that electronically identifies and dramatically reduces noise, while faithfully preserving the music, movie dialogue or tranquility you desire. We designed these headphones primarily for airplane travelers. But owners soon started telling us how much they enjoy using them in other places to reduce distractions around them. They're excellent for listening to music whether you're on the go, at home or in the office.

"Forget 'concertlike' comparisons; you'll think you're onstage with the band." That's what *Travel + Leisure Golf*



said when these headphones were first introduced. You'll relish the sound of a bass guitar. Or a flute. Or the delicate inflections of a singing voice. The audio is so clear you may find yourself discovering new subtleties in even your favorite music.

"The QuietComfort 2 lives up to its name, enveloping you in blissful sound in the utmost comfort. It's easy to forget they are on your head." That's what respected



columnist Rich Warren reports. To enjoy peace and tranquility, simply turn them on. To add Bose quality sound, attach the included audio cord and connect them to a laptop computer, portable CD/DVD/MP3 player, in-flight audio system or home stereo. They also offer a fold-flat design for easy storage in the slim carrying case.

**Use them as a
concert hall – or a
sanctuary.**

**Try the QC2 headphones
for yourself, risk free.**

You really must experience them to believe it. Call toll free to try these headphones for 30 days. Use them on your next trip, in your home or at the office – satisfaction guaranteed. If you aren't delighted, simply return them for a full refund.

**Call 1-800-901-0256, ext. Q6778
today.** The QC2 headphones are available

directly from Bose – the most respected name in sound. When you call, ask about making 12 easy payments, with no interest charges from Bose.* And discover a very different kind of headphone – QuietComfort 2 Acoustic Noise Cancelling headphones.

**FREE
shipping
with your
order.**

To order or learn more:

1-800-901-0256, ext. Q6778
www.Bose.com/QC

BOSE®
Better sound through research®

*Bose payment plan available on orders of \$299-\$1500 paid by major credit card. Separate financing options may be available for select products. See website for details. Down payment is 1/12 the product price plus applicable tax and shipping charges, charged when your order is shipped. Then, your credit card will be billed for 11 equal monthly installments beginning approximately one month from the date your order is shipped, with 0% APR and no interest charges from Bose. Credit card rules and interest may apply. U.S. residents only. Limit one active financing program per customer. ©2008 Bose Corporation. Patent rights issued and/or pending. The distinctive design of the headphone oval ring is a trademark of Bose Corporation. Financing and free shipping offer not to be combined with other offers or applied to previous purchases, and subject to change without notice. Risk free refers to 30-day trial only and does not include return shipping. Delivery is subject to product availability. Quotes reprinted with permission: *Simon Garfinkel, TechnologyReview.com, 7/9/03; Travel + Leisure Golf, 7/03; Rich Warren, News-Gazette, 5/19/03.*



Good Greenhouse Gas

A new device turns carbon dioxide into fuel and plastic

TECHNOLOGY A new process is on the horizon that may provide an answer to Earth's growing carbon dioxide problem: Turn it into fuel.

When CO_2 loses one of its oxygen atoms, it becomes carbon monoxide (CO), an ingredient in a type of fuel called synthesis gas, or syngas. Syngas is made through a reaction between CO and hydrogen, and can be converted to gasoline, diesel or jet fuel or used as a raw material for plastics.

Removing the oxygen from CO_2 is as simple as heating the gas to 4,352°F, when it spontaneously breaks up into CO and

oxygen. Trouble is, the large amounts of energy required make the process costly. Now, Sandia National Laboratories has developed an affordable solar-powered system that can pull apart CO_2 at a much cooler 2,732°F.

The prototype, called the Counter Rotating Ring Receiver Reactor Recuperator, or CR5, uses a large mirrored dish to capture solar energy in a two-chambered device. That energy heats rings made from a ceramic material called cobalt ferrite to 2,732°F, at which point the rings release oxygen molecules without losing their

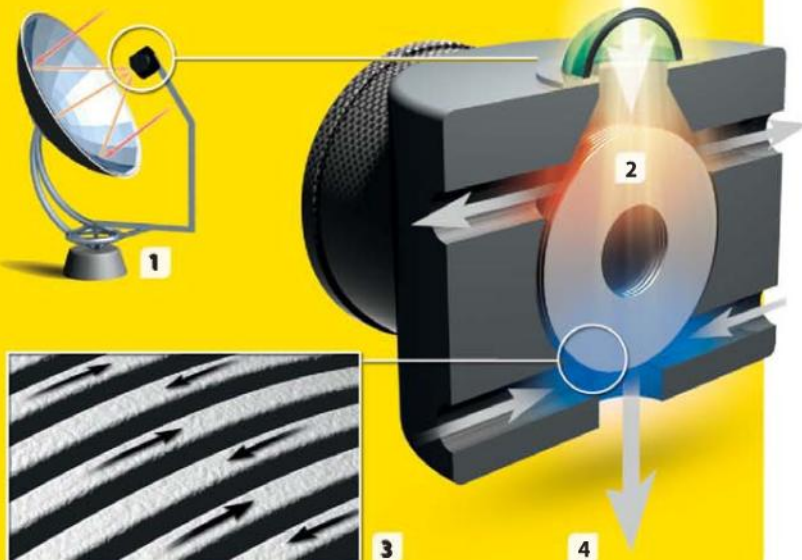
structural integrity. The rings then move to the second chamber where they are bathed in CO_2 , which cools them to 2,012°F. At this temperature, the rings strip the CO_2 of one oxygen molecule to replace those it lost, resulting in CO.

Don't expect CR5 to solve our carbon dilemma anytime soon, though: The technology is at least 15 to 20 years away from market, says Ellen B. Stechel, the manager of Sandia's Fuels and Energy Transitions Department. Eventually, the CO_2 could be collected directly from a source—a coal plant, for example—and pumped through the CR5 in real time. The gas could also be stored in large tanks in a liquefied form to be pumped into the CR5 later. Future prototypes may also use stored thermal energy as a backup to solar energy on cloudy days.

Splitting CO_2

The CR5 system uses solar energy to remove oxygen atoms from carbon dioxide to make fuel. Here's how.

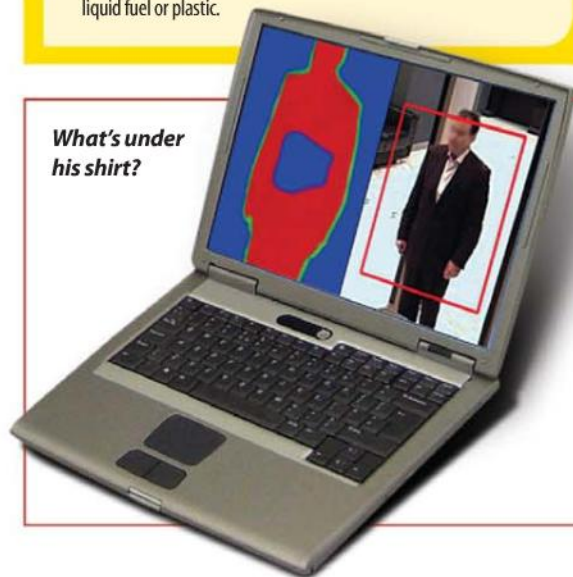
1. A parabolic mirror focuses sunlight on the reactor. The rays hit rotating ceramic rings.
2. The top half of the rings are heated to 2,732°F by the sunlight. At this temperature, the ceramic releases some of its own oxygen molecules.
3. As the heated rings rotate to the bottom of the reactor, their temperature falls to 2,012°F as they are cooled by a continuous bath of CO_2 . Each ring rotates in the opposite direction of those directly next to it [inset], which helps the rings heat and cool efficiently.
4. At 2,012°F, the ceramic strips the CO_2 of oxygen to replace what was lost during the heating process. The resulting carbon monoxide is later combined with hydrogen to form the base of liquid fuel or plastic.



What's under his shirt?

A Better Bomb Detector

TECHNOLOGY Those agonizing security lines at the airport may soon be a thing of the past. A new scanner from British company ThruVision spots weapons hidden under clothing from a distance of up to 82 feet. The system analyzes so-called T-rays—radiation with frequencies in the terahertz range—which are emitted by all objects, each with its own specific frequency. The scanner can passively pick up the radiation signature of explosives, liquids, narcotics, weapons, plastics and ceramics without revealing body details. The technology is being marketed to large sporting arenas, checkpoint-control installations and international airports to allow for a wider range of scanning than is currently possible with conventional detectors and to prevent bottlenecks of crowds at security.





SmartShedding[®] Technology

Allows the master outlet to sense when your computer has either been turned off or has gone into sleep mode, so it can shut off power to peripherals plugged into the controlled outlets—saving you power and money.

Your data should last forever. And so should our planet.

Save \$40* a year on your electric bill with the most efficient battery backup yet.

Let's protect what's important

What's in your computer? Photos, music, personal files, financial data, broadband access, videos, and more. Your computer has never been more important, and yet it has never been at higher risk for damaging power surges and other disturbances.

So like most people, you need to protect your assets. But like most people, you'd also like to protect the environment. With our new energy conscious products, you can do both. Energy efficient by design, our new smart products protect the power going in your computer, at a cost that is quickly offset by big energy savings. How? Not only do the new Back-UPS ES[®] and SurgeArrest[®] use power very wisely, they also boast a master/controlled outlets feature, which automatically powers down idle devices to conserve energy.

APC power protection products are available at:



that was easy

PC Connection



"The price tag on the new UPS is \$99. While I'm not in the habit of endorsing products in this blog, if you're in the market for a workstation-class UPS, why not opt for the greener option?"

- Heather Clancy,
ZDNet.com

In fact, while protecting your power supply, we're up to 5 times more energy efficient than any other solution. By saving you \$40 a year in energy costs, our Back-UPS ES pays for itself in 2 short years. The high frequency, low copper design has a smaller transformer and environmental footprint. Even the packaging has been carefully selected and manufactured to maximize use of recycled materials and minimize waste.

In this world, every decision you make counts. So protect your power with a battery backup that works to protect the environment. It conserves power, it pays for itself, and it's backed by APC's 20-plus years of Legendary Reliability[®]. For more information on this or our other great products, or for information about environmentally responsible disposal of your old battery, visit www.apc.com



Energy efficient solutions for every level of protection:

Save \$25 per year* on your electric bill!

Surge Protection

Starting at \$34

Guaranteed protection from surges, spikes, and lightning.

7 outlets, Phone/Fax/Modem Protection, Master/Controlled Outlets



Save \$40 per year* on your electric bill!

Battery Back-UPS[®]

Starting at \$99

Our most energy efficient backup for home computers.

10 outlets, DSL and Coax protection, Master/Controlled Outlets, High Frequency Design, 70 minutes of runtime¹



APC can help with your other power protection needs. Visit apc.com to see our complete line of innovative products.



Enter to Win a Back-UPS[®] ES 750G! (a \$99 Value)

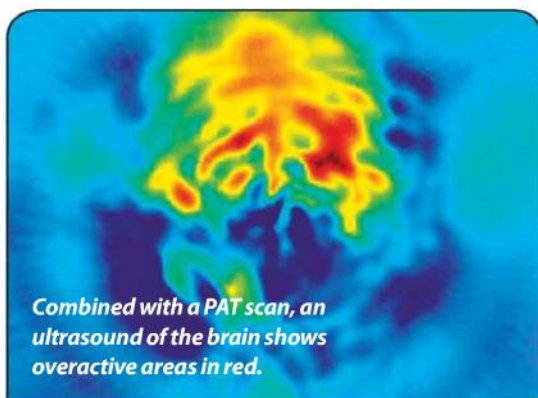
Also, enter keycode to view other special offers and discounts.

Visit www.apc.com/promo Key Code e404w or Call 888.289.APC x8076 or Fax 401.788.2797

APC
Legendary Reliability[®]

©2008 American Power Conversion Corporation. All trademarks are owned by Schneider Electric Industries S.A.S., American Power Conversion Corporation or their affiliated companies.
e-mail: esupport@apc.com • 132 Fairgrounds Road, West Kingston, RI 02892 USA • 998-0968 ¹Runtimes may vary depending on load.

*Average savings are based on comparable competitive models, and are comprised of two energy saving features: An ultra efficient electrical design, and the master/controlled outlets feature.



Combined with a PAT scan, an ultrasound of the brain shows overactive areas in red.

Epilepsy on the Brain

A new test helps treat seizures

MEDICINE About one third of people with epilepsy do not respond to drugs, and may need surgery to remove the overactive brain regions responsible for their seizures. To locate the diseased parts, doctors often implant electrodes directly on the surface of the brain during electroencephalography (EEG) or use scans like magnetic-resonance imaging (MRI). But now there may be a better way.

Researchers at the University of Florida recently used a technique called laser-induced photoacoustic tomography (PAT) to locate overactive areas in rat brains. PAT uses a laser to penetrate the skull without cutting flesh. When the laser strikes brain tissue, the light causes small vibrations detectable with an ultrasound. The overactive parts of the brain absorb the most light, and so they vibrate more.

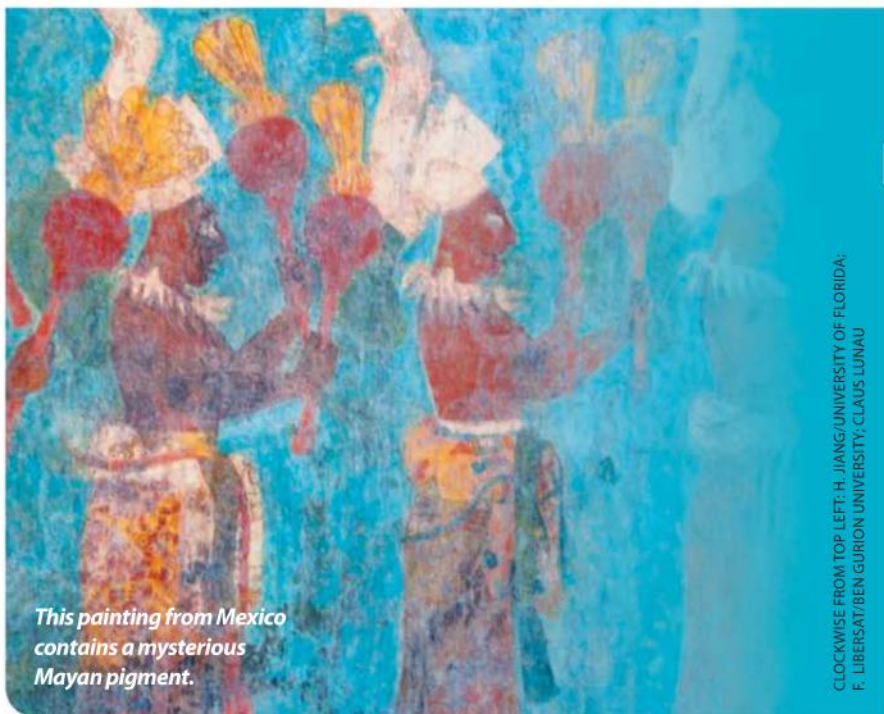
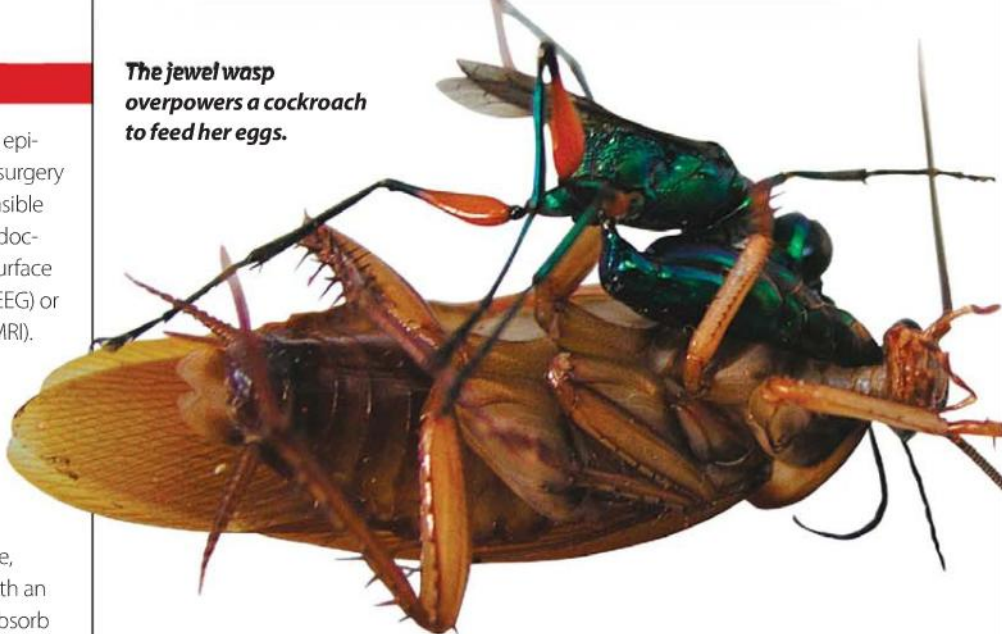
PAT technology offers better resolution than other brain-imaging techniques and can clearly locate the overactive areas, making surgery more successful. PAT is far less invasive than implanting electrodes, which is usually done again after surgery to see if the overactive areas were completely removed or have grown back. The test takes seconds, versus several minutes for MRI and other scans, and can be done bedside—an advantage for patients who aren't easily moved or who might not be able to sit still. Researchers are at work on a laser that can generate the vibrations through a thick human skull.

FLASH! European researchers recently detected carbon-13 in 4.25-billion-year-old diamonds. Small amounts of $c-13$ usually indicate organic material, so the ancient gems—the oldest diamonds ever found—might hold proof of life on Earth far earlier than 3.5 billion years ago, the current best guess.

How to Wrestle a Roach

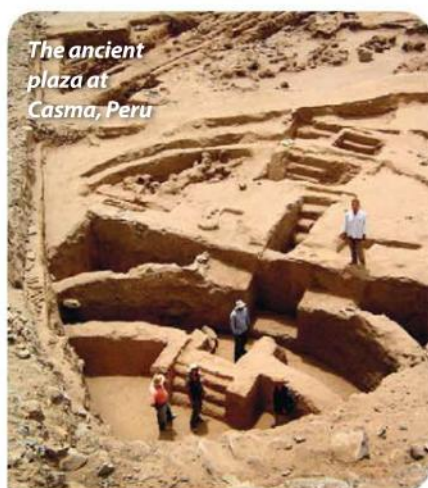
BIOLOGY With a sting, the jewel wasp can paralyze a cockroach, which the wasp then uses as food for its offspring. Israeli scientists recently revealed just how this vicious process works when they discovered that the wasp actually stings the cockroach twice. A first sting to the thorax debilitates the roach's front legs, allowing the wasp enough time to sting the head. This second sting blocks a brain chemical that regulates movement. The wasp then takes the cockroach by the antennae and leads it—like a dog on a leash—to an ideal spot. There the wasp lays its eggs on the roach's belly. When the eggs hatch, the wasp larva burrow into the roach's abdomen and devour its internal organs, eating the roach alive over the course of a week. Even for a cockroach, it's a sad way to go.

The jewel wasp overpowers a cockroach to feed her eggs.



This painting from Mexico contains a mysterious Mayan pigment.

CLOCKWISE FROM TOP LEFT: H. JIANG/UNIVERSITY OF FLORIDA; F. LIBERSAT/BEN GURION UNIVERSITY; CLAUS LUNAU



The ancient plaza at Casma, Peru

The New Oldest American Structure

ARCHAEOLOGY German and Peruvian scientists have unearthed what may be the oldest man-made structure ever found in the Americas. Carbon dating revealed that the plaza, found in the northern Peruvian city of Casma, is 5,500 years old. That predates an ancient city in Caral, Peru, previously believed to be the oldest structure in the Americas, by 500 years.

The archaeologists also discovered four or five other plazas beneath this one, which they think may be even older.

Not-so-Camouflaged Chameleons

This reptile changes color to communicate

BIOLOGY Chameleons and camouflage go hand in hand, right? Wrong, according to observations of 21 species of southern African dwarf chameleons—the first research to study *why* the lizards change colors. Scientists at the University of Witwatersrand in South Africa and the University of Melbourne in Australia used a spectrometer to measure the range of color changes male chameleons display.

The researchers then used computer modeling to approximate chameleon vision. They found a correlation between the colors that a species can see and the colors the species display, which means

chameleons may use their coloration to communicate with one another.

The scientists also compared the color changes with the colors of the animals' habitats. The displays made the chameleons stand out against their habitat rather than blend in. According to more computer modeling, predatory birds could also detect the changes, indicating that the chameleons actually put themselves at risk by taking on new hues. Although many chameleon species change colors for camouflage, now we know that some, like the southern African dwarf, may use the ability specifically for social signaling.



To read more on animal camouflage, see page 54.

How Mayans Made Blue Paint

A pot discovered more than a century ago reveals the secret to the Mayans' durable pigment

ANTHROPOLOGY The Mayans are known for their bright blue paint, but scientists have long pondered the ingredients for the pigment, which is astonishingly resistant to age, acid, weathering, biodegradation and even modern chemical solvents. The paint, first discovered in 1931, is known to be made by combining indigo, a blue vegetable dye from leaves, and palygorskite, a white clay mineral. The mystery was what method the Mayans, who ruled Central America from A.D. 250 to 900, used to fuse the dye and clay together. Now a research team from the Field Museum in Chicago has uncovered it.

Scientists recently analyzed a three-footed clay bowl found in 1904 in a well in the Mayan ruins of Chichén Itzá in modern-day Mexico. (The bowl has been at the Field Museum since its discovery but was never analyzed until now.) It contains incense made from copal, a tree resin the Mayans used for ritual and medicinal purposes, as well as small white and blue fragments, which showed signatures for palygorskite and indigo. Based on this find, the researchers concluded that the burning of a mixture of copal, indigo and clay brought the temperature up to 302° to 392°F. The dye's molecules are then incorporated into pa-

lygorskite, stabilizing the color—the key to why Maya Blue is so long-lasting. The resilience of the color makes it one of the great technological and artistic achievements of pre-Columbian Mesoamerican culture.



Blue and white colors are visible in this ancient pot containing copal incense.





*This horned toad of the genus *Proceratophrys* was recently discovered in Brazil.*

Fourteen New Species Discovered

Brazilian scientists report surprising animal finds

BIOLOGY The Cerrado region of Brazil is living up to its classification as one of the world's top biodiversity hotspots, areas singled out by conservationists for a great variety of life. During a recent monthlong expedition to a nature reserve in the region, scientists discovered 14 previously unknown animals.

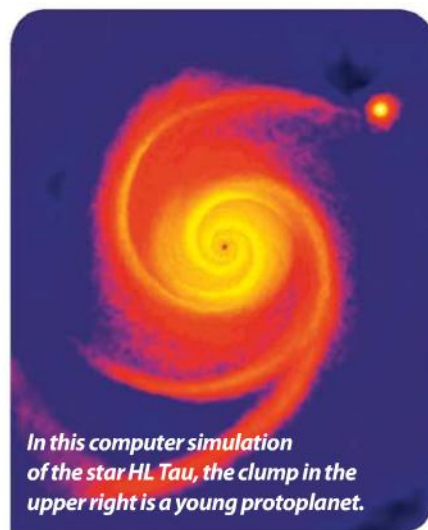
The most fascinating find may be a legless lizard, which has the characteristic eyelids and external ears of a lizard but is missing limbs and a pointed snout. The animal resembles a snake in appearance and in its slithering movements, researchers say. The scientific team, which consisted of 26 zoologists from various universities in Brazil, also found eight new fish, a horned toad, two reptiles, a tiny woodpecker and even one mammal: a fat-tailed mouse opossum.



■ Cerrado region

The Cerrado region's wooded grasslands once covered an area half the size of Europe, but it is now being converted to cropland and ranchland, and the original animal and plant life is disappearing at an alarming rate. All of the newly discovered species were found in the Serra Geral do Tocantins Ecological Station, a 1.8-million-acre protected nature preserve within the region.

The legless lizard looks and moves like a snake.



*In this computer simulation of the star *HL Tau*, the clump in the upper right is a young protoplanet.*

Baby Planet Found

ASTRONOMY The distant constellation Taurus is home to the youngest planet ever found, say astronomers at the University of St. Andrews in Scotland. For now, the object, which is 14 times the size of Jupiter, is a protoplanet—a disk of gas and dust in the very early stages of planetary development.

The recent discovery is in orbit around HL Tau, a star that is probably no more than 100,000 years old. Since a planet can form only after the birth of its star, this protoplanet cannot be older—and scientists believe that it may in fact be much younger. A second star may have passed by HL Tau around 1,600 years ago, and the flyby could have triggered the formation of the protoplanet, known as HL Tau b.

Regardless of whether the planet is 1,600 or 100,000 years old, it's still considered a newborn. The youngest planet previously known, TW Hya b, in the constellation Hydra, is 10 million years old. Observing the planet at such an early stage may shed new light on the hotly debated processes behind planet formation, researchers say.

FLASH! A new bandage developed by a company in England contains a chip and sensors to monitor the wearer's temperature, blood glucose and other conditions after being discharged from a hospital. It transmits the information to a base station that keeps an electronic record, which can be downloaded by a doctor or nurse.

Order today and Save \$100s!

Rare Hoard of 100-Year-Old U.S. Gold Coins Released to Public

HISTORIC U.S. GOLD ON SALE

Just discovered hoard of U.S. \$10 Gold Liberty Coins Now Available

Our buyers just discovered one of the most significant European Bank hoards of U.S. gold in years. They secured 1,769 magnificent U.S. gold coins guaranteed to be over 100 years old. The vintage coins in this hoard represent dates ranging from 1866 through 1907 that uniquely represent the history of our nation in fine gold.

Uncirculated Gold Coins from the Past are Timeless Treasures

Each of these \$10 Gold Liberty coins is certified in Uncirculated Condition. As gold values have soared with unpredictable oil prices and the falling dollar, you may never again have the opportunity to own these gold coins at this price.

With the falling dollar, demand for these coins continues to escalate as collectors and investors scramble to scoop up U.S. gold coins for their pure gold content and scarcity.

Certified genuine uncirculated U.S. gold coins have historical and numismatic value that bullion gold cannot match, making these coins even more attractive.



*Shown larger than actual size
of 27 mm in diameter*

As low as
\$595 ea.

**Don't Miss
This Opportunity:
Order Now!**

Consider that the number of U.S. coin collectors has sharply risen to over 50 million today, you may never get a second chance to take advantage of this opportunity. Order now while our limited supplies last. Buy more and save! Due to our limited supply of these coins, we must issue a strict limit of 10 coins per customer. Why pay \$599 or more for similar coins? Prices and orders subject to availability, so call today. Your satisfaction is assured by our 30-day money-back guarantee.

Order More & Save

	\$ per coin	shipping	total
1 Liberty Coin	\$649	\$15 S&H	\$664
3 Liberty Coins	\$635	FREE!	\$1,905
5 Liberty Coins	\$619	FREE!	\$3,095
10 Liberty Coins	\$595	FREE!	\$5,950

Call Toll-Free:

1-800-585-9240 ext. 2258

New York Mint, 5577 W 78th St., Edina, MN 55439
Not affiliated with the U.S. Government

EXERCISE IN EXACTLY 4 MINUTES PER DAY

Winner of the Popular Science Award for the
"Best of What's New" in Leisure Products



\$14,615



ROM • MANUFACTURED IN CALIFORNIA SINCE 1990

TIME IS IT. Over 92% of people who own exercise equipment and 88% of people who own health club memberships do not exercise. A 4 minute complete workout is no longer hard to believe for all the people who since 1990 have bought our excellent Range of Motion machine (ROM).

Over 97% of people who rent our ROM for 30 days wind up purchasing it based upon the health benefits experienced during that tryout, and the ROM performance score at the end of each 4 minute workout that tells the story of health and fitness improvement.

If you value your time at more than \$5 an hour, the ROM machine is the least expensive method of exercise for you.

The ROM 4 minute workout is for people from 10 to over 100 years old and highly trained athletes as well. The ROM adapts its resistance every second during the workout to exactly match the user's ability to perform work. It helps to balance blood sugar,

and improves bad backs and shoulders.

Too good to be true? Get our free video and see for yourself. The best proof for us is that 97% of rentals become sales. Please visit our website at: www.FastExercise.com.

The typical ROM purchaser goes through several stages:

1. Total disbelief that the ROM can do all this in only 4 minutes.
 2. Rhetorical (and sometimes hostile) questioning and ridicule.
 3. Reading the ROM literature and reluctantly understanding it.
 4. Taking a leap of faith and renting a ROM for 30 days.
 5. Being highly impressed by the results and purchasing a ROM.
 6. Becoming a ROM enthusiast and trying to persuade friends.
 7. Being ignored and ridiculed by the friends who think you've lost your mind.
 8. After a year of using the ROM your friends admiring your good shape.
 9. You telling them (again) that you only exercise those 4 minutes per day.
 10. Those friends reluctantly renting the ROM for a 30 day trial.
- Then the above cycle repeats from point 5 on down.

The more we tell people about the ROM the less they believe it.

From 4 minutes on the ROM you get the same results as from 20 to 45 minutes aerobic exercise (jogging, running, etc.) for cardio and respiratory benefits, plus 45 minutes weight training for muscle tone and strength, plus 20 minutes stretching exercise for limberness/flexibility.

Order a **FREE** DVD from www.FastExercise.com or call (818) 504-6450

Factory Showroom: **ROMFAB**, 8137 Lankershim Blvd., North Hollywood, CA 91605

Fax: (818) 301-0319 • Email: sales@FastExercise.com

RENT A ROM FOR 30 DAYS. RENTAL APPLIES TO PURCHASE.

Ask Us



P. 29 When did childhood illnesses emerge?



P. 30 How do turtles flip onto their backs?



P. 33 What is the safest way to put out a grease fire?

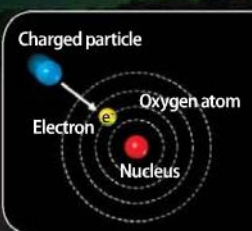
What gives the northern lights their colors?

At extreme latitudes, particles from the sun hit oxygen atoms in the atmosphere, producing a multicolored glow.

When a **charged** particle (an electron or proton) collides with atoms or molecules in the Earth's atmosphere, the particle transfers some of its energy to the molecule, electronically exciting it. The excited molecule then releases this excess energy as light—and different atomic species create different colors. If a nitrogen atom is hit, for example, it produces red or bluish light, while oxygen atoms produce green or red. The colors in the aurora borealis, or northern lights (and the aurora australis near the South Pole), depend on which chemical species in the upper atmosphere is excited by particles from the solar wind. In the end, the aurora is a mixture of these colors, and often appears to the eye as a greenish white glow.

Green Means Oxygen

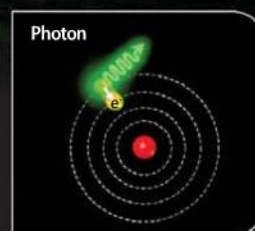
The lights have varied colors, depending on which atoms or molecules the charged particles from the sun hit. Here, green light is produced by oxygen atoms.



1. A charged particle from the sun collides with one of the oxygen atoms in the Earth's atmosphere.



2. Part of the particle's energy is absorbed by the oxygen atom.



3. The excess energy is released, and light is emitted—in this case appearing green.

Why does a tight rubber band around your wrist leave an indentation?

Since **skin is** mostly water, the pressure of the band causes the fluids to squeeze out to the sides, leaving a dent in the tissue. Also, blood flow to the area is reduced as the vessels are constricted. When the band is removed, the fluids begin to flow back to the

area and the indentation disappears.

If pressure on skin is maintained over time, as with patients confined to a bed or wheelchair, pressure sores, or bedsores, can form. The compressed tissue is deprived of oxygen and nutrients, causing cells to die.

DID ANCIENT ROMANS WRITE FRACTIONS?

Roman numerals were not designed for writing fractions. Often, Romans just wrote out the word for the fraction they wanted to express. They did have symbols for some commonly used fractions, however, including the *uncia* ($\frac{1}{12}$) and *semis* ($\frac{1}{2}$).

THE ULTIMATE IN OPTICS SHOPPING: www.adorama.com

14 Day Money Back GUARANTEE Please check our website for details

FREE
Shipping
ON THOUSANDS
OF PRODUCTS
SEE OUR WEB SITE



NEXSTAR 130 SLT

130mm (5.1") diameter
Newtonian Reflector
Telescope with Motorized
Altazimuth Mount & 4,000+
Object Database



SKYSCOUT

A fun learning tool
for all ages, the SkyScout
personal planetarium puts the
knowledge of an expert astronomer
in the palm of your hand.
Item Includes: Carry Case,
Earphones, Hand Strap, USB Cable



Nikon

D90

- 12.3-megapixel DX-format CMOS imaging sensor
- 5.8x AF-S DX NIKKOR 18-105mm f/3.5-5.6G ED VR included
- Continuous shooting as fast as 4.5 frames-per-second
- D-Movie Mode • 3-inch super-density 920,000-dot color LCD monitor • Built-in image sensor cleaning
- 11-point AF system with Face Priority
- One-button Live View



ETX-125PE 5"

1900mm Focal Length
Premiere Edition Maksutov-
Cassegrain Telescope with
UHTC BLUE TUBE,
Motorized Altazimuth Mount,
Autostar Computerized
Controller & Tripod



MYSKY HAND-HELD AUDIO/VIDEO SKY GUIDE WITH GPS

The Meade mySKY is an
easy-to-use multi-media device
that will guide you through the
night sky better than if you had
your own private astronomer
standing next to you.



Nikon

MONARCH

8 x 42 Monarch,
Water Proof & Rubber
Armored Roof Prism Binocular
with 6.3 Degree Angle
of View, U.S.A



TRIPODS & HEADS

SPOTTING SCOPES

FLASHPOINT

CARBON FIBER TRIPODS EXCLUSIVELY AT ADORAMA.COM

ALL THE FEATURES OF A HIGH-PRICED
CARBON FIBER TRIPOD WITHOUT THE HIGH PRICE

Flashpoint tripods feature European styling. They open and close
with ease and have leg locks that really lock solid.
Legs are multi-positionable and with the low center column,

Tripods Shown
w/Optional Head



Bushnell

TROPHY 65MM

Waterproof & Rubber Armored
Straight View Spotting Scope
with 20-60x Zoom Eyepiece,
Tripod & 2 Cases.



FLASHPOINT

F-1 MAGNESIUM ALLOY TRIPOD BALL HEAD WITH QUICK RELEASE,

Flashpoint Ball Heads feature smooth operational
movement and positive locking. Made of magnesium alloy, they are
30% lighter than standard materials and that's
a real savings for photographers on the go



SOLAR POWER

Brunton

SOLARIS 6 WATT FOLDABLE SOLAR ARRAY

The next generation of Solaris foldable-solar-
technology is here. The Solaris 6 are the most
compact models in Brunton line. CIGS technology maxi-
mizes performance while optimizing portability.



ADORAMA

MACRO FOCUSING RAIL SET

Where critical focusing is desired

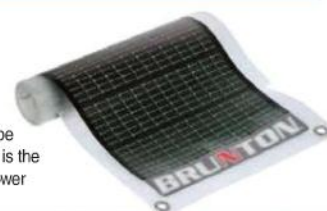
- A must for macro photography. Constructed of all metal parts
- Moves in 4 directions : forward, backward, right and left
- Engraved scale • Fine focusing knob for precision accuracy
- Can be used with any tripod.



Brunton

9 WATT SOLARROLL FLEXIBLE SOLAR MODULE

The SolarRoll quickly rolls up into an included tube
for easy packing and storage. Simply stated, this is the
item to bring along if you need ample, reliable power
without extra weight or bulk.



MICROSCOPES



EPIX DIGITAL ZOOM

ePix Digital Zoom (26x-130x)
Microscope with Integrated Camera



BIOLOGICAL MICROSCOPE

with Built-in Digital Camera, 1600x Power,
LED Illuminated & USB Interface



MODEL 9260

Meade Model 9260
Microscope
with 51 Piece Kit



Customer Relations: 800-815-0702 • 212-741-0466
Mon-Thurs. 9-4:30, Fri. 9-1, EST
FAX # 212-463-7223

ADORAMA INC.
Source for the Educated Photographer

STORE: 212-675-6789
HOURS: Mon.-Thurs. 9-6:30pm
• Fri to 1:00 • Sun. 9:30-5:30





Measles is known to have existed at least 1,100 years ago.

When did childhood diseases arise?

Common childhood diseases like measles and chicken pox do not leave any traces, such as characteristic changes in bones, that we can find by examining skeletons. This means researchers do not know much about how widespread these illnesses were in the Middle Ages or earlier. But they do know that measles and smallpox existed by around A.D. 900, which is when ar-Razi, a Persian physician, wrote a description of the ailments. Considered by some to be the father of pediatrics, ar-Razi distinguished between the illnesses and described the symptoms of both.

HOW LARGE ARE THE BIGGEST BACTERIA?

Thiomargarita namibiensis, nicknamed the “sulfur pearl of Namibia,” is the largest bacteria that has ever been found. It can be up to one three-hundredth of an inch in diameter, which sounds small but is just large enough to be visible to the naked eye.

Why do Mentos cause soda geysers?

When you drop a Mentos candy into a two-liter bottle of pop, a soda fountain results. Here’s why: Soda is basically a solution of sugar, water, flavoring and carbon dioxide. (The process by which the carbon dioxide is added to the liquid is called carbonation.) Some of this carbon dioxide comes back out of the solution and forms the soda bubbles we know and love, and some of it stays suspended between water molecules. But you can make more of the carbon dioxide escape by providing a surface where the carbon dioxide molecules can congregate. An object (like a straw or a mint) added to the soda does the trick. A few carbon dioxide molecules bind to the surface of the object and, through a process called nucleation, aggregate more carbon dioxide until visible bubbles form. All those bubbles have nowhere to go but up—and out—taking the soda with them.

Bubbles will form around plenty of objects, including your finger, but Mentos mints are especially successful. No one knows exactly why, but scientists have made some guesses. The most common theory: It’s a combination of Mentos’ rough surface (which provides more nucleation sites than smoother objects) and the candy’s density (Mentos sink to the bottom of the soda bottle, causing a reaction all the way down).



Mentos’ rough surface [enlarged here] helps make this explosion happen.

How do turtles right themselves when flipped on their backs?

Turtles have developed techniques to turn over when they end up on their backs due to a fall or fight. The method they use to get out of this vulnerable position depends on the shape of each species' shell. Terrestrial turtles, including tortoises, often have high, domed shells that help protect

against predators. These shells come in handy when turtles end up on their backs. The dome shape makes the reptiles unstable in this position, so a simple bob of the head or legs can trigger a roll back onto the belly. Thanks to gravity, some turtles will even roll over without moving a muscle.

Most aquatic species have flat backs, though, and can't depend on their shells for help. Instead, they stick their necks out as far as possible. Then they press the back of their necks against the ground to roll onto their sides and tip themselves over into an upright position.

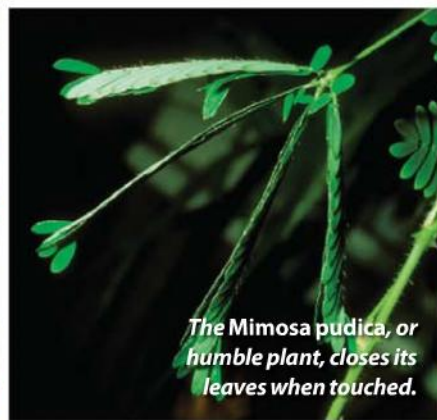
Flat-shelled turtles use their necks to right themselves.



Are galaxies still being created?

New research indicates that they are. Most major galaxies were created early in the universe's history, and for a long time, astronomers thought large galaxies like our 12-billion-year-old Milky Way were no longer being born. But recent discoveries suggest that the universe is still spawning large galaxies like our own. Since its launch in 2003, the Galaxy Evolution Explorer (GALEX) space telescope, a joint project of NASA and the California Institute of Technology, has spotted several galaxies that researchers believe to be as young as 100 million to one billion years.

How do some plants "move"?



The Mimosa pudica, or humble plant, closes its leaves when touched.

We normally associate movement with animals. But not all plants are as passive as they might appear. Some open and close each day, while others fold up when touched. Carl Linnaeus, the Swedish botanist, called these "sleep movements" in the 1700s, but today most botanists refer to them as nastic movements.

The process is controlled by turgor pressure (the pressure of fluid inside a cell) in an area called the pulvinus, the swelling or joint at the base of a leaf or stalk. The pulvinus has two parts. When cells in one part swell with fluid, cells in the other part shrink, causing the plant to close. The process is reversed when the plant needs to open.

Plants control the amount of liquid in the cells by changing their osmotic pressure—for example, by pumping potassium ions into a cell to increase its liquid content. The increased concentration of potassium ions causes water to diffuse through the porous cell membrane into the cell, causing the plant to either open or close.

Introducing the world's simplest cell phone experience – with service as low as \$10 a month*

It doesn't play games, take pictures,

NEW or give you the weather

**No
Contract**

The Jitterbug® developed with Samsung®.

It's the cell phone that's changing all the rules.

For people like me, who want a cell phone that's easy to use. Over the years, cell phones have become smaller and smaller with so many complicated features. They are harder to program and harder to use. But the Jitterbug® cell phone has simplified everything, so it's not only easy to use, it's easy to try. No crowded malls, no waiting in line, no confusing sales people, or complicated plans. Affordable and convenient cell phone service is only a toll-free phone call away.

*Questions about Jitterbug? Try our pre-recorded
Jitterbug Toll-Free Hotline 1-800-230-9045*

The new Jitterbug® cell phone makes calling simple!

- Large, bright, easy to see display and buttons
- Comes pre-programmed and ready to use right out of the box
- No contract required
- An operator is always available to help you, and will call you by name
- Push "Yes" to call directly from your personal phone list
- Soft ear cushion and louder volume for better sound quality
- Separate Volume Up/Down button on cover of phone
- Hearing aid compatible
- Familiar dial tone confirms service (no other cell phone has this)
- Service as low as \$10 a month*
- Access help wherever you go

Why pay for minutes you'll never use!		
	Simple 30 Plan†	Simple 60 Plan†
Monthly Price	\$15.00	\$20.00
Included Minutes/Month	30	60
Operator Assistance	24/7	24/7
911 Access	FREE	FREE
Long Distance Calls	No add'l charge	No add'l charge
Nationwide Coverage††	Yes	Yes
Trial Period	30 days	30 days

*Available in a simple
12-button Dial phone
and an even simpler
3-button OneTouch
phone for easy access
to the operator, the
number of your
choice, and 911.*



*12-button Dial Phone
available in
Graphite and White.*

Service as low as \$10 a month and a friendly 30-day return policy**. If you've ever wanted the security and convenience of a cell phone, but never wanted the fancy features and minutes you don't need... Jitterbug® is for you. Like me, you'll soon be telling your friends about Jitterbug®. Call now.

jitterbug brought to you by **firstSTREET**
for Boomers and Beyond®
1998 Ruffin Mill Road
Colonial Heights, VA 23834

Jitterbug® Cell Phone Item# BU-4722

Call now for our lowest price.

Please mention promotional code 37059.

1-866-540-0297

www.jitterbugdirect.com

IMPORTANT CONSUMER INFORMATION: Subject to Customer Agreement, select calling plans, and credit approval. Other charges and restrictions may apply. Screen images simulated. Coverage and service not available everywhere. Copyright © GreatCall, Inc. Jitterbug and GreatCall are trademarks of GreatCall, Inc. Samsung is a registered trademark of Samsung Electronics America, Inc and its related entities. *Not including government taxes, assessment surcharges, and set-up fee. **Applies to phone and monthly service charges only, provided call time usage is less than 30 minutes and phone is in like-new condition. Usage charges may apply. †All plans require the purchase of a Jitterbug phone. In addition, there is a one time set up fee of \$35. ††Jitterbug will work almost everywhere in the U.S. where cellular service is available from most of the major carriers.



100% Satisfaction Guaranteed

Better Hearing Made Easy

Get the world's first disposable hearing aid

If you or your loved one has mild to moderate hearing loss, the all-new Songbird® flexfit™ is the ideal solution. Easy and affordable, it offers a revolutionary alternative to costly traditional hearing aids. Use it only when you need it, just like reading glasses. Adjustable for a personal fit, it's perfect for those who want to improve hearing on their own terms—without sacrificing quality or comfort.

**ALL
NEW!**

**Improve your hearing without
hassle or major expense**

- Crystal-Clear Digital Sound Quality
- Lasts for 400 Hours of Active Use*
- No In-Office Fittings or Maintenance
- No Batteries to Replace
- Order from Home—by Phone or Online



Makes conversations clearer and more enjoyable

**You may not always need help hearing.
For the times you do, trust Songbird.**



Not available in stores

Try It Now Risk-Free†

Call 1-877-212-7329



Compact design
as shown in hand



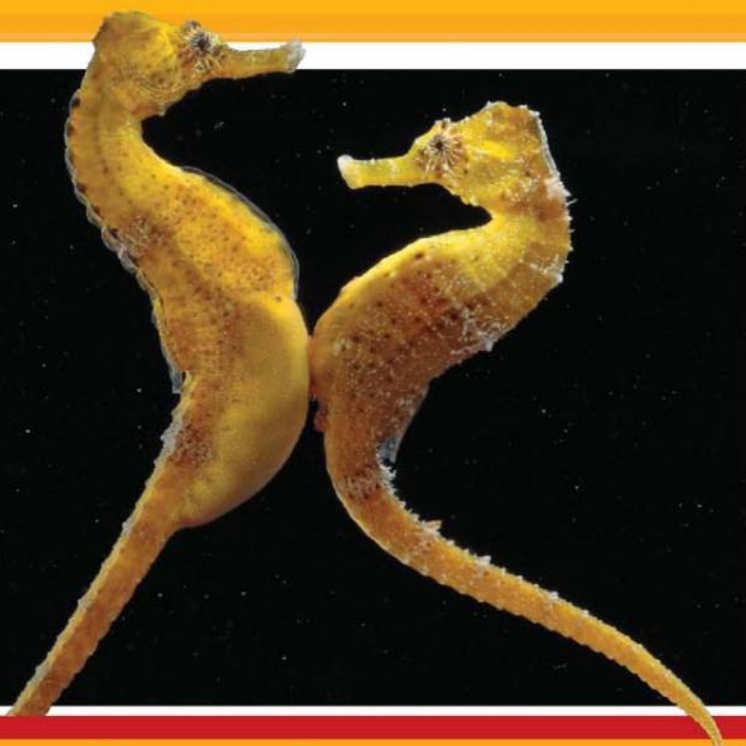
Product worn as shown—
hides discreetly behind the ear

*Under typical use patterns, battery lasts for 400 hours of active use (when turned on). Make sure to turn the device off when not in use to maximize battery life. †Less shipping and handling. The Songbird flexfit™ disposable hearing aid is for mild to moderate hearing loss. Not intended for use by anyone under 18 years of age. Hearing loss can be a symptom of a medically treatable condition. Consult your doctor prior to using any hearing aid. For more information call 1-800-789-1830.

PR07220835



Seahorse
lovin'

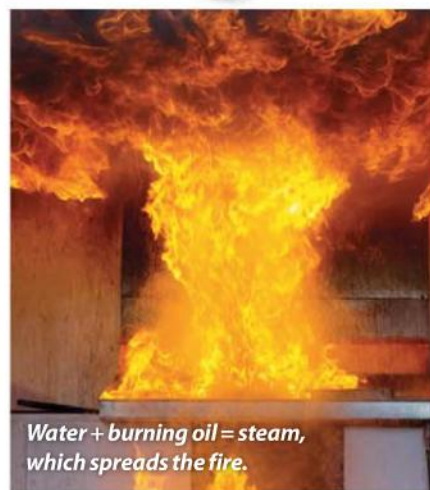


How do seahorses incubate their eggs?

Fish have widely varied methods of reproduction. Seahorses, perhaps the oddest fish, are among the most interesting reproducers of the group.

For many fish, the female lays a large quantity of eggs, which the male fertilizes. Both adults swim off, leaving the eggs to their fate, and most of the young become food for other animals. Some fish lay fewer eggs, which they tend to guard more carefully. Males usually stand watch.

Seahorses take this one step further, since it's the male that actually carries and nourishes the fertilized eggs. After an elaborate courtship dance, the female lays her eggs in a pouch on the front of the male's body, using a tube-shaped organ called an ovipositor. The male then fertilizes the eggs with his sperm and maintains them in his pouch, which secretes a fluid containing nutrients and oxygen. After an incubation period of several weeks, the male "gives birth" from the pouch. The babies resemble small adult seahorses.



Water + burning oil = steam,
which spreads the fire.

Why doesn't water put out a grease fire?

When grease or cooking oil burns, it's far hotter than 212°F, the boiling point of water. So when you add water to the pan, a huge cloud of hot steam results. Steam expands to take up an area 1,700 times as large as liquid water. This expansion happens so quickly and powerfully that it splatters the oil, spreading the fire.

So how do you extinguish a grease fire? The best way, according to the U.S. Fire Administration, is to smother the flames by carefully placing a lid on the pan or by covering it with baking soda. If the fire can't be extinguished, call 911.

Do vehicles emit more pounds of carbon dioxide than fuel consumed?

They sure do. According to the Environmental Protection Agency, one gallon of gasoline, which weighs about six pounds, produces about 19 pounds of carbon dioxide when you're driving. Gasoline consists of hydrocarbons, which are molecules made up of hydrogen and carbon atoms. When gasoline burns, the carbon atoms combine with the heavier oxygen atoms—and while the fuel contributes only the carbon atom to create carbon dioxide, the air in the engine contributes two oxygen atoms to the reaction. As a result, the pounds of carbon dioxide coming out of the engine are more than double the pounds of gasoline you put into it.



**ASK US
AND WIN A
SCIENCE
ILLUSTRATED
T-SHIRT!**



Send your burning question to our editors. If we answer it in an issue, we'll give you this cool T-shirt.

E-mail your questions to:

askus@scienceillustrated.com



Creatures of the

NIGHT

Bats are full of surprises, from where they live to how they navigate in the dark to what they eat (hint: It's rarely blood). A look at one of the world's most fascinating mammals



As a humid darkness falls over the rainforest, the air is alive with the sound of wings. Across the forest, and around the world, bats rule the night sky. With nocturnal lifestyles that keep them safe from all but the most determined enemies, bats have flourished. There are more than 1,100 species—which make up nearly a fourth of all mammalian species—dispersed across every continent except Antarctica. Whether portrayed as moody superheroes or bloodsucking villains, bats have a dark reputation. The more we learn about bats, however, the more diverse and misunderstood they turn out to be.

Take, for instance, the fact that only three out of the 1,100-plus species actually feed on blood. These vampire bats, which are only found in Latin America, prey on birds and large mammals, but almost never humans. Outside of this practice—in which they lap up blood after making an incision in their prey—scientists say they're actually gentle creatures. Hungry cave mates can count on a shared meal from more fortunate hunters, for instance.

About 70 percent of bats eat insects. In Texas, it's estimated that 20 million Mexican free-tailed bats gobble up more than 200 tons of insects every night. Bats' bug prey

includes farm pests like night-flying beetles and moths, as well as mosquitoes—animals that actually *do* feast on human blood. Some bats also eat fish and crustaceans, while others go for small vertebrates like rodents, frogs and lizards.

Still other bats eat fruit or nectar. They spread fruit seeds in their guano, or droppings, which keeps forests growing, and they help pollinate plants by moving from bloom to bloom in search of sweet nectar.

Bats can vary widely in size from species to species. In fact, the smallest mammal on Earth may be a bat: Thailand's tiny hog-nosed, or bumblebee, bat, which measures 6 inches from

Form for Function

Bats' curious appearance—somewhere between bird and rodent—doesn't exactly endear them to us. But all those strange body parts play an important role in bats' success.



TEETH: Bats' teeth differ from species to species depending on their diet. Insectivores have sharper teeth than species that dine on soft fruits or nectar. Vampire bats prick sleeping prey with two teeth, then lap up the blood as it trickles out. Their saliva contains an anticoagulant to keep the blood flowing.



EARS: Bats have extraordinary hearing. Many species, particularly a group called big-eared bats, have developed enormous ears, which aid in echolocation, or sonar.



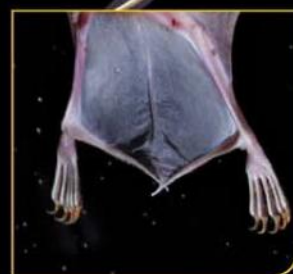
EYES: Most bats rely on echolocation to find their way in the dark. It's unknown how much they supplement echolocation with sight. Old World fruit bats, however, do not use sonar—they navigate visually. Scientists believe their night vision surpasses that of humans, although it's probably limited to black and white.



WINGS: Bats' wings, which are made up of long fingers joined by a thin membrane, are more flexible than those of other flying animals. They use this flexibility to generate lift, reduce drag, and make incredibly sharp turns—essential while hunting tiny, agile bugs. Wingbeats also help amplify their sonar cries.



CLAWS: Bats that dine on insects, fish and shrimp caught on lake surfaces use their long claws to trawl. Other species use their claws to hang from branches.



TAIL MEMBRANE: Most bats have a tail membrane, similar to the one that makes up their wings, between their legs. They use it to help catch and disable prey.

wing to wing and weighs just 0.07 ounces. The fruit-eating flying foxes lie at the other end of the spectrum. These tropical-island giants can have a 5-foot wingspan and can weigh more than two pounds.

Home Sweet Home

Panama's tiny Barro Colorado Island may be the best place on Earth to study bat diversity—and the worst place for anyone who's squeamish about them. More than 70 species live on the island's 6 square miles. (By contrast, there are more than 40 species in the United States and 37 in Europe.) Elisabeth Kalko, a biologist at the University of Ulm in Germany and a researcher with the Smithsonian Tropical Research Institution, has devoted years of study to the bats on this island, and has discovered many of the strange places bats call home.

During one visit eight years ago, Kalko and her team tracked a group of bats with transmitters the scientists had previously attached to the animals. Kalko discovered the bats roosting in live termite nests. Thanks to the bugs' metabolic activity, termite nests are usually 2° to 4°F hotter than the outside air, and the researchers believe the bats were taking advantage of the

stable, warm temperature.

There is no obvious benefit for the termites, however, which usually swarm and attack when disturbed. "The termites may have already sealed themselves off from the cavity," says Kalko, "or the bats may use chemicals that keep the termites off them." Kalko is investigating with the help of chemical ecologists from the University of Ulm, but one thing is cer-

tain: Outside of this genus, *Lophostoma*, scientists have never observed another bat variety roosting in termite nests.

Bats take shelter in a wide variety of places. Around the world, most species live inside caves,

cliff crevices, tree holes and abandoned buildings—where they bask in darkness, isolation from predators, and stable temperatures and humidity. But surprisingly, others choose a more exposed life on the surface of trees, rocks or buildings, or even tucked under large leaves or inside tube-shaped ones. Flying foxes sometimes roost on tree branches in colonies containing hundreds of thousands of bats.

Impressive Navigation

Flying foxes are also distinguished for their reliance on good eyesight—a surprising trait in an animal that

Flying foxes sometimes roost on tree branches in colonies containing hundreds of thousands of bats.

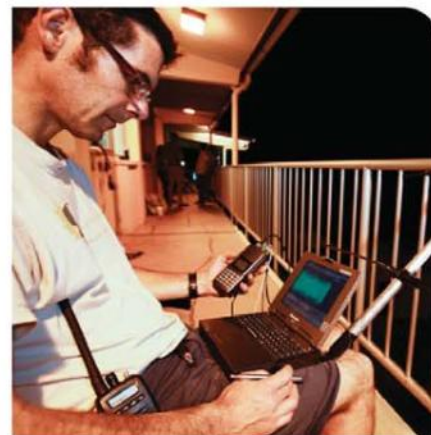
Bats are best adapted for hanging upside down. Special tendons in their toes allow them to grip branches and rocks without actively exerting themselves.



Biologist Elisabeth Kalko uses large nets to capture bats in the Panamanian rainforest.



Once a bat is caught, Kalko attaches a tiny radio transmitter to its back.



At the field station, scientists can follow the bat's every movement.

Seeing with Sound

Powerful, supersonic cries coupled with some of the best hearing among mammals adds up to an advanced navigation system called echolocation.

This bat's high-frequency cry is part of an echolocation system so accurate it can track a single airborne mosquito.



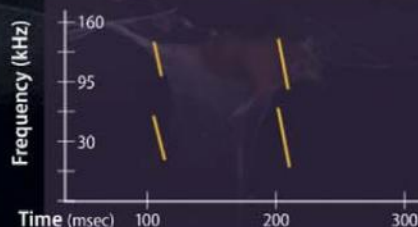
During echolocation, bats send out short calls as often as 200 times per second at up to 110 decibels—as loud as a smoke alarm, though at frequencies inaudible to humans. They vary their cries in frequency and structure for various purposes. Narrowband calls, which are focused within a small range of frequencies, can travel

farther than broadband calls, which are spread over a larger range and can provide more detail about a target.

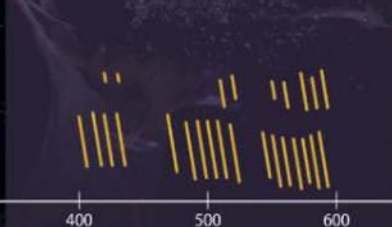
The echoes tell bats the location of objects like obstacles or prey, as well as details like an insect's shape and size. The insects' wingbeats help to give them away, since flapping wings produce slight changes in the echo

frequency and amplitude. The smaller the insect, the more it flaps its wings, the more changes in the echoes.

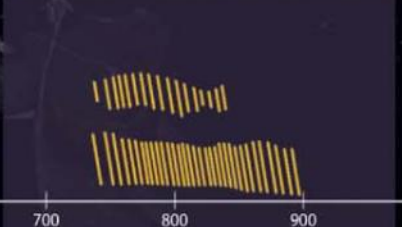
Immediately after capturing prey, bats can commence calling despite a mouthful of bug, so they can navigate and continue to hunt while they eat what they've just caught. Some bats can consume 2,000 bugs a night.



1 SEARCH: During this phase, the bat produces about 10 cries per second.



2 HUNT: Now that the prey has been located, the bat closes in. Its cries become more frequent—25 to 50 per second.



3 CAPTURE: As the bat grabs its meal, its cries are only about 100 milliseconds long. The bat may produce as many as 200 of these short cries per second.

is saddled with the saying, “blind as a bat.” Bats are split into two suborders: *Megachiroptera*, the 186 generally large species of Old World fruit bats found in Africa, Asia and Australia, and the usually smaller *Microchiroptera*, which comprises all the other bat types found around the world. Most *Megachiroptera*, including flying foxes, rely on good night vision and smell to get around and catch prey in the dark. But what about the rest?

In 1793 Italian physiologist Lazzaro Spallanzani first noticed that bats could fly around obstacles even when unable to see. It was only when he blocked their ears that the bats’ sense of navigation failed them. But the explanation had to wait until the mid-1900s, when

American zoologist Donald Griffin studied bats’ cries with microphones that were capable of registering their incredibly high-pitched sounds.

Griffin proved that bats orient themselves and track prey using ultrasonic cries in a system he named echolocation. When bats shriek, they emit high-pitched vocalizations that bounce off objects and back to the bats’ ears or other receptors. Essentially, bats determine their

proximity to the objects based on how long it takes for the sound waves to make the round-trip. Changes in the echoes’ frequency and amplitude deliver additional size and shape information about these objects to a bat. (See “Seeing with Sound,” page 38.) Bats also

Bats send out calls as loud as a smoke alarm, though at frequencies inaudible to humans.



Latin America’s fringe-lipped bats are among those that feast on frogs.

Spix’s disk-winged bats have developed suction cups at their joints that make it possible to cling to flat, slick leaves in the tropical forests of Central and South America.





Lesser long-nosed bats, found in the southwestern United States and Mexico, prefer flora, like this saguaro fruit, over insects.

use their wingbeats in echolocation, which saves energy and may be why they are able to produce such powerful cries. Every time a bat brings its wings upward, the movement compresses its thorax, forcing air out past its vocal cords without much additional effort.

Annemarie Surlykke, a biologist at the University of Southern Denmark, studies how bats use sonar to echolocate. She and researchers at the University of Maryland recently put bats to the test in an obstacle course. Surlykke found that bats moved their sound beams in the same way we move our eyes when entering an unfamiliar room: They shifted their focus sequentially from object to object, instead of aimlessly sweeping their sound beams.

"We know from behavioral experiments that bats can detect motionless insects by echolocation alone, and that they do not have to use eyesight or smell or rustling noises," says Kalko. Their echolocation system is so accurate that while using only sonar, bats unerringly



Brown big-eared bats' ears can be almost as long as their bodies.

find their insect prey in the dark—they don't strike at random structures atop the leaves.

Influential Animal

Aside from whales, bats are the only mammals to use echolocation. They're also the only mammals that fly. Scientists have pondered which of these two unique abilities bats developed first: echolocation or flight? A recently discovered fossil may help answer that question. The extinct bat, *Onychonycteris finneyi*, had wings but lacked the skull and ear structures required for echolocation. The wings were also slightly different from those of most modern bats, with a shape that indicates *O. finneyi* alternated between flapping its wings and gliding. Researchers say the discovery is in line with theories that bats may have evolved from terrestrial mammals to gliders to the active flyers we know today. Echolocation probably came later, possibly as bats adapted from day to night.

This development has since shaped the evolution of some of the species bats eat. Moths can pick up supersonic bat cries; the trait likely developed as a defense mechanism when bats began to infiltrate the insects' nocturnal domain. A bat's cries must be transmitted and then received before it can accurately strike, a lag that sometimes gives a moth enough time to drop out of the bat's path.

And in 2000, Jayne Yack and James Fullard, biologists at Carleton University and the University of Toronto in Ontario, found that nocturnal butterflies—often referred to as the “missing link” between daytime butterflies and nighttime moths—can also hear the cries of bats and take evasive measures. Yack and Fullard posit that life in the daylight may have been another evasive measure: Butterflies escaped bats by being active during the day and taking shelter at night. Some scientists believe echolocation may have also influenced the evolution of some flowering plants, which have an ideal shape for bats to find with sonar—and spread their pollen as a result. It's just more proof that, creepy as they may be, bats are worthy of our respect. ■

5 Cool Things You Don't Know About Bats

1

Compared with other small mammals, bats have exceptionally long life spans. The oldest bat ever observed in the wild was 34 years old.

2

Vampire bats aren't actually Count Dracula in disguise, but that hasn't stopped scientists from acknowledging the pop-culture connection: The anticoagulant in one species' saliva, which keeps blood flowing so bats can keep drinking, is known as draculin.

3

Some bats practice heterothermy, in which they bring their body temperatures down to that of their surroundings while at rest. Some also hibernate in the winter, and can even tolerate body temperatures below freezing.

4

Bats prefer to fly, but they can swim if they have to. Bat-watchers have observed flying foxes taking short dips to collect dropped food and using their wings to swim back to land.

5

Among mammals, bats have some of the largest colonies—populations can number in the millions. Relatives find each other by smell and calls.



Bats packed together in their roost.

Flying Saucers Come Home



The first commercial flying-saucer line, the M200 series from Moller International, could go on sale next year.

Forget UFOs. The first circular aircraft could soon hit the market right here on Earth. They won't take you to space, but they might just be worth the long—very long—wait



It's designed to seat two, take off and land vertically, fly 10 feet above the ground, and reach 75 miles an hour.

It's about the size of a car, but it's round instead of boxy. Yup, it's a flying saucer. Next year, California-based Moller International hopes to introduce the M200G personal recreation craft, the first of what the company expects to be a full line of "volanters"—vertical-takeoff-and-landing aircraft. The design is 300 years in the making.

When the Wright brothers made the first powered flight in 1903, they inaugurated basic principles that survive to this day, including thin wings for lift and a vertically mounted propeller to provide forward thrust. But two centuries earlier, Swedish inventor Emanuel Swedenborg had already dreamed up a flying-saucer-shaped aircraft. Countless designers around the world have since envisioned round planes.

Because of their shape, circular aircraft can theoretically move anywhere—up, down, and side to side—without needing to point in that direction. This provides the potential for highly attractive vertical-takeoff-and-landing (VTOL) or short-takeoff-and-landing (STOL) capabilities, the latter of which permits the use of a far shorter runway than is needed by conventional craft of the same size. Armed forces worldwide are especially interested in VTOL and STOL airplanes because they can lift off from cramped aircraft-carrier decks or almost any flat surface in remote locations where runways are not available. Round aircraft are also advantageous in principle because they could fly faster than the other notable VTOL aircraft, helicopters, and their thin shapes are potentially far less detectable by radar, making them ideal for covert reconnaissance missions. Not to mention, the concept is just plain cool.

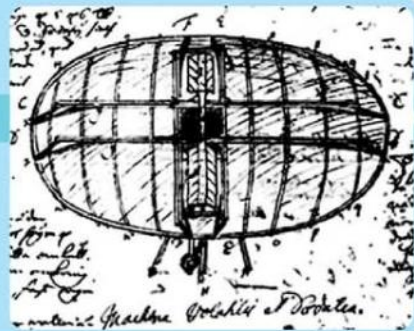
With all these advantages, circular aircraft should be commonplace by now. So where are all the flying saucers? Despite the benefits, the technology has long been hampered by major drawbacks. The biggest challenge is that round airplanes are highly unstable [Continued on page 47]

Flying Saucers through the Ages

Inventors have long been intrigued with the shape and potential of round aircraft. Most of the ideas, however, barely got off the ground.

1714 EMANUEL SWEDENBORG,

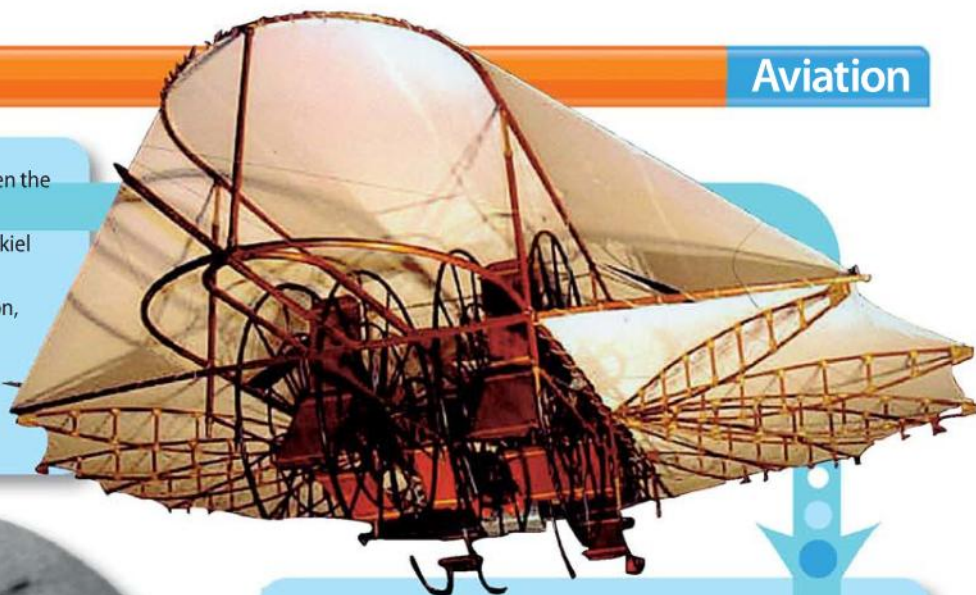
a Swedish mystic and scientist, produced the first known sketch for a rounded aircraft [right], an oval plane made of wood. Engines hadn't been invented yet, so he devised arm-powered, cloth-covered flapping wings. A description of Swedenborg's Flying Machine, as it's known, appeared in a periodical in 1716, but it never progressed beyond a sketch.



1929 AMERICAN DESIGNER Steven Paul Nemeth wind-tunnel-tested a model of his round propeller plane [above], the Roundwing, a.k.a the Umbrellaplane. Five years later, he built a full-scale aircraft, measuring 16 feet wide and 20 feet long. That year, the Roundwing made a successful flight.

Nemeth soon swapped the craft's 90-horsepower engine for a 120-horsepower model, and the plane showed outstanding short-takeoff-and-landing capabilities. It could lift off in just 65 feet and land in 25 feet at a speed of 30 mph, and it was extremely stable in flight. Nemeth hoped to mass-produce the planes and sell them for \$1,400 apiece. The Great Depression, however, grounded his plans.

1902 GUS STAMPS may have beaten the Wright brothers by a year. According to eyewitness accounts, Stamps flew the Ezekiel Airship [right], a semi-elliptical, engine-powered plane designed by Burrell Cannon, a Baptist minister, engineer and inventor. The plane purportedly flew about 160 feet at an altitude of 12 feet before crash landing near Pittsburg, Texas.



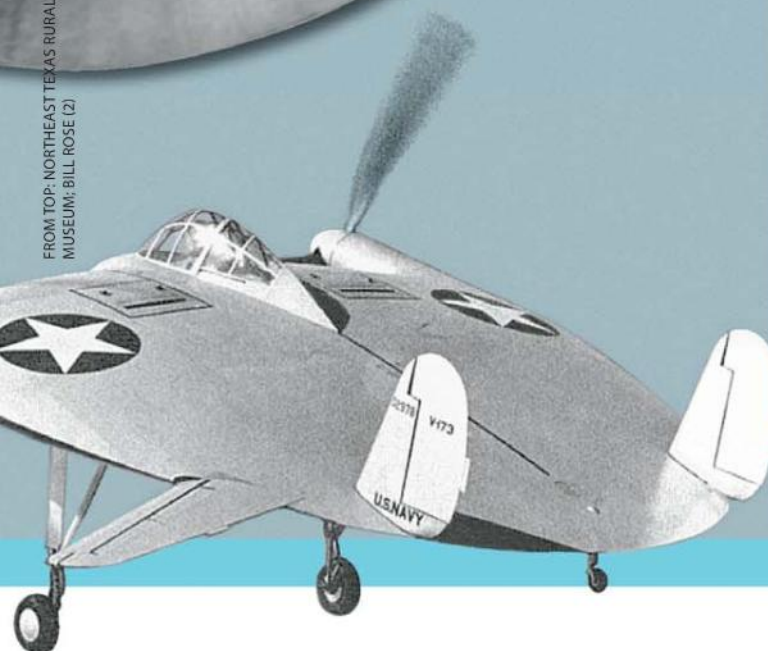
1913 BRITISH DESIGNERS Cedric Lee and George Richard hired engineer James Radley and assistant Eric England to create this wreath-shaped, propeller-driven plane [left]. England flew it five miles over Shoreham, England, before the engine died during landing. He survived the crash, but the plane itself wasn't as lucky. The team salvaged the wreckage to create a new, modified version with three-wheeled landing gear and additional elevators, the wing flaps that move the plane up and down. The newly designed plane, which took flight in 1914, had major problems with control, and the pilot, Gordon Bell, was not able to stabilize it before a second crash landing. Lee flew a third version himself, but he lost control of the plane and ended up in the River Adur. This time the plane could not be salvaged, and the men gave up their attempts to develop a commercial aircraft.



1942 AERONAUTICAL ENGINEER Charles H. Zimmerman developed this prototype Navy fighter plane [left], dubbed the V-173 and nicknamed the Flying Pancake. The Navy wanted to move more of its aircraft to the water after the attack at Pearl Harbor destroyed more than 180 of its planes, and it hoped that the V-173's STOL capabilities would permit the round, twin-engine plane to operate from both small aircraft carriers and modified freighters.

The Pancake's first test flight took place in November 1942. Because of a lightweight design and a steeply raised undercarriage angle, the plane was able to achieve takeoff in less than 200 feet. After a 13-minute flight, the plane landed in an astonishingly short distance—fewer than 50 feet, or just twice its length. With a cruising speed of just 75 mph and a maximum speed of 138 mph, however, the craft was less than ideal as a fighter plane. It was stable in the air when it flew nose-up at an almost 45-degree angle, but it pointed nose-down during landing, making it hard to control. The two piston engines were also deafeningly noisy.

The Navy carried out 170 more test flights before the Pancake was finally scrapped in 1947. The plane was restored in 2003, including an overhaul of both engines and the replacement of its original skin. It's now in storage at the Smithsonian Institution in Washington, D.C.



FROM TOP: NORTHEAST TEXAS RURAL HERITAGE MUSEUM; BILL ROSE (2)



1944 **ARTHUR SACK**, a German model-plane enthusiast, completed the propeller-driven AS-6 V-1 [above] in 1944. The elliptical craft was cobbled together with discarded parts of planes by Messerschmitt, a German aircraft manufacturer. Nazi test flights conducted by pilot Rolf Baltabol at Brandis Airfield near Leipzig demonstrated critical problems, including a dysfunctional rudder and ill-fitting parts. After more modifications, engineers also realized that the engine wasn't powerful enough, but there weren't resources to procure another. Various adjustments did little to help, and Baltabol recommended that engineers perform more wind-tunnel tests and replace the engine, but this never happened.

That summer, another attempt with a different pilot at the controls ended with the landing gear badly damaged. The AS-6 V-1 was returned to storage at Brandis Airfield, and Allied bombing soon damaged it so severely that the remains ended up as scrap.

1954 **ENGINEERS ONCE** dreamed of a flying saucer that could travel faster than the speed of sound. In 1954 British-Canadian aircraft designer John Frost began work on a top-secret craft for the U.S. Air Force code-named Project Ladybird. His plans called for a round vertical-takeoff-and-landing plane with a top speed of Mach 3.5—three and a half times the speed of sound—that could fly at an altitude of more than 80,000 feet.

The Air Force planned to produce the round aircraft in several sizes, the largest measuring 100 feet in diameter. Frost even suggested that the edges of the saucer be armored, so that it could be used as a missile to attack Soviet bombers. In 1955 the U.S. Air Force changed the project's name to Silver Bug. Wind-tunnel testing soon revealed

that Frost's ambitious craft was highly unstable at supersonic speeds. There were also doubts about the plane's ability to withstand the high temperatures that it would be exposed to at those speeds.

Frost later designed an equally unstable aircraft known as the concept VZ-9AV Avrocar [below]. A Frisbee-shaped, jet-powered vehicle, the Avrocar was a prototype for a larger circular aircraft intended for troop transport and reconnaissance. Two such craft were built, and neither proved suitable for military use. The noisy saucers pitched and rolled uncontrollably after lifting off to a height of just a few feet, and the planes could reach a top speed of only 35 mph, far below the supersonic speeds the Air Force had hoped for. The military never produced the planes.



FROM TOP: U.S. AIR FORCE; BILL ROSE

[Continued from page 44] because they don't employ the conventional aerodynamic systems—specifically, lift-generating wings and both vertical and horizontal stabilizers—that usually keep aircraft airborne. “If a plane is moving through the air at a high enough speed, aerodynamic forces can be used to stabilize it,” says Paul Moller, the president of Moller International. But VTOL craft, which must become airborne with zero forward momentum, need another way to generate lift and achieve stability.

To overcome this obstacle, Moller's M200G uses its propulsion system to stabilize itself. The craft moves using eight small ducted fans, each powered by its own Wankel-style rotary engine, that lift the M200G into the air and push it forward, backward and sideways. Varying the thrust from the fans also provides stability—for example, a little extra thrust from the right-side engines prevents that side of the craft from dipping. Using multiple inertial sensors and accelerometers, an aircraft-stability computer constantly monitors the altitude of the craft and sends commands to the engines to adjust thrust in each fan up to 400 times per second, maintaining stability. The aircraft is constructed of ultralight materials such as aluminum and fiberglass, which increase the vehicle's strength and maximize the engines' power.

With a starting price of \$90,000, the M200G will initially be a toy for the rich. It will be limited to flying below 10 feet, eliminating the need for Federal Aviation Administration certification of each pilot. Eventually, the company hopes to offer low-cost aircraft. “Artificial stability systems will get better and cost less in the future,” Moller says, “allowing us all to be able to afford strange and wonderful new flying machines that defy conventional aerodynamics.” Flying saucers, it turns out, may be just the beginning. ■



1990s RUSSIA'S SARATOV

Aviation designed an elliptical craft [above] with wings called the EKIP (which stands for Ecology and Progress) for civilian air travel and military use. Saratov tested a proof-of-concept, remote-control, model-size craft in 1994 and an unmanned prototype weighing 26,455 pounds in 1996, with the hope that a larger version would have a range of 3,278 miles and carry up to 396 tons of cargo. As a bonus, it would be able to take off and land on either a runway or water. The plane, dubbed the “Russian

UFO” by the American media, was unstable during wind-tunnel testing. Several remedies were proposed, including new tail-fin arrangements, and the designs looked promising.

By the end of the decade, though, the Russians dropped their support for the project due to financial concerns, and Saratov turned to the American military. NAVAIR, a division of the U.S. Navy, took interest in the project. But in 2005, it also abandoned the technology for unknown reasons, and for now, the EKIP idea is grounded.

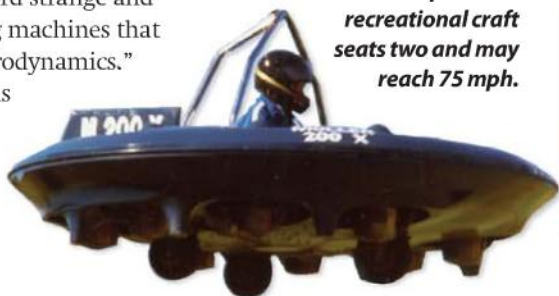


2002 SIKORSKY AIRCRAFT

Corporation in Connecticut developed an unmanned aerial vehicle in the 1980s capable of taking off and landing vertically. The doughnut-shaped, rotor-powered Sikorsky Cypher [left] was designed for surveillance and reconnaissance flights. It could fly autonomously using its onboard computer or be controlled remotely by a pilot on the ground.

Until the end of the 1990s, the U.S. Marine Corps continued to develop the technology for the Cypher, including GPS navigation, visible- and infrared-light video cameras and a laser range finder. A derivative model, the Cypher II, later renamed Dragon Warrior by the Marine Corps, featured several upgrades and included wings, but the project was short-lived—the Defense Advanced Research Projects Agency, a technology-focused government group, withdrew funding in 2002.

Moller's personal recreational craft seats two and may reach 75 mph.





A rock the size of Mars smashes into the young Earth. The resulting debris eventually forms the moon.

HOW MOONS FORM

Giant-Impact Theory

Roughly 30 million years after the sun and Earth form, the solar system is still full of huge space rocks left over from the formation of the planets. One of them collides with a young Earth, and the material knocked loose from both bodies coalesces to create the moon.



1. The collision results in an enormous explosion that blasts chunks out of Earth's mantle.

LUCKY STRIKE

A new study reveals that the planetary collision that created the moon is surprisingly uncommon. And without it, Earth as we know it wouldn't exist



2. Some of the material goes into orbit around Earth, along with fragments from the colliding body.



3. The debris spreads into nearby space, while the colliding body's core melds with the planet.



4. Gravitational forces from the loose pieces gradually pull them together into one body.



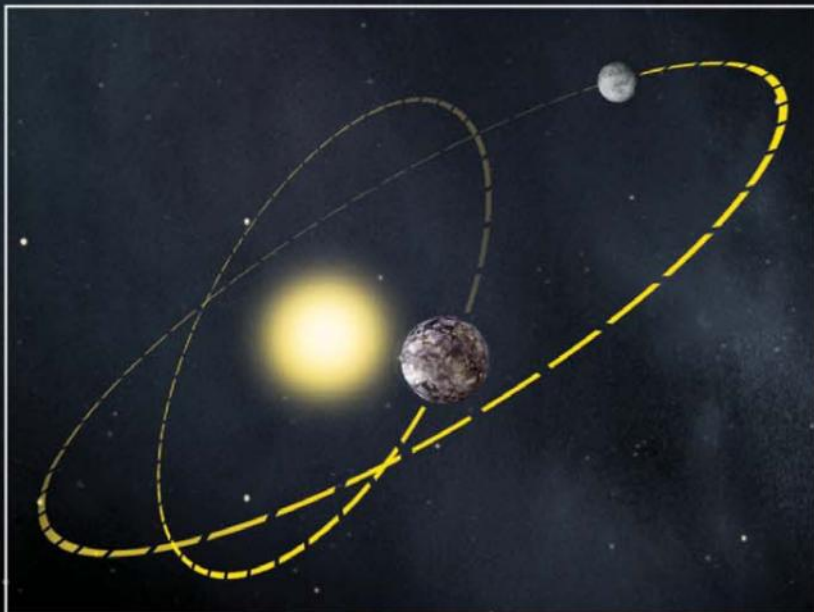
5. In a process that takes as little as one century, the pieces unite to form the moon.

HOW MOONS FORM

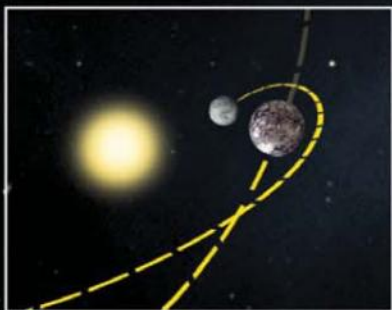
Capture Theory

Rocks and dust left over from the recent formation of celestial bodies orbit stars, usually in asteroid belts. Some of these rocks, which may have originated in other parts of the solar system, are captured by young planets to become their moons. These moons are small enough to be controlled by a planet's gravitational pull.

In our own solar system, Mars probably captured its two moons, Phobos and Deimos, from the asteroid belt between it and Jupiter. The two more closely resemble asteroids than the moons found in orbit around other planets.



1. Space rocks—often in asteroid belts—orbit stars. When a rock in orbit around a star comes close to a planet, it is slowed by the planet's gravity.



2. If the rock has just the right velocity, it moves out of its orbit around the star and goes into orbit around the planet. To be captured, the rock must be small enough to be controlled by the planet's gravity.



3. After a long period of time, the new moon enters the same orbit as the host planet's other moons. Less frequently, the new satellite immediately enters the same orbit upon capture.

Since its birth approximately 4.5 billion years ago, the moon has played a vital role in our planet's history. Its gravitational pull helped shape Earth's early landscape. Its tidal forces created opportunities for life to move from water to land. And it stabilized the planet's tilt, giving us the seasons and helping to diversify Earth. We're lucky to have it. New research indicates that moons like ours are extremely rare.

The Moon's Origin

Our moon is large in proportion to Earth—much larger than the other moons in our solar system, compared with the planets they orbit. The diameter of Earth's moon is one quarter the width of Earth. By comparison, it would take 27 of our solar system's largest moon, Ganymede, laid end to end, to match the width of its mother planet, Jupiter.

Scientists have come up with three theories of how planets in our solar system acquired their moons. Earth, Mars, Jupiter, Saturn, Uranus and Neptune have at least 150 moons among them (Mercury and Venus are moonless, as far as we know). About two thirds of these moons formed when a planet captured rocks and dust in its orbit. The other third were most likely created at the same time as the planets, and from the same gas and dust.

Earth's moon, however, could not have been formed by either of those methods. It's too massive to have been captured by our planet's gravitational pull. And it contains the same kinds of oxygen isotopes as Earth, which indicates that the moon was formed nearby. Also, data from a mission to the moon in the 1990s proved that an ocean of magma once covered it; the heat required to maintain the molten rock could not come from a capture scenario. As for a simultaneous-formation theory, experts say the moon's metallic makeup differs too much from Earth's to have come from the same materials at the same time: The moon's iron core is significantly smaller in proportion to the planet's.

What's Inside the Moon?

Just like Earth, scientists believe that the moon has a solid metal core, surrounded by a mantle of liquid metal. The evidence includes calculations recorded by seismographs left on the moon during the Apollo missions. The devices recorded the reaction of the moon after meteorite impacts and detected movements that would indicate a metallic core. The moon's rotational state also depends on a body with a metallic core.

The solid core is believed to be mostly iron, with some nickel. Outside the core is the mantle and then, finally, the moon's crust. Unlike Earth, there is no geological activity on the surface. Yet the moon's irregular rotation creates stresses that result in violent moonquakes deep in the mantle.

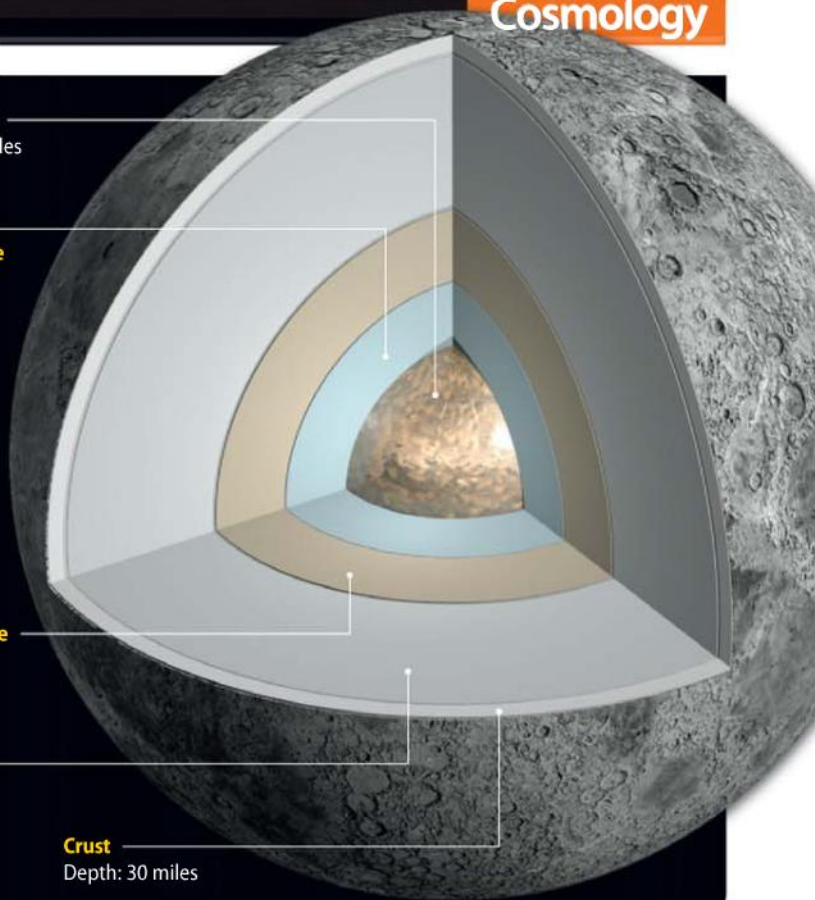
Solid metal core
Diameter: 250 miles

Metallic liquid surrounding core
Depth: 190 miles

Moonquake zone in mantle
Depth: 190 miles

Mantle
Depth: 435 miles

Crust
Depth: 30 miles



Instead, most scientists believe that our moon is the result of a collision between the young Earth and a giant rock about the size of Mars hurtling through space. When the sun and Earth were roughly 30 million years old, the impact of that rock knocked some of Earth's mantle loose and sent that middle layer of material flying into space. There, it eventually combined with material splashed off from the killer rock and coalesced into the moon. Scientists say this theory—the giant-impact hypothesis—explains why the Earth and the moon's inner metals differ so much: Both the colliding object and Earth had iron cores. But parts of only their iron-depleted mantles were flying out into space. Their rich iron cores and other remaining material fused to form Earth—the bigger, denser Earth we know today.

Searching for Dust

In 2003, astronomers Nadya Gorlova of the University of Florida and George Rieke of the University of Arizona set

out to determine just how common such collision-formed moons are. Rieke, who had built one of the cameras on NASA's Spitzer Space Telescope, used the satellite to search the skies for

evidence of other smash-ups.

Today's telescopes can't take pictures of planets outside our solar system, known as exoplanets, so the team couldn't directly look for Earth-



Astronomer Nadya Gorlova of the University of Florida and her team used NASA's Spitzer Telescope to determine that moons like ours are extremely rare.

9 Cool Facts about Our Moon

1 There isn't actually a dark side of the moon. The sun illuminates both sides, but the same side always faces Earth.

2 Lycanthropy is a mental disorder in which a person believes he can mutate into a dangerous beast—a werewolf, for example. Our culture has come to associate this condition with full moons.

3 Between 1969 and 1972, the manned Apollo missions brought back almost 842 pounds of rock samples from the moon.

4 Although it's often said that the moon orbits Earth, the two technically circle each other. Both objects orbit around the center of mass of the combined Earth-moon system—a point 1,802 miles away from Earth's center.

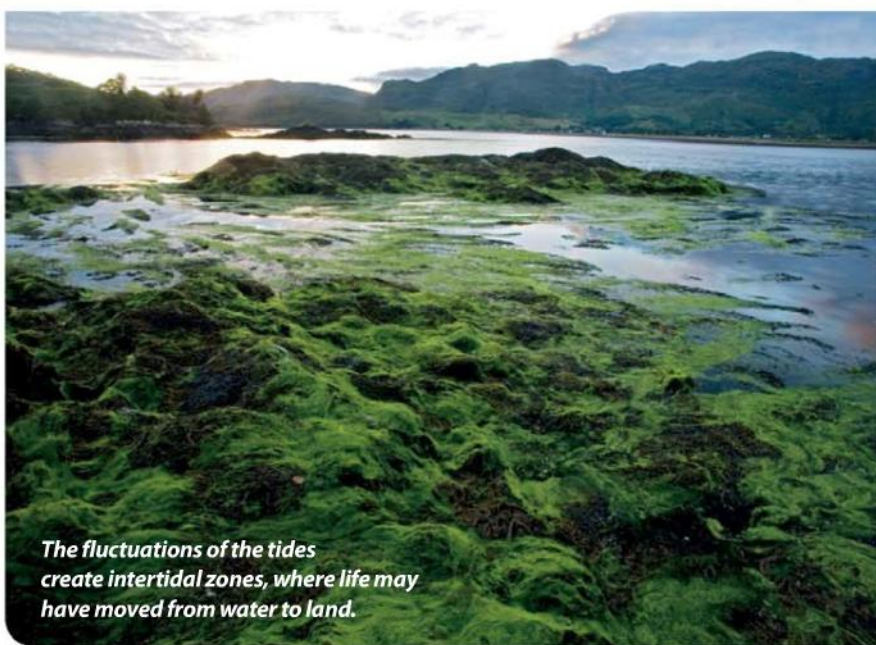
5 During the *Apollo 14* mission in 1971, astronaut Alan Shepard hit several golf balls on the moon, but his space suit was so stiff that he had to swing with one hand.

6 The moon's largest basins, which were created by meteor impacts, are hundreds of miles across.

7 Lunar rocks are made of approximately 40 percent oxygen. Scientists have successfully extracted it from the rocks in laboratories, and some hope that the element could one day help sustain human colonies on the moon.

8 In order to see the American flag on the moon, the eight-foot-wide mirror on the Hubble Space Telescope would need to be about 650 feet in diameter.

9 The "man in the moon" is made up of dark plains, or maria, and lighter highlands. The pattern is perceived as a toad by the Chinese, while other cultures see a rabbit.



The fluctuations of the tides create intertidal zones, where life may have moved from water to land.

moon systems like ours. Instead, they used the infrared telescope to search for dust clouds, which scientists believe result from collisions. They narrowed their search to stars that are roughly the same age as our sun when the moon was most likely formed.

The results: one dust cloud among 400 stars. Based on this finding, the astronomers calculated that collisions form just 5 to 10 percent of moons in the universe. And that's probably a high estimate, since there's no guarantee that dust spotted by Spitzer will necessarily result in a moon. In that case, our natural satellite—and its effects on our planet—are even rarer.

Lunar Landscaper

The moon's influence on Earth is clearly visible in ocean tides, which are caused by the satellite's strong gravitational force (the sun also has an effect on tides, but to a much lesser extent). This force is a result of both the moon's size and its proximity to the planet. But at one time, those tides were probably much stronger. Over the past few hundred years, astronomers have observed the moon slowly receding from Earth, which means that the two bodies were probably much closer together at some point in the past.

According to Linda Elkins-Tanton, a professor at the Massachusetts Insti-

tute of Technology, the young moon was close enough to significantly alter Earth's surface. Today, tidal effects create bulges in the ocean in the direction of the moon. But soon after the impact, when Earth's surface was still liquid, the nearby moon's gravitational pull would have had a much more severe effect, pulling the magma on the surface far higher than today's ocean tides. And even though that early melted landscape has long since disappeared, the moon still causes a bulge in the Earth's crust. Although it's just a fraction of the earlier effect, the moon distorts the planet's shape by a few centimeters every time it passes overhead.

A team of researchers led by Elkins-Tanton at MIT and the Jet Propulsion Laboratory in Pasadena, California, is investigating the possibility that very early tides also produced extra heat in the Earth's interior. They suspect that friction created by the gravitational pull of the moon on the planet's interior heated the core, which may have sped up the onset of plate tectonics—movement that helped shape the way our planet looks today. According to Elkins-Tanton, once a planet begins to cool and create a solid plate, it becomes much harder for tectonics to take place. "This may need to start early, or it won't start at all," she explains.

The Great Diversifier

Terrestrial life may also owe a debt to tidal forces. The ebb and flow of oceans creates intertidal zones, coastal environments that are submerged in water at high tide but exposed to air at low tide. Over millions of years, this constant shifting between two ecologies may have encouraged organisms to transition from water to land.

Additionally, the moon helps give us stable seasons, a boon for animal and plant diversity. Most planetary researchers believe that the Earth's axis, which is inclined at 23.5 degrees, is the result of the collision that created

the moon. The inclination means that parts of the Earth will receive varying intensities of sunlight over the course of a year, creating seasons.

Many of the other planets in our solar system also have an inclined axis and seasons. But the pull of gravity from our moon keeps the Earth on a consistent axial rotation, rather than undergoing extreme changes in inclination such as those observed on Mars. The Red Planet experiences seasons, but its unstable axis moves from vertical to an almost 35-degree inclination, causing drastically hot and cold periods. These dramatic climate

changes, which are in part a result of the planet's lack of a stabilizing moon like ours, don't bode well for life. The moderate inclination of the Earth's axis, on the other hand, has resulted in a variety of stable ecological niches for organisms to exploit.

Rare as our moon may be, it's unlikely that it's the only collision-formed moon out there. One day, when technology finally allows scientists to directly observe bodies outside our solar system, we may come across another. And if it's as influential as ours, we might be surprised at what we find on its planet. ■

HOW MOONS FORM

Co-Creation Theory

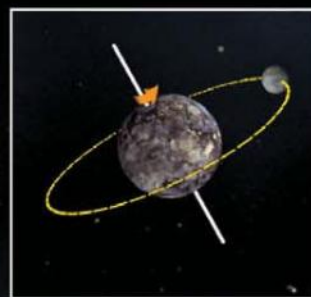
Some moons, including Jupiter's large satellites, form simultaneously from the same materials as the planets they orbit. These are the largest types of moons, but they're still small in proportion to their host planet. They're strictly associated with the huge gas-and-ice-giant planets.



1. Dust and rocky fragments in space begin to coalesce into clumps. The largest clump becomes dominant.



2. The dominant clump has a strong gravitational pull and therefore accretes faster, eventually forming a planet.



3. Satellites are created when other clusters that are too large to be absorbed go into orbit around the planet.

HOW MOONS FORM

Fission Theory

A moon is created from material that flies off a protoplanet, one that is in its formative stages. Since the planet's outermost layer is still molten, it is easy for it to come loose.

Scientists now say that none of our solar system's moons were created this way, although the theory has not been ruled out for distant moons.



1. Shortly after its formation, a planet rotates very fast and some of its outer layer flies off.



2. This still-fluid material goes into orbit around the planet and gradually hardens.



3. The material coalesces into a moon with the same composition as the planet's surface.

Masters of Disguise

Animals use camouflage to hide from and confuse predators and prey. For some such animals, their natural appearance mimics, matches, and fades into their surroundings. Others actively shift shape, texture or color to blend in. This amazing ability to hide in plain sight has evolved in parallel across thousands of species, and each animal's cloaking technique is unique. "They all need to look invisible," says zoologist Martin Stevens of the University of Cambridge, "but the mechanisms can be quite varied." Recent research has focused on how some rare species—cuttlefish, for instance—can even tailor their quick changes to deter different predators. On the following pages, we capture some of North America's most ingenious disappearing acts.

PHOTOGRAPHS BY ART WOLFE

PETAL PERFECT

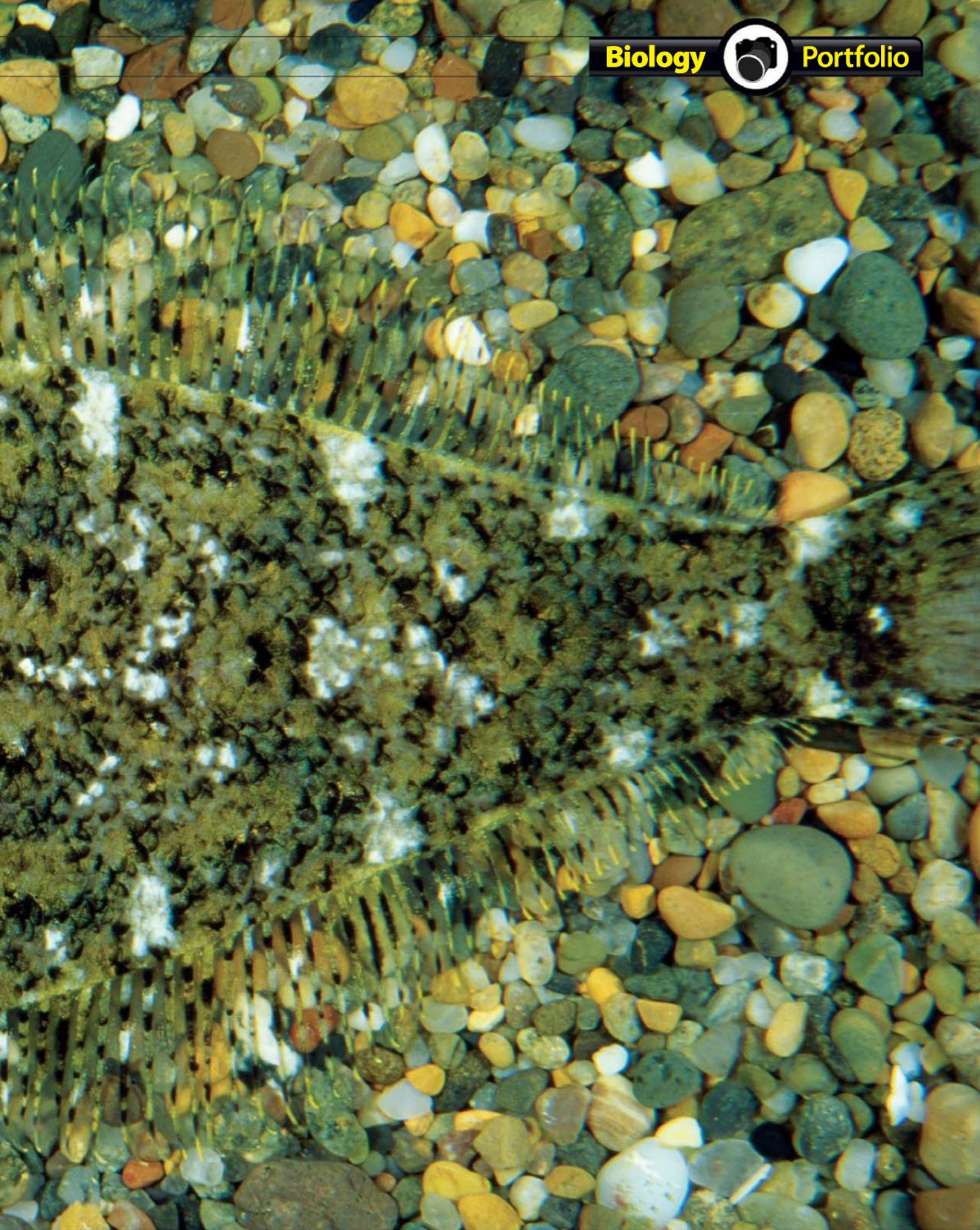
Instead of webs, the goldenrod crab spider, *Misumena vatia*, uses camouflage to ambush its prey, slowly changing color to match the flower on which it's perched. It does this by moving yellow pigment closer to or farther from its outermost layer of cells. The species is most often found among yellow and white blooms, but it can morph into a green or bluish hue when necessary, or even take on reddish spots or stripes. Thus disguised, the arachnid waits frozen, its front legs poised to snap closed in a deadly embrace on hapless insects that come into range. The spider's venomous bite can take down bugs as large as butterflies and bumblebees.



OFF THE HOOK

Here, a speckled sanddab nestles into the ocean floor, its skin mottled to mimic the pebbly background. A member of the flounder family, *Citharichthys stigmaeus* can change its topside appearance with cells called chromatophores. Pigment granules in these cells migrate closer to the cell surface to create patterns on its brown skin. This camouflage hides the fish from predators off the Pacific coast where it's found and enables it to surprise its prey—smaller bony fishes, shrimp and worms.









EBONY AND IVORY

Its unique black-and-white coloring helps the many-spotted tiger moth both stand out *and* blend in. Native to the western U.S., this moth may feed on mildly toxic plants like milkweed, taking the plant poisons into its own body as a natural defense against predators. Most often, the species' white body advertises "I taste bad" to birds who spot it flying in the air, says biologist Rebecca Simmons of the University of North Dakota. But when it comes to rest against a dappled background, like the one pictured here, *Hypercompe permaculata*'s coloring also breaks up the outline of its body, allowing it to blend in and hide from birds that might not heed its white warning.

HIDE YOUR YOUNG

Huddled together against a rocky Canadian cliff face, a typical nesting site, these two gyrfalcon chicks blend into the marbled stone. Adult *Falco rusticolus* patrol the air in arctic regions, feeding on their tundra neighbors, the well-hidden ptarmigan [facing page] and other smaller birds. Gyrfalcons are clad in inconspicuous gray, white and brown feathers, with a light underside.





COUNTERMEASURES

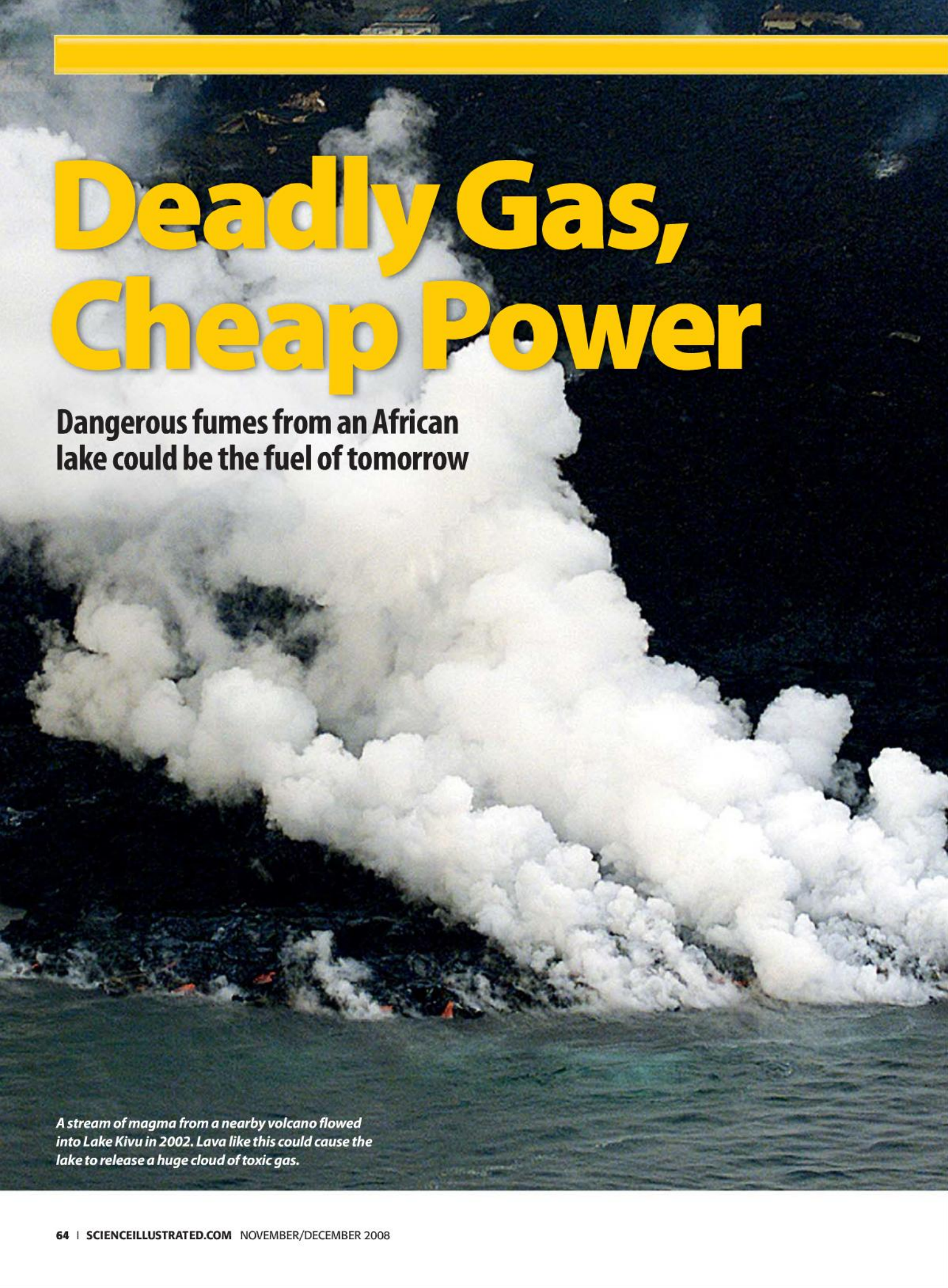
The round object in the center-right of this photo is no rock—it's a rock ptarmigan hiding motionless among the stones and moss of the Alaskan tundra. (Look for its beak to spot its head.) In the winter snow, *Lagopus muta* exchanges its brown feathers for white, maintaining year-round protection from its main predator, the gyrfalcon. In the spring, males retain their white feathers after the snow disappears, advertising themselves to potential mates. Once they've mated, and before the brown feathers grow back, males roll around in the dirt, creating a makeshift camouflage, which is eventually replaced by a summer disguise like the one on the female shown here.



A CROSS TO BEAR

Known for its distinctive high-pitched call, the spring peeper frog's coloring ranges from grayish to reddish brown, a fitting adaptation to the leaves and dead grass of its wooded habitat in the eastern and midwestern United States. Darker markings, including the cross on its back, help break up *Pseudacris crucifer's* silhouette against its surroundings. To add to the illusion, the tiny frog can also adjust its hue slightly within the gray-brown range to better match its environment.



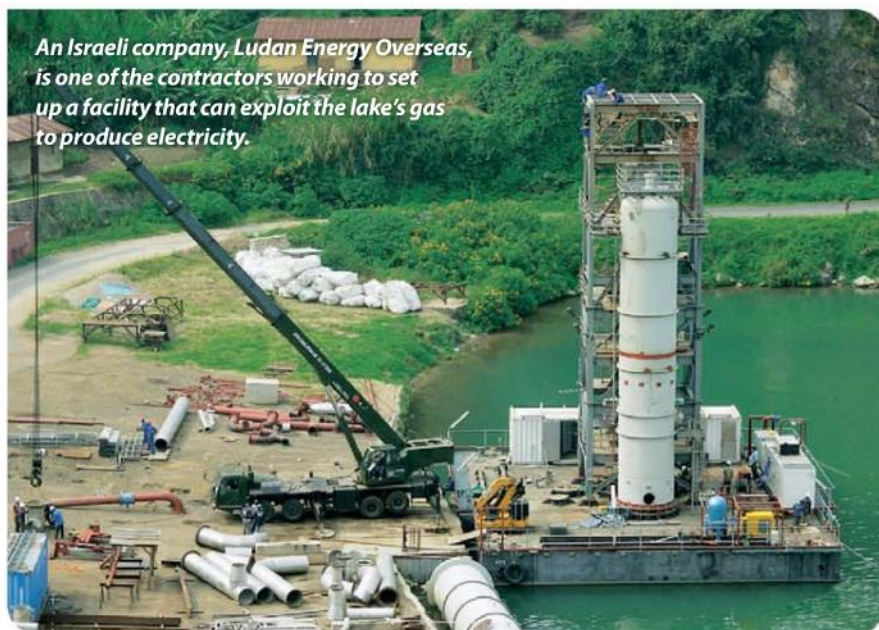


Deadly Gas, Cheap Power

Dangerous fumes from an African lake could be the fuel of tomorrow

A stream of magma from a nearby volcano flowed into Lake Kivu in 2002. Lava like this could cause the lake to release a huge cloud of toxic gas.

An Israeli company, Ludan Energy Overseas, is one of the contractors working to set up a facility that can exploit the lake's gas to produce electricity.



To live on the banks of Africa's Lake Kivu is to risk your life every day. Large amounts of methane, carbon dioxide and hydrogen sulfide gas are dissolved in various layers of the lake's deep waters. Scientists warn that a disturbance such as a volcanic eruption or earthquake could cause a redistribution of the lake's waters and the gases in them. This shuffling, known as an overturn, could unleash an invisible, suffocating cloud of these compounds—a rare event known as a limnic eruption—killing as many as two million people nearby. Now, rather than simply wait for disaster, scientists hope to put some of that gas to use, as cheap energy.

Lake Kivu, located on the border between Rwanda and the Democratic Republic of the Congo, is one of Africa's largest lakes. It covers 1,040 square miles and is nearly 1,600 feet deep. The region is particularly volcanically active, and magma and groundwater feed gases and minerals into the lake.

Carbon dioxide dissolves best in high-pressure, low-temperature water like that at the bottom of the lake—and the CO₂ makes the water more dense, so it stays at the deepest levels. Dissolved methane, hydrogen sulfide and minerals also increase the water's density. Organic materials, such as dead plants and fish,

decompose on the lakebed, producing additional methane. As a result, the bottom of the lake contains layers of pressurized solutions of water and gas—a lot like a bottle of soda—while the less-dense layers of water on top act like a cap.

Over time, the deepest waters of the lake have accumulated about 60 cubic miles of CO₂ and about 14 cubic miles of methane. With these gases mostly trapped at the bottom, the lake's dark depths are a time bomb.

Do Not Disturb

A disturbance of the lake could have the same explosive effect that occurs when you open the top of a soda bottle or pop a champagne cork—a bubbling over of liquid and gas. In the lake, the cause of the sudden release might be an earthquake or the immersion of hot lava that disturbs the layers of water in the lake. Large amounts of gas would bubble up and, just like it happens in the bottles, the contents of the lake would surge up and spill over.

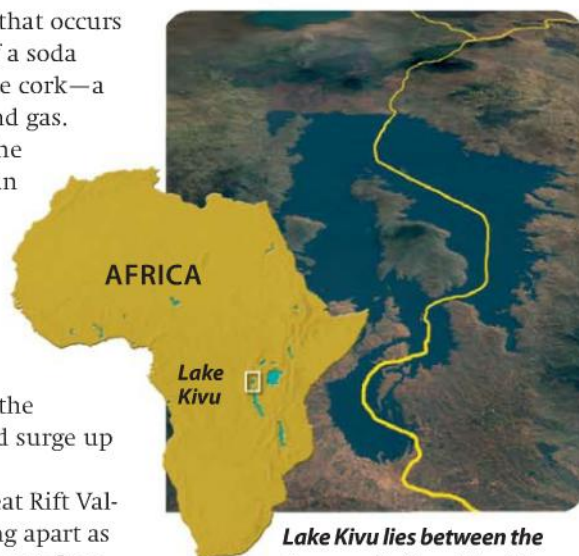
The lake lies in the Great Rift Valley, where Africa is splitting apart as two tectonic plates move away from each other, making it an earthquake

hot zone. Early this year, there were two serious quakes, which killed a total of 40 people.

There have also been volcanic incidents at Lake Kivu in the past. On January 17, 2002, a stream of lava from Mt. Nyiragongo, a volcano approximately 11 miles from the lake, burned its way through the lakeside city of Goma, forcing between 300,000 and 400,000 people to flee and destroying several nearby areas. When the lava hit the water, it created a huge cloud of steam, and some scientists worried that a deadly overturn would result. Luckily, the lava sank only about 300 feet into the lake—not deep enough to release a toxic cloud of CO₂ and methane.

Had the molten rock sank to a depth of 1,000 feet, it might have unleashed a catastrophe like the one that hit Lake Nyos in Cameroon in 1986. In the course of just a few hours, Lake Nyos released enough CO₂ to kill 1,700 people as far as 15 miles from the lake, suffocating them in a cloud of dense carbon dioxide. The event may have been triggered by a landslide, but the exact cause is unknown. And Lake Nyos wasn't the first such disaster. In 1984, an overturn at Lake Monoun, also in Cameroon, killed 37 people.

Samples taken from the sediments on the bottom of Lake Kivu and from deposits on its rocks reveal that over-



Lake Kivu lies between the Democratic Republic of the Congo and Rwanda.

turns like these have, in fact, occurred there within the past 5,000 years—and some scientists believe that another could strike within the next century unless something is done.

Putting Gas in the Machine

In Cameroon, the solution has been to install pumps that gradually pull gas from the bottom of Lake Nyos and Lake Monoun and release it at the water's surface. Researchers now realize that a similar method could bring the methane gas in Lake Kivu up into a power plant onshore. The lake contains enough gas to deliver inexpensive, clean electricity to the region

for many years. A preliminary project is now in operation, and the governments of the two countries that share the lake are hoping to produce large amounts of power as soon as 2020. Rwandan officials estimate that Lake Kivu could supply electricity to almost the whole of the country for more than 40 years, with some left over for the Congo.

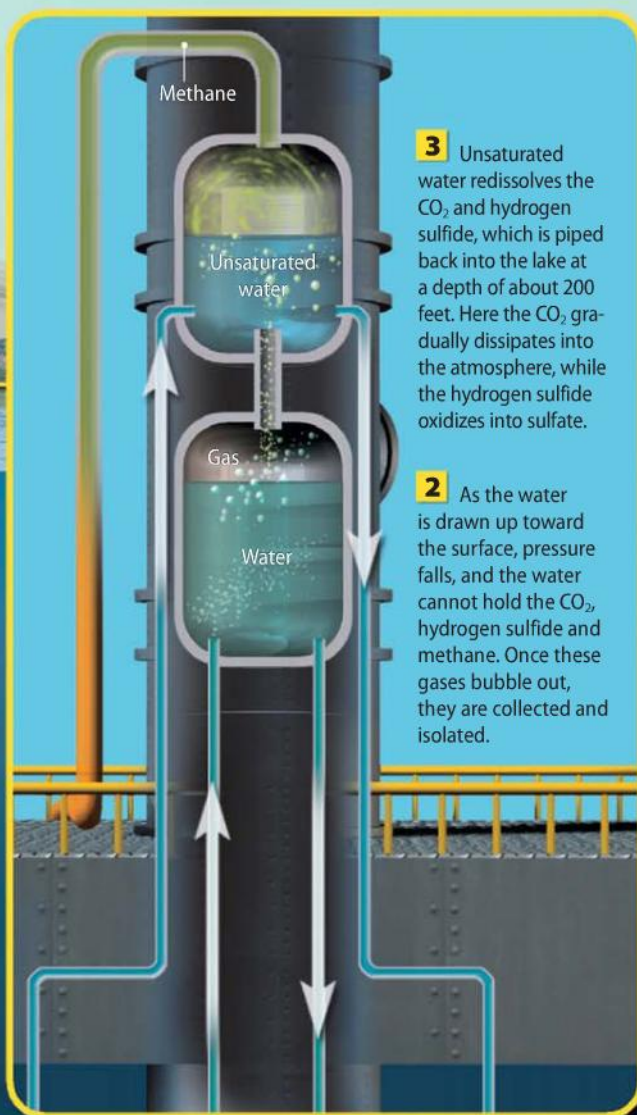
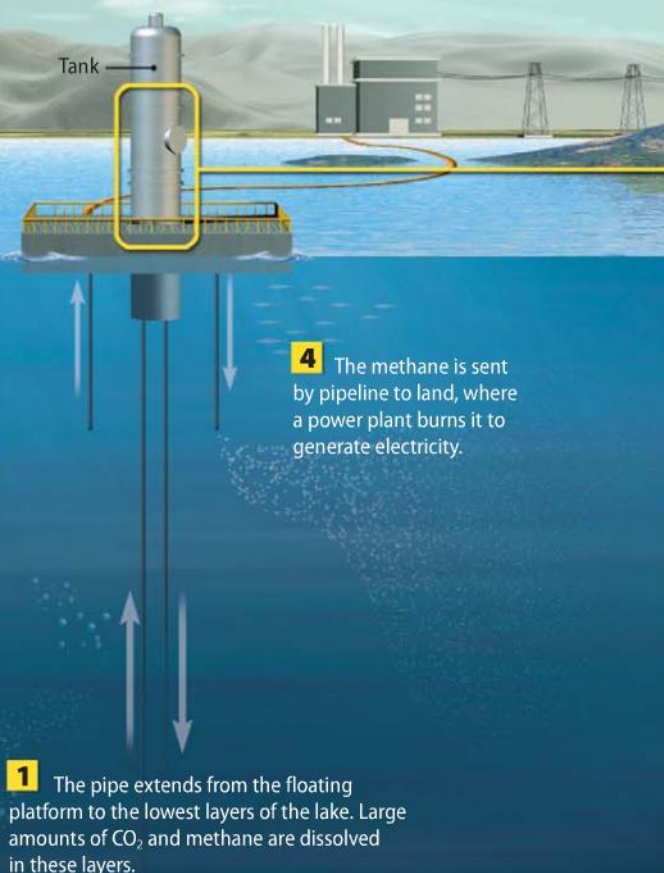
Both countries have drafted an agreement to put Lake Kivu's methane to good use, and a number of investors, including the World Bank and contractors such as COWI, a Danish consulting group, are working to get the project under way.

From a technical perspective, the process should be simple. A local brewery used methane from the lake bottom for many years to produce its energy, proving that the gas can be brought up from the lakebed and used to power businesses and homes in the area. In the 18 years before it closed, in 2004, the brewery relied almost exclusively on power produced by the lake's gas.

In principle, all that's required is sinking a pipe deep enough to reach the floor of the lake and pumping up the lowest layer of water. As the water rises, its pressure falls, and it releases bubbles of methane, CO₂ and

Pipes Bring Gases up from the Deep

Prototypes of a floating installation remove carbon dioxide, hydrogen sulfide and methane gas from the water and send the methane to a power plant on land. Here's how:



other gases. The bubbles increase the buoyancy of the water and force it upward and out of the pipe, creating a partial vacuum that pulls more bottom water up; eventually, the pump is no longer necessary. The methane can then be separated from the CO_2 and hydrogen sulfide and sent to a power plant, where it will be burned to provide energy for turbines.

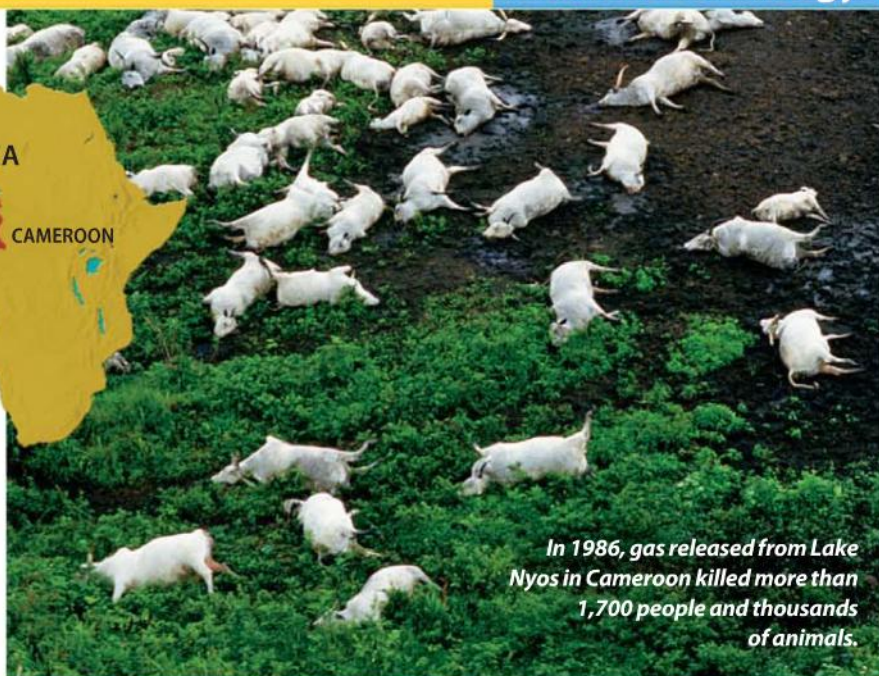
Complicating matters, however, is the fact that the lake's CO_2 is not useful, and releasing the greenhouse gas in the process would contribute to global warming. It's the price that must be paid, say those involved, for avoiding a deadly disaster. "If we don't do anything, there will be an eruption," says Finn Hirslund, a senior engineer at COWI. "The question is how to avoid that the right way." For now, the plan is to pump the CO_2 back into the upper levels of the lake water, from which it will slowly dissipate into the air.

A Bottomless Tank

Scientists and engineers estimate that there are almost 10 cubic miles of methane available for extraction in Lake Kivu, and in time they expect that installations will be built to pump gases up from several locations in the deepest parts of the lake.

The Rwandan and Congolese governments hope that by 2020 methane from the lake will provide 400 megawatts of electricity to be divided equally between the two countries. According to one company involved in the project, the resulting power will cost a fourth of the current price of electricity in Rwanda.

In the meantime, as organic material sinks to the bottom of Lake Kivu and decomposes, more methane will continue to be produced—about 3.2 billion cubic feet a year. But rather than threatening the lives of those who make their homes on its shores, the lake could, in fact, be a source of livelihood in the region. ■



In 1986, gas released from Lake Nyos in Cameroon killed more than 1,700 people and thousands of animals.

Africa's Other Killer Lakes

Researchers know of three lakes in the world with the geological structure that make them capable of trapping and releasing deadly amounts of gas. All three lakes are in Africa, and in the past 25 years, two of them have demonstrated just how dangerous they are. The disasters at Lake Nyos and Lake Monoun in the 1980s were the first indications to scientists that the phenomenon was even possible. Pumps have been installed in both lakes to pull gas from their depths.

Lake Nyos is located in northwestern Cameroon. Under its waters lies a pocket of volcanic magma, out of which CO_2 seeps and dissolves into the lake's water. On August 21, 1986, something—most likely a landslide, but possibly an earthquake or thunderstorm—triggered the release of a large amount of CO_2 from the lake. The gas spread up to 15 miles from the lake in a thick, suffocating cloud. Some people managed to escape, but 1,746 died, and thousands of animals were killed by a lack of oxygen. On the advice of scientists, a pumping system was installed in the lake in 2001.

Lake Monoun is near Lake Nyos in Cameroon. On the night of August 15, 1984, people living near the lake heard a strange boom. It came from the lake, which released a CO_2 cloud that spread out and suffocated 37 people, including 10 people in a truck (according to published reports, two people sitting on the truck's roof, above the CO_2 cloud, survived). What triggered the disturbance is still unknown. Pumps were installed in 2003 to avert a repeat disaster.



Pumps in Lake Nyos in Cameroon will reduce the gas content in the lake.

Evolutionary Throwbacks

What happens when primitive traits reemerge in a species? Are they just coincidence, or nature's best-kept secret for survival?



Divers hold a dolphin that has unusual rear flippers.

Babies with tails, whales with hind legs, horses with extra toes: You might think this list of oddities belongs in the pages of fantasy novels. But such rarities actually exist in the real world. And, no, they're not simply a coincidence. They are what scientists call atavisms—a recurrence in an organism of an ancestral trait that was believed to have disappeared long ago. Experts believe that these evolutionary throwbacks occur because genes for primitive features are often preserved in DNA even if most members of the species don't "express" them. Why, then, do these ancient characteristics show up occasionally in some animals? The answer requires a look at the principles of evolution.



What Are Atavisms?

An atavism is the extremely rare reappearance of an inherited trait that a species once possessed generations ago. The result of a chance genetic mutation, atavisms are known in many animal species, from horses born with extra toes to human babies with tails. Some species begin to develop these traits but lose them before birth. Dolphin embryos [above left], for instance, have tiny hind-leg buds that disappear by birth. Occasionally, those buds develop into rear flippers [above right]—an atavism.

Rules of Survival

The theory of evolution—fundamental in the field of biology—describes the process by which the inherited traits of a population change and are passed

on from one generation to the next. The theory holds that all living species evolved from common ancestors. In fact, molecular biology shows us that everything from the simplest bacteria

to human beings are made of the same basic genetic building blocks: DNA. And the sequence of that DNA has changed with each successive generation over many millions of years to spawn the diverse life that we know today.

The fundamental driver behind evolution is a process known as natural selection, a term coined by Charles Darwin in the 19th century. This process accounts for the notion that heritable traits that are beneficial or neutral for survival and reproduction become more common in a population, while harmful traits become more rare. Statistically speaking, the “fittest” organisms in a given environment survive and pass on their genetic advantages to the next generation. The English peppered moth is an example. Before the industrial revolution, this breed of moth was light in color. But as trees became darker as a result of the soot and other waste that manufacturing created, darker moths outlived lighter moths because they blended in with the trees and avoided predators. The darker moths then passed on their advantageous color to their offspring. Eventually, dark moths outnumbered light ones.

Scientists once thought that genes ousted by evolution were lost forever, but evidence now suggests that they may simply lie dormant in DNA. That would explain why humans can still sometimes be born with tails and whales sometimes form legs. The question is, what causes these traits to reemerge millions of years later?

Mysterious Mutations

The expression of a trait and the physical development of body parts are controlled by genes, which turn on and off during the developmental process. If the “on” signal doesn’t work, then the trait may suddenly cease to appear. If the “off” signal fails, an organism could end up with extra body parts—or a body part that should have disappeared during development but failed to do so. These chance mutations in one or a few members of a species are

Vestigial vs. Atavistic

Living primitive snakes—a group that includes pythons and boas—have vestigial legs called anal spurs, which they use to grasp other snakes during courtship and mating. The spur [circled] corresponds to a femur in an actual leg, and may be evidence that primitive snakes had functioning legs millions of years ago. This is not an atavism, which is a hidden trait that rarely gets expressed. Rather, it is a



vestigial trait: one that is expressed in all members of a species but no longer serves its original function. Other modern snakes such as garter snakes and rattlesnakes don't have the spurs. Legs on those species would be true atavisms.

the basis of atavisms. Unlike a birth defect, which is a mutation that has no connection to a primitive trait, an atavism is a special kind of mutation that results in the reexpression of a past trait.

An example of an atavism is the rare human tail. In human fetuses, a short tail emerges during embryonic development, a genetic holdover from our very distant vertebrate ancestors who had tails. But under normal circumstances, the tail stops growing in the womb after a certain period of time and then begins to disappear. The mechanism is under genetic control, and the remaining bones coalesce to form the tailbone—a vestigial body part, meaning that

it is the vestige of what was once a tail way back in our ancestral genetic history. The tailbone is common to all humans and therefore is not an atavism, but it no longer serves its original function as a tail. Instead, the tailbone now provides a connection for important muscles like the gluteus

maximus. If, however, during embryonic development, the genetic “off” signal is disrupted when the small tail emerges, the baby is born with a tail that’s more or less well-developed. In

some babies, this atavistic tail is made up of fat and skin, but in others it can have bones and muscles and even be capable of movement.

Another example of an atavism where the genetic “off” signal failed

Atavisms are physical proof of evolution—evidence of the link between past and present.

Is It an Atavism?

For researchers, it's often a matter of debate whether something is a true atavism (a rare reoccurrence of an ancestral trait), a vestigial characteristic (a common trait or organ that no longer performs its original function) or merely a random birth defect (a rare mutation). Below, we break it down.

EXTRA NIPPLE

Atavism?

Probably not.

One out of every 20 people has one or more extra nipples. They are rarely functional, and most experts believe they are birth defects as opposed to atavisms because our most direct ancestors (primates) had only two nipples. Still, because we are related to other mammals, which as a rule have more than two nipples, a look way back in our ancestral tree could indicate that extra nipples may be atavistic.

WEBBED DIGITS

Atavism?

Probably not.

Sometimes people are born with two or more of their fingers or toes grown together. This could be a throwback

to the fins that our earliest ancestors possessed. As fetuses, our hands and feet begin as flat structures, and it is only later in embryonic development that the spaces between digits arise, as the tissue there destroys itself. But because we don't exhibit many other fishlike traits and because it is hard to tell which genes are activated or deactivated when webbed digits occur, this mutation is more likely a birth defect.

DOLPHINS AND WHALES WITH BACK LIMBS

Atavism?

Yes.

Though relatively common in whales (an estimated one in 500), this is an atavistic trait. Fossil evidence shows that ancestors of whales and dolphins all had four limbs and lived on land. Over millions of years, they made their move to the water. Their hind appendages slowly became smaller and smaller until they were no longer there. But the genes that code for the hind limbs still exist in modern whales and dolphins and, in fact, code for the growth of their front flippers. The embryos of these species have small hind-leg buds that usually disappear during

development. In some cases, the genes that code for limb growth "forget" to turn off, resulting in atavistic hind limbs.

EXTRA DIGITS ON HUMANS

Atavism?

No.

Human babies are sometimes born with extra fingers or toes. Usually there is only one extra digit, but there have been cases of children born with eight or nine fingers on each hand. Most present-day vertebrates have only five fingers or toes, and possibly fewer—and this was established very early on in our genetic history. Therefore, extra fingers and toes are most likely birth defects.

EXTRA DIGITS ON HORSES

Atavism?

Yes.

The modern horse, *Equus*, has one functional toe, the hoof. But *Equus* evolved from horses whose forelegs had three toes. As embryos, horses still develop the same way their ancestors did, but now two of the three growths that originally became toes become part of the horse's leg. Modern horses with three toes, called polydactylous horses, undergo a genetic reexpression that results in toes that are functional—unusual in an atavism. Although this is extremely rare, at least two famous historical steeds were polydactylous: the mounts of both Julius Caesar and Alexander the Great.



The forelegs of the horse evolved from having three toes [far left] to having one [far right].

to work: dolphins with two additional flippers near their tails. In the spring of 2006, Japanese fishermen discovered one such dolphin swimming off the coast of Wakayama in western Japan. Normally, dolphins have a dorsal fin, a tail fin and two flippers up front. And at first glance, the dolphin with additional flippers appeared to have a random birth defect. But scientists soon realized that this was not the case.

Dolphins are a type of toothed

whale, and fossil records show that whales descend from four-legged land animals. In fact, fragmentary bones deep inside large whales' bodies are evidence of ancient hind legs. And as many as one in 500 whales, including the mysterious dolphin, have atavistic hind limbs that you can actually see.

Ancient Traits in Storage

The fact that certain traits can appear millions of years after their disappear-

ance goes to show that genes are astonishingly durable. In fact, scientists have demonstrated that it's possible to bring sleeping genes back to life as long as 100 million years later. In one experiment, researchers were able to coax the tissue in chicken beaks to sprout toothlike structures. Birds' ancestors, reptiles, possessed teeth an estimated 50 to 100 million years ago.

If the genetic recipe for teeth can remain hidden within an organism's



DNA for millions of years, there's no telling what other ancient body parts also lie dormant. The quest to find them has some scientists rethinking their understanding of heredity and genetics. Where once they described an estimated 90 percent of nucleotides—the building blocks of genes—in cells as “junk DNA” because they appear to have no function, now researchers wonder whether the “junk” might harbor the genetic code for evolution's entire history, complete with instructions for making ancient traits and body parts.

It's easy to see how such a massive stockpile of information could come in handy. Species such as the walking stick, for instance, have lost and reacquired wings over thousands of years to gain survival advantages in different environments [see “A Trove of Traits,” right]. Experts aren't entirely sure why walking sticks have flip-flopped in regard to their wings, but they speculate that in some environments, loss of wings may have increased the fertility of female insects, so the walking sticks without wings reproduced more in those regions. Another theory is that walking sticks without wings were better able to hide, so they survived in greater numbers when they were wingless. The insects may have displayed wings again at other times in other environments when it helped them to escape predators. Walking-stick populations may have been able to adapt relatively quickly because they had the stored genes that produce wings.

The Role of Atavisms

In the world of atavisms, however, throwback traits usually appear randomly and seldom serve a beneficial function for an entire species. Then why do they exist at all? No one knows for sure. What scientists do know is that atavisms are proof of evolution—tangible evidence of the link between past and present. They show how quickly anatomy can change from generation to generation and how tenacious genes can be, waiting silently for millions of years only to suddenly reemerge. ■



A Trove of Traits

Some groups of animals have redeveloped the same traits several times, allowing them to survive in various environments. For example, insects such as walking sticks lost their wings repeatedly—only to redevelop them again when they became advantageous. Although these wings are not atavisms, they are evidence that the genetic histories and instructions required to develop certain traits are stored over generations.



Seven Little Piggies Make History

Pigs are offering new possibilities for studying Alzheimer's disease

In the search for disease treatments, the next best thing to human guinea pigs is, well, actual pigs. Believe it or not, their skin and cardiovascular, digestive, urinary and central nervous systems are all very similar to ours. That's why, in recent decades, scientists have established swine models for osteoporosis, heart disease, diabetes, kidney disease and urinary-tract disorders. Mini-pigs, in particular, which weigh about 70 pounds, are easy to examine using hospital scanners and can undergo the same surgical procedures as we do. In fact, most medical students practice on anesthetized pigs before moving on to people. Pigs are also good subjects for behavioral studies such as those necessary for research on Alzheimer's disease, the fatal form of dementia that affects an estimated 4.5 million Americans over the age of 65. It's the sixth leading cause of death in the U.S. and costs the nation \$100 billion annually.



The piglets rest after their delivery.



Last year, a multidisciplinary team of scientists from two Danish institutions, Aarhus University and the University of Copenhagen, began using pigs to study Alzheimer's. But not just any pigs. The researchers created transgenic pigs—animals whose genomes contain genes from another species. In this case, human genes.

The team introduced the human gene for the heritable form of Alzheimer's into porcine fibroblasts, the skin cells most often used for cloning because they multiply quickly. The researchers chose the heritable form

of the disease, which develops early in life, because it can be detected genetically, rather than the more common, nonheritable form of Alzheimer's, which manifests later in life and has not been linked to a specific gene. They then used a unique cloning technique to make seven genetically identical pigs with the Alzheimer's gene.

According to Arne Lund Jørgensen, who is leading the study at Aarhus, pigs could suffer from Alzheimer's as humans do. "A porcine model shows that the pig brain has the metabolic pathway to produce Alzheimer's-like

pathology," he says. This could offer an improved understanding of the mechanisms involved in the disease and bring scientists closer to better treatments or even the ever-elusive cure.

Making Transgenic Pigs

The researchers achieved two firsts: Their transgenic pigs are the first to carry a human Alzheimer's gene, and they're the first pigs produced by a relatively new method called handmade cloning.

To introduce the disease gene, Jørgensen's team first removed a fibro-

An Easier Way to Clone?

Scientists Arne Lund Jørgensen and Gábor Vajta worked together to create the cloned Alzheimer's pigs. Jørgensen developed the pig model, and Vajta produced the test subjects through his own technique called handmade cloning.

Vajta perfected the method in 2001, and within two years he cloned the first

handmade cow embryo. But cloning pig eggs was particularly challenging—it took 100,000 eggs to successfully clone one, and three years to master the final technology.

The relatively new technique involves dissolving the egg cell's outer membrane, called the zona pellucida, which simpli-

fies further manipulations to the cell. In more commonly used methods, technicians cut a hole in the zona pellucida. The cloning process then takes place inside the cell using specialized instruments called micromanipulators. Vajta's method allows scientists to work on the cell with minimal, less-expensive equipment

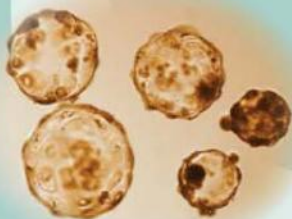


1 A skin cell called a fibroblast is removed from an adult pig, and the human Alzheimer's disease gene is introduced.

2 An unfertilized egg is removed from the ovaries of a sow.

3 The egg cell's zona pellucida, or "shell," is dissolved with enzymes.

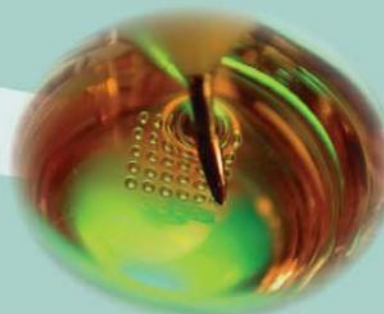
8 Up to 50 such blastocysts, derived from identical copies of the original Alzheimer's fibroblast, are implanted into a sow, which gives birth to identical piglets 16 weeks later.



7 The cells are cultured in a system developed for fragile, zona-free cells until they develop into a blastocyst, an early embryonic stage.

Creating the Perfect Test Subjects

A combination of pigs' anatomy, life span, intelligence and behavior makes them ideal models for human degenerative-disease research. To study Alzheimer's, scientists created seven genetically identical piglets that carry the disease. Here's how they did it.



6 One hour after the first fusion, the fused cells are merged with an additional DNA-free egg cell. The egg cell now contains the complete genetic material from the fibroblast and the egg. Cell division is set in motion by electrical and chemical stimulation.



blast from an adult female pig. The Alzheimer's gene was then inserted into the fibroblast. Once the scientists determined that the Alzheimer's gene was active inside the cell, they allowed it to multiply. They then prepared the pig ova—the cell that will eventually grow into the piglet—to accept the fibroblast's genetic material. To do this, Gábor Vajta, a cloning expert and an affiliate professor at the University of Copenhagen, used a method he developed in 2001. The key: using enzymes to dissolve the zona pellucida, or outer membrane, of the egg. This allowed

the scientists to easily manipulate the egg cell's components by hand, rather than using micromanipulators, tiny instruments used in traditional cloning [for more on this process see "An Easier Way to Clone" on facing page].

Vajta then fused the fibroblast carrying the Alzheimer's gene with the egg cell, which was electrically and chemically stimulated to ultimately become a blastocyst, an embryonic phase. The team produced 40 to 50 identical blastocysts using Alzheimer's fibroblasts that had multiplied from the original. Veterinarians implanted

these blastocysts into a sow.

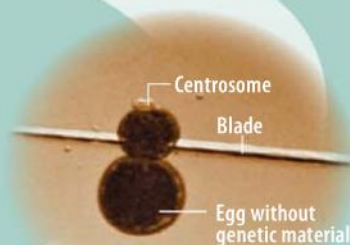
The impregnation resulted in seven identical piglets born in the summer of 2007. Three months later, an autopsy on one piglet showed that the Alzheimer's gene was indeed active in its brain. The researchers will now watch the remaining pigs age, with the hope that the disease will progress in the same way it does in humans.

What We Know So Far

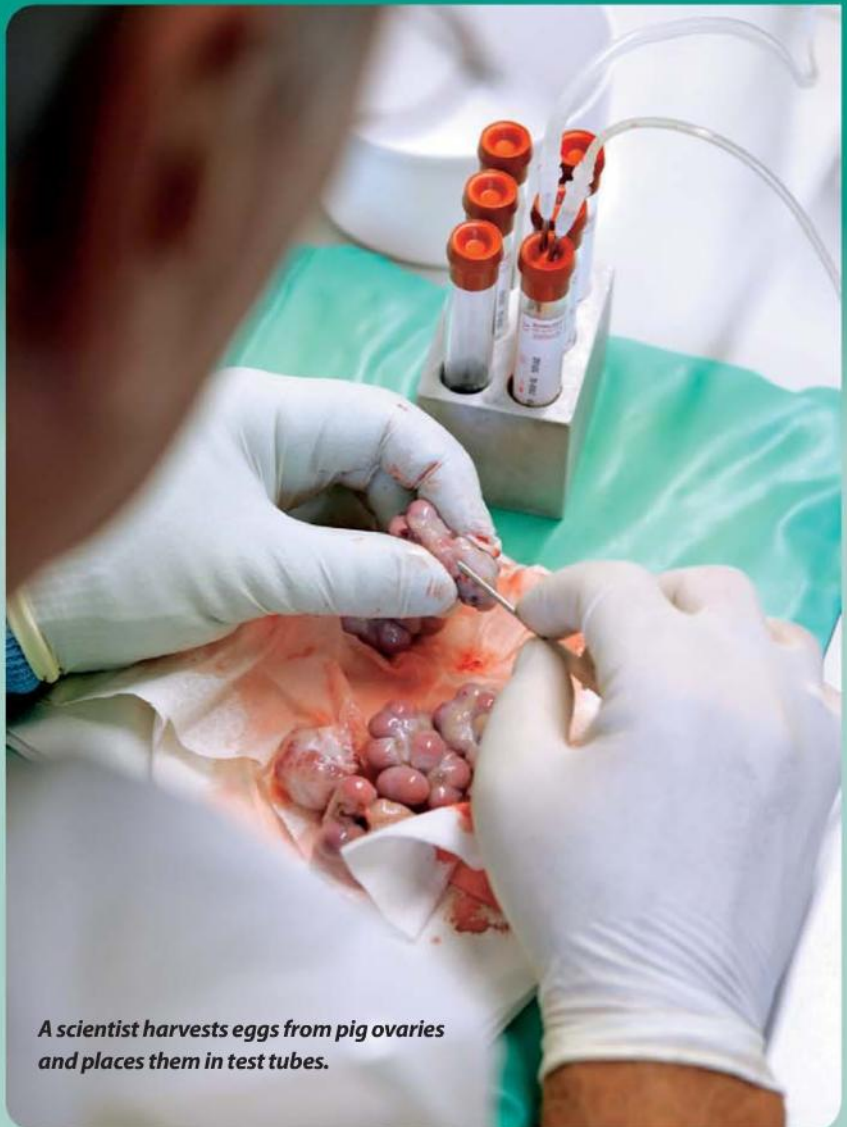
The heritable form of the disease, also known as early-onset Alzheimer's, is the result of a genetic mutation passed

under a microscope, and may prove to be more efficient than traditional cloning. In addition to other benefits, the absence of the outer layer allows technicians to locate and remove the chromosomes without the use of potentially damaging staining and ultraviolet illumination.

4 The scientists locate the genetic material—chromosomes and the centrosome—on the surface of the egg cell under a microscope and make a bisection by hand, using a microblade to remove them.



5 An electric shock fuses the chromosome-depleted egg cell with the skin cell that now carries the Alzheimer's gene.



A scientist harvests eggs from pig ovaries and places them in test tubes.



Veterinarians in Denmark delivered the seven piglets by cesarean section.

Impregnating Pigs

Once the cloned blastocysts were ready, veterinarians at the Biomedical Faculty of the University of Copenhagen took over. Their first challenge was to implant the embryos in the sow's uterus at precisely the right time. Normally, five-day-old embryos are implanted in a sow five days after she goes into heat. But the cloned embryos are more fragile than ordinary eggs, so they were given one more day to develop in the lab before being implanted. To guarantee success, the veterinarians implanted 40 to 50 cloned embryos, rather than the usual 20 to 30.

The vets monitored the pregnancy with ultrasound every two weeks. The sow gave birth to seven cloned transgenic piglets by cesarean section on day 114. They nursed from their mother immediately and were given a bottle of her milk every other hour after that.



The newborn piglets were earmarked so researchers could tell them apart.

down in families. It is the cause of between 5 and 10 percent of cases. Late-onset Alzheimer's, which appears after age 60 in people who usually don't have a family history of the disease, accounts for the rest. Both forms lead to the destruction of nerve cells and neural connections in the cerebral cortex of the brain. The condition destroys memory and causes confusion, disorientation and, eventually, death. Despite intensive research, Alzheimer's disease is poorly understood, and doctors still lack medical treatments to prevent the brain damage it causes.

The process of neurodegeneration begins when enzymes snip a component of nerve cells into small pieces. The resulting protein, called beta-amyloid, accumulates in clumps between the cells. Some of these clumps eventually become large plaques. According to Samuel Gandy, a professor of Alzheimer's-disease research at the Mount Sinai School of Medicine in New York City, amyloid protein outside the nerve cells causes the formation of what are called neurofibrillary tangles inside neurons. Here, a normal component called tau protein accumulates in the twisted fiber proteins. As the disease progresses, brain cells die and the brain itself shrinks, although it's unknown exactly how the two proteins influence cell death. The disease starts in the hippocampus, a part of the brain involved in learning and memory, and later spreads to the rest of the brain.

Although these major steps have been mapped through brain scans and autopsies, scientists need to study how the disease progresses. That's where the pigs come into play. If all goes as planned, the pigs should show signs of brain pathology at age two, which in pig years corresponds to the age when people with early-onset Alzheimer's begin to exhibit symptoms.

Transgenic pigs may one day become test subjects for Alzheimer's drugs, helping scientists develop better treatment for humans.

Tracking the Disease

Mouse models for Alzheimer's have never been able to simulate anything comparable to the last stages of the disease. "Plaque-forming mice do not show extensive nerve-cell death," Gandy says. "It's nothing like human Alzheimer's." But the research group has good reason to believe that their work in pigs will be more successful

than the studies in mice. Research indicates that pigs' nerve cells may possess the biochemical machinery needed to trigger the disease, Jørgensen says. The scientists will use computerized axial tomography and positron-emission tomography (PET) scanners—the same

devices that help diagnose Alzheimer's in humans—to detect the two destructive proteins, beta-amyloid and tau, in early stages. To find beta-amyloid, for instance, the scientists can inject a chemical substance into the bloodstream that attaches to the protein deposits in the brain. If amyloid clumps are present, the substance will accumulate there and be detectable on PET scans. In the later stages of the disease, researchers will be able to follow the progressive death of neurons in the brain using the scanners.

The technology will allow researchers to study for the first time the long-term effects of the disease. "Because the cloned pigs are genetically identical, we expect the pathological changes we find in one pig to be present in the others," Jørgensen says. This will enable researchers to correlate pathological-disease development with changes in behavior.

One very early behavioral symptom the researchers will look for is a diminished sense of smell. They will also test for a loss of memory and spatial recognition by placing the pigs in a room with four compartments, one of which contains a reward. Healthy pigs quickly



Gábor Vajta, a cloning expert, spent years perfecting the technique used for the research.

learn which compartment contains the reward and go right to it. The pigs with Alzheimer's, however, will probably have a harder time remembering which compartment holds the reward.

To further test memory, the pigs will be put in a room with two toys. The following day, one of the two toys will be replaced. Healthy pigs spend more time examining new objects, but once the diseased pigs' memories begin to diminish, it's expected that they will spend the same amount of time sniffing both the old and new toys.

Guinea Pigs

If Alzheimer's progresses in pigs as it does in humans, the animals will give us more than just a better understanding of the disease. Transgenic pigs may also one day become test subjects for Alzheimer's drugs, helping scientists develop better treatments for humans.

Thanks to their longevity, pigs will ideally provide new possibilities for understanding and treating diseases in which an organ's function slowly degrades. Currently, pig genetic sequencing is conducted on an experiment-by-experiment basis—a costly, lengthy

A researcher holds one of the pigs that may further our understanding of Alzheimer's disease.



process. In 2001, scientists began sequencing the complete pig genome which the international Swine Genome Sequencing Consortium expects to publish by early 2010. With both this and the human genome in hand,

transgenic pig models are expected to accelerate. According to Jørgensen, drug and treatment testing of human diseases on transgenic pigs and other large-animal models may eventually be the world standard. ■

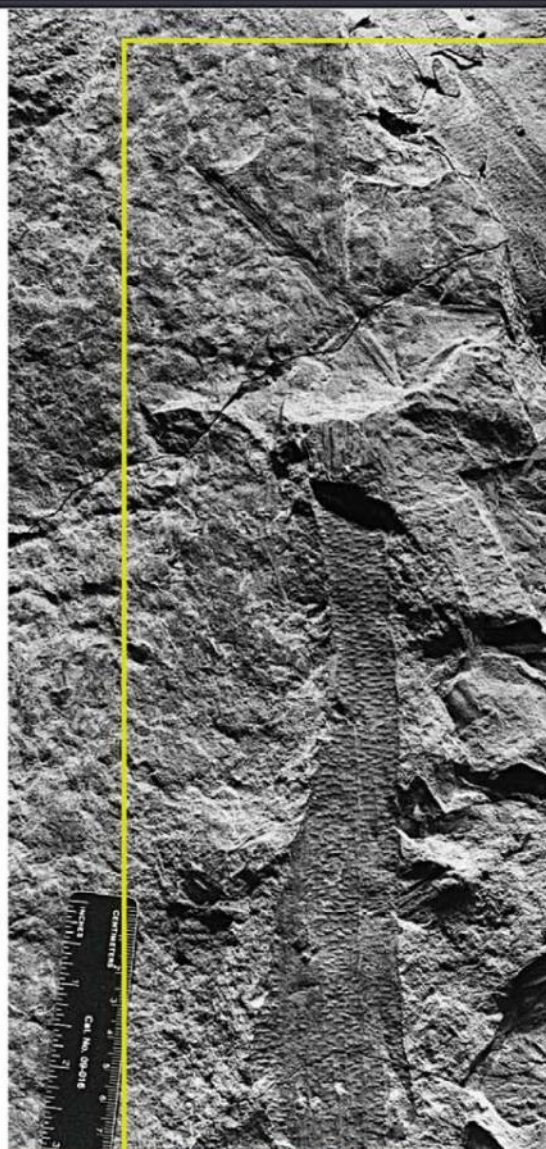
THE WORLD'S OLDEST TREES

Scientists uncover the secret of a mysterious ancient forest in New York State. It could contain remnants of the Earth's first trees

A few years ago, Linda VanAller Hernick and Frank Mannolini, geologists at the New York State Museum in Albany, discovered two ancient plant fossils in a quarry in Schoharie County, New York. One was a prehistoric *Eospermatopteris* trunk, a so-called Gilboa stump, named after the New York town where scientists found a forest of the fossilized tree trunks in

the 1840s. The other fossil, resembling a palm tree, was more interesting. It looked like what they believed the crown of a Gilboa stump would be, although that elusive crown had never actually been found.

In Venezuela and Belgium, scientists have unearthed fragments of similar palm-like fossils, which they thought were short-trunked trees. They



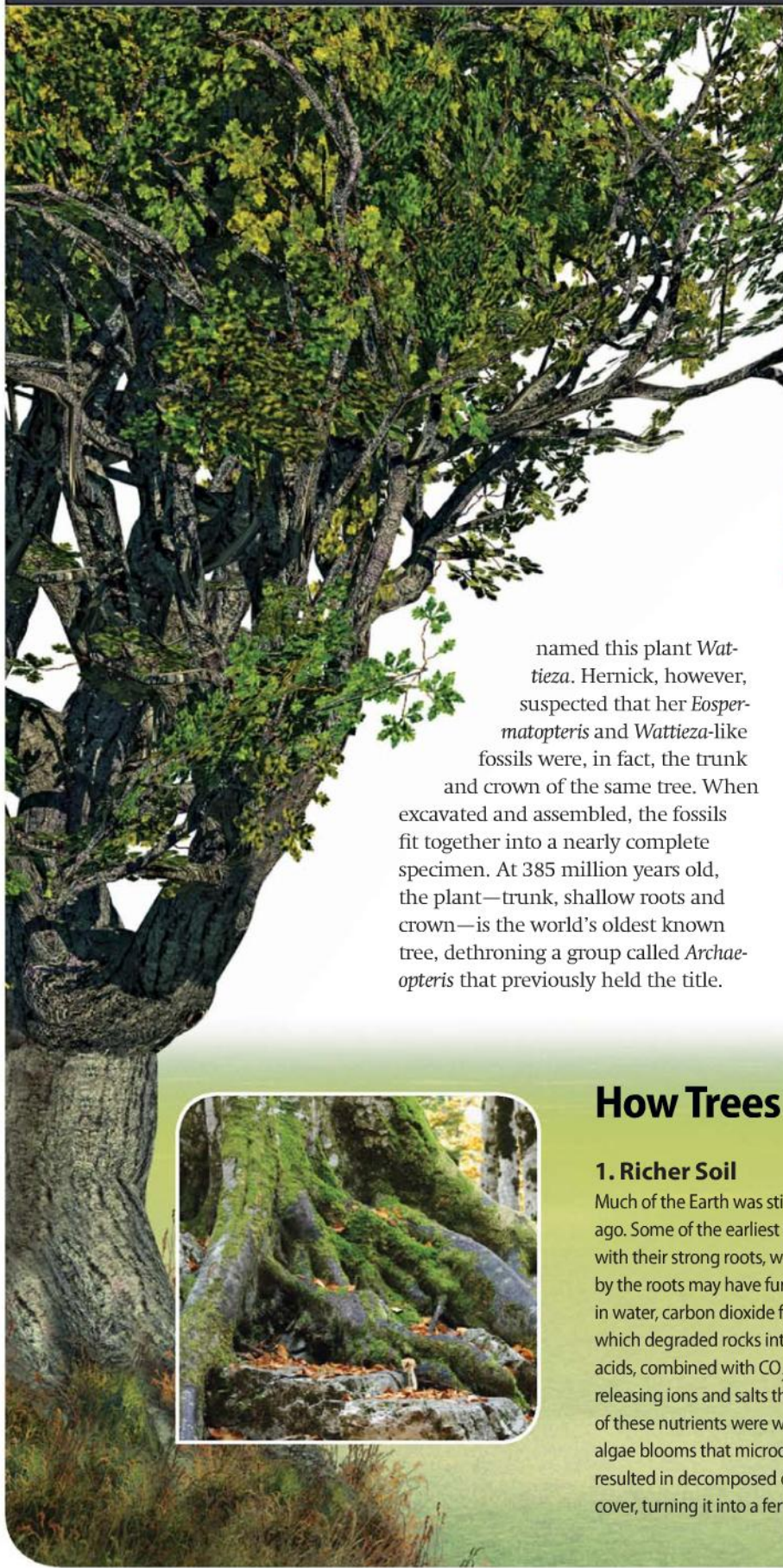
The Devonian period, 416 million to 359 million years ago, marked the emergence and proliferation of trees.



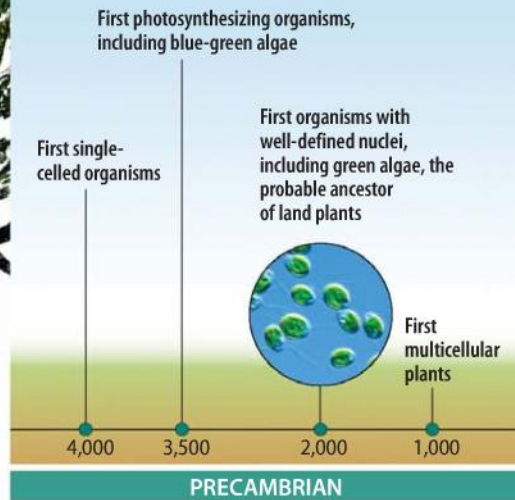


The First Tree?

The line drawing [right] depicts the oldest known tree. To its left is its fossilized trunk, and the larger image on this page is a close-up of the crown and branches.



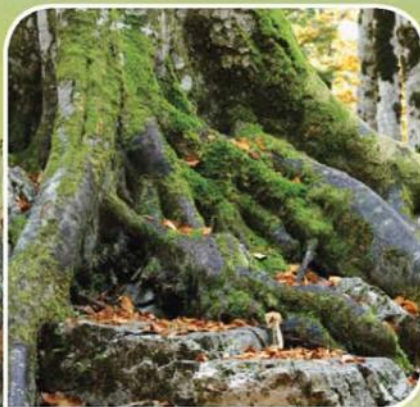
From Cells to Trees



named this plant *Wattieza*. Hernick, however, suspected that her *Eospermatopteris* and *Wattieza*-like fossils were, in fact, the trunk and crown of the same tree. When excavated and assembled, the fossils fit together into a nearly complete specimen. At 385 million years old, the plant—trunk, shallow roots and crown—is the world's oldest known tree, dethroning a group called *Archaeopteris* that previously held the title.

Paleobotanists now believe that the specimens found in New York, Venezuela and Belgium were all members of the same family of trees, called *Cladoxylopsid*, which emerged in the Devonian period, when plants were prevalent. Scientists determined the ages of the fossils using radiometric testing, a method that dates the rock layers in which fossils are found.

"In the past, people guessed at what these trees looked like," says William Stein, a paleobotanist at Binghamton

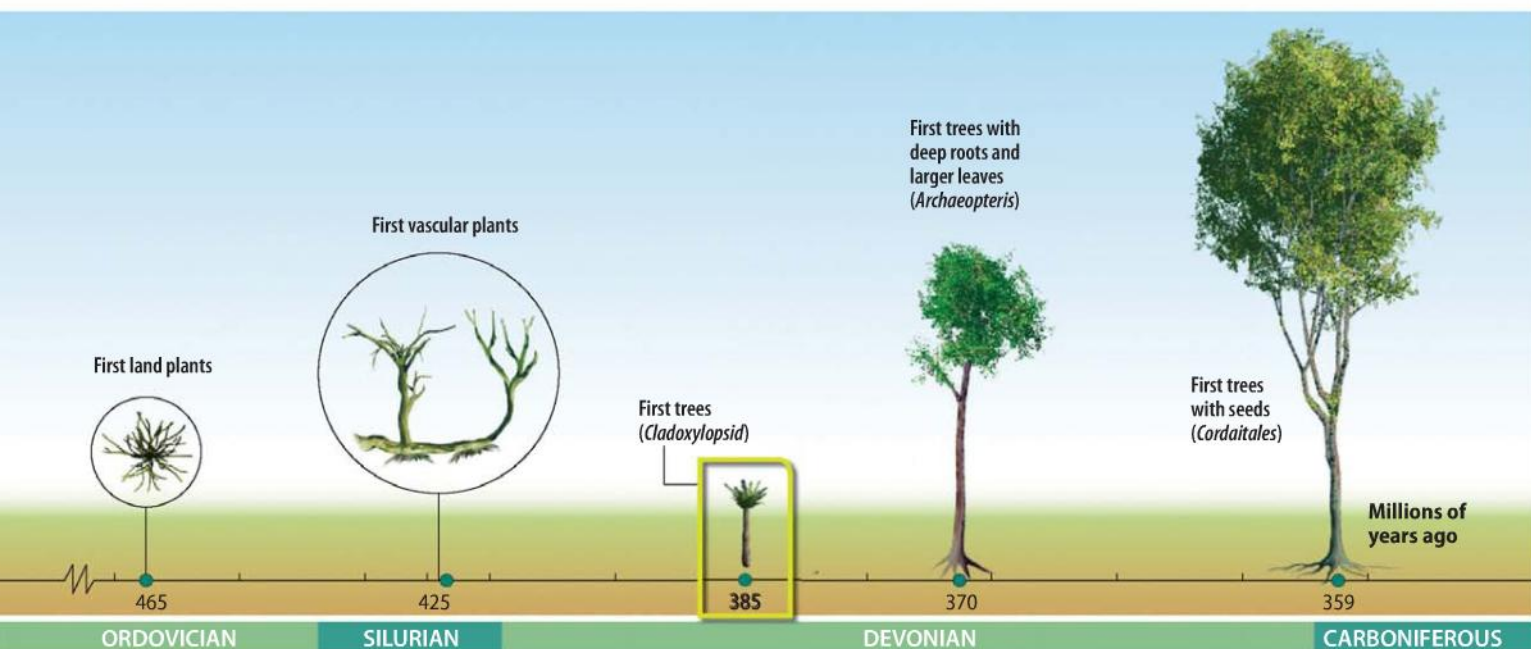


How Trees Changed the World

1. Richer Soil

Much of the Earth was still barren and covered by rocks 370 million years ago. Some of the earliest trees probably helped break these rocks down with their strong roots, which cracked the surface. Organic acids secreted by the roots may have further helped change the terrain. When dissolved in water, carbon dioxide from the atmosphere created carbonic acid, which degraded rocks into claylike soil high in silicate minerals. The roots' acids, combined with CO_2 from the atmosphere, broke the silicates down, releasing ions and salts that the trees could then absorb as nutrients. Some of these nutrients were washed out into lakes and rivers, contributing to algae blooms that microorganisms could feed on. This explosion of life resulted in decomposed organic material that enriched the claylike ground cover, turning it into a fertile soil component called humus.

FROM LEFT: MIKKEL JUUL JENSEN; PICTAL/FOCI; MIKKEL JUUL JENSEN/M. ABBEY/PRINC/FOCI AND NATURAL HISTORY MUSEUM, LONDON; PRECEDING PAGES, FROM LEFT: CHASE STUDIO/PHOTO RESEARCHERS INC./FOCI; STATE UNIVERSITY OF NEW YORK (2)



University who is studying the trees. “Now we know.” The crown consists of a primitive branch system that most closely resembles modern palms, although Stein is quick to point out that these plants are three times as old as the dinosaurs and have no modern equivalent. The complete tree was 20 to 25 feet tall, and the crown shows

scars where it discarded old branches onto the forest floor.

No one knows how the *Eospermatopteris* tree grew or what its interior looked like. Some paleobotanists theorize that the trunk was made of strong threadlike fibers similar to those found in palm trees. Others believe that it may have been hollow toward the top,

with a solid trunk only at the base for stability. Despite remaining questions, however, we now have a much better idea of what the world’s first forests looked like.

Small Plants Became Big Trees

The first plants established themselves on land during the Ordovician period,



2. New Niches

The first trees provided habitats high up in the canopy, in the shade of their leafy branches and amid their discarded branches and leaves on the ground. These environments eventually created opportunities for organisms to evolve. As forests later expanded and an even greater variety of plants emerged, the number of ecological niches grew. It’s theorized that when ice ages occurred, trees—along with the entire biosphere—responded by shifting to those areas not covered by glaciers. As glaciers receded, plants and animals reoccupied their habitats.



3. (Much) Cooler Climate

The idea is highly speculative, but some paleobotanists believe that there’s a connection between land plants like trees and a drop in CO_2 levels during the Carboniferous period (359 million to 299 million years ago), which could have led to an ice age. As tree roots broke down rocks, they created space for water to gather. An increase in water resulted in more breakdown of CO_2 , since the compound is soluble in water. This CO_2 was converted into carbonic acid, which helped to erode rocks in lower levels of water, creating space for more water to gather, and the cycle continued.

Plant Pioneers

First Vascular System *Cooksonia*

To transition from water to land, plants had to develop water-transport tissues that—like the human circulatory system—could provide each individual cell with water and nutrients from the earth. According to the fossil record, the first vascular plant was the moss-like *Cooksonia*, which emerged about 425 million years ago and was discovered fossilized in Wales. Its vascular tissue, called xylem, was a major step in plant evolution and allowed later flora to grow taller. Over time, early plant stems went from a few inches to a foot off the ground. Today, the wood in trees is composed of xylem.



First Trees *Cladoxylopsid*

This group includes the trees in the Gilboa, New York, forest, as well as the Venezuelan and Belgian *Wattiezas*. These 385-million-year-old trees were still restricted to wet areas due to their sporing reproductive system (unlike seeds, spores contain no water for sprouts) and their lack of deep roots, which limited the amount of water and nutrients they could take in from the earth. But their woodlike trunks provided them the stability to grow higher, while their vascular systems moved the water and nutrients they absorbed through their roots to their tops. Height ensured that the first trees received plenty of sunlight, providing an important competitive advantage over shorter vegetation.



First Deep Roots & First Large Leaves *Archaeopteris*

As trees continued to develop taller trunks, they needed roots that could burrow deep into the ground to anchor the plants and take in more water and nutrients from the soil. The Gilboa stumps had shallow roots, but by 370 million years ago, *Archaeopteris* had developed deep ones. Fossils from the group, which have been found around the world, show that the trees grew up to 100 feet tall and had thick trunks terminating in green crowns. Still, *Archaeopteris* was limited to wet environments because it depended on sporing for reproduction.

This group is also credited with large leaves, which help trees obtain more energy from sunlight during photosynthesis and therefore grow much larger. The leaves on the first *Archaeopteris* trees resembled those of today's ginkgos. Large amounts of water evaporate off these leaves to keep them cool—something true for all modern leafy plants.



First Trees with Seeds *Cordaitales*

The shift among green plants from spores to seeds began with *Archaeopteris*, which used an advanced sporing system that produced male and female sex cells much like those contained in seeds. The first true seed-bearing plants were the pteridosperms, primitive fernlike plants that appeared in the late Devonian period. But it was not until 359 million years ago that the first trees with seeds, *Cordaitales*, which are ancestors of today's conifers, emerged. Their loosely formed conelike pods contained seeds. This advance allowed *Cordaitales* to multiply quickly and form forests away from bodies of water.

tens of millions of years before the heyday of the *Cladoxylopsids*. These terrestrial pioneers most likely sprang from aquatic organisms like green algae and spores and were still totally dependent on access to large amounts of water.

Without roots to absorb water from the earth and provide stability for upward growth, and without a vascular system to transport water to every part of the plant, terrestrial flora could grow no more than a few inches tall. Fossils of this ancient flora are plentiful near the town of Rhynie in eastern Scotland. One example found there, the 425-million-year-old *Cooksonia*, resembles today's mosses. Scientists believe that it's the first plant to have developed a vascular system, and that this step in evolution allowed plants to grow taller.

By the late-middle Devonian period, 385 million years ago, the trees at Gilboa had emerged. They had a vascular system—made up of shallow roots and water-conducting cells—and stronger trunk material to support the plant in an upright position. Unlike most modern trees, which develop seeds, they still depended on sporing, a primitive yet efficient form of reproduction used today by ferns, mosses, bacteria and fungi. Because their crowns weren't as full as those of later trees, the world's earliest forests were probably sunnier than today's.

By the late Devonian period, 370 million years ago, plants varying in size, scale and type were flourishing in forests around the world. *Archaeopteris*, a tree with large ginkgo-like foliage, deep roots, a wide trunk and the precursors of seeds, was among these. The genus was enormously successful and spread quickly over the Earth. Deep roots allowed the trees to be firmly anchored while soaring 100 feet into the air, and its larger leaves absorbed more energy from sunlight, facilitating further growth.

Like the *Cladoxylopsids*, *Archaeopteris* used spores to reproduce, but its system was much more complex than that of

its predecessors. Spore sacks developed on the undersides of the tree's leaves, like those that develop on the underside of modern fern's fronds. Until the appearance of *Archaeopteris*, spore cells, which were dispersed by wind, grew into young plants without fusing with another cell. *Archaeopteris*, however, had two types of spores, one that produced egg cells and another that produced sperm cells. This fertilization method is considered by some to be the intermediate step between traditional sporing and seed-bearing.

Spores can survive for incredibly long periods of time in almost any environment, but sporing plants are completely dependent on external water sources. Seeds, which are enclosed in a hard shell, are durable as well. But seeds have an advantage over spores: Their shells store fats, starch and water as backup nourishment for the plant to use once it sprouts.

And unlike most spores, both past and present, seeds also contain two sex cells, one male and one female. This trove of genetic material allows for more adaptations, which is one reason that seed-bearing flora—the more than 300,000 flowering plants on Earth, for instance—have been so successful.

Trees of Life

Paleobotanists believe that the world's first trees competed for water and sunlight. Those that were best adapted thrived, while others disappeared—but not without first leaving their mark. As ancient trees spread across the planet over millions of years, they had a profound influence on other forms of life. Their leaf litter, for instance, gave animals a place to live. *Eospermatopteris*'s discarded branches created an ecosystem on the forest floor where the first arthropods, a group that now includes insects and spiders, could develop. Later, *Archaeopteris*'s leaves fell into waterways, providing nourishment for emerging fish species.

An Ancient Forest of ... Fungus?

Large column-shaped fossils found in Quebec in 1857 were once thought to be the world's oldest trees. Scientists originally concluded that the columns—which are up to three feet thick and 26 feet tall—were the trunks of enormous conifers they dubbed *Prototaxites*. The fossils are 420 million years old, which would have made them the planet's earliest trees.

In 1872, however, a scientist cast doubt on this interpretation, suggesting that the *Prototaxites* were actually giant algae growths. The debate continued over the next century, and in 2001, a scientist at the American Museum of Natural History proposed that the fossils were neither trees nor algae, but fungi. This claim was met with widespread skepticism until last year, when a research team from the University of Chicago confirmed that the columns were indeed a prehistoric fungus.

Green plants and fungi both use carbon. Green plants get their carbon from the air, while fungi obtain it by the decomposition of dead plants and animals. Plants that absorb carbon from the air have a very narrow range of carbon isotopes. The *Prototaxites*, though, demonstrated a wide variation of carbon isotopes, indicating that they consumed different forms of organic matter to obtain carbon. According to C. Kevin Boyle, a paleobotanist at the University of Chicago, experts now widely agree that the *Prototaxites* were fungi that resembled giant telephone poles.



Trees? More like mushrooms, say scientists.

Today, it's hard to imagine our planet without its great variety of trees. Consider the superlatives: the North American giant sequoia, for instance, whose trunk circumference can reach more than 100 feet, or the recently discovered Swedish spruce with its 9,550-year-old roots. Or take the blossomed beauties, like the dainty cherry and

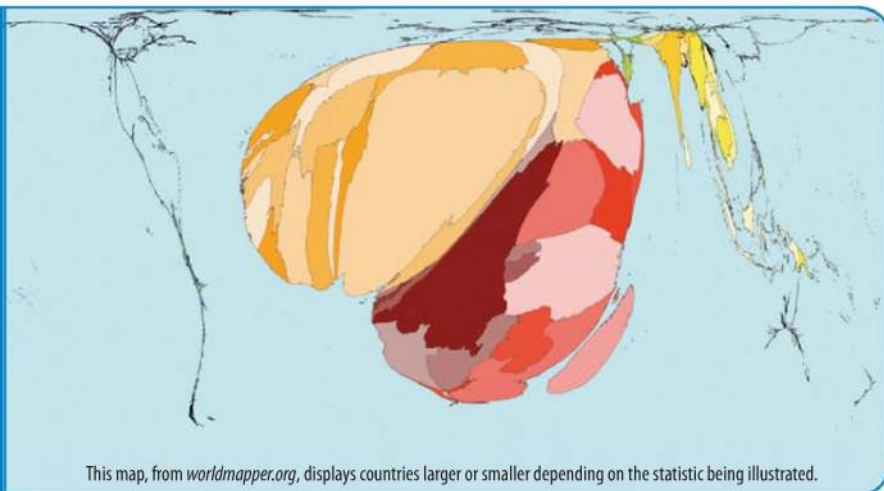
the bold magnolia. Or the providers, which give us timber, coffee, spices and fruit. Compared with these marvels, members of the *Cladoxylopsid* family would look unremarkable if you were to stand in a forest of them. But we are indebted to these otherwise ordinary specimens for the magnificent trees we have today. ■



Our Lopsided World

Malaria Still a Killer in Africa

More than 80 percent of all deaths due to malaria happen in sub-Saharan Africa. Malaria is a disease caused by a parasite that is most commonly carried by some species of female *Anopheles* mosquitoes. Outside of Africa, cases occur in South and Southeast Asia, Central America and parts of South America.



This map, from worldmapper.org, displays countries larger or smaller depending on the statistic being illustrated.

Elemental Secrets

Magnesium

■ *The green color in plants results in part from magnesium, which has a central role in the chlorophyll molecule that harvests light during photosynthesis.*

■ *Magnesium is a metal that burns easily, with an intense white flame that is hard to extinguish. It reacts with the nitrogen in air, so it doesn't need oxygen to burn. This bright white illumination was once the source of camera flashes and is still used in fireworks.*

■ *Although the metal alone is fairly strong, its strength increases when combined in alloys with aluminum, zinc and manganese for use in manufacturing. It is also five times as light as steel and is used in the production of cars and airplanes, where low weight is critical.*

Protons

12

Mg

24.305

Atomic weight

Research Footnotes

A Metal That Keeps Pigeons Away

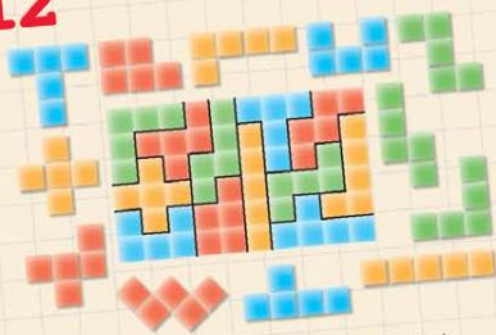
In 2003, Yukio Hirose, a professor at Kanazawa University in Japan, began to investigate why pigeons foul some statues and leave others alone. His test subject: a 120-year-old bronze figure located in a park in Kanazawa. This statue has never had a pigeon problem.

Hirose took samples and discovered that the bronze in the statue contains the element gallium. Several tests indicate that this silver-gray metal somehow repels pigeons and other birds, although the cause is unknown. He went on to win the top prize for chemistry at the Ig Nobel awards, a parody of the Nobel Prizes celebrating unusual scientific research.

Tricky Number 12

If you have five square tiles, you can make them into exactly 12 unique figures, as shown here. These figures are called pentominoes, a term coined by Southern California University mathematician Solomon W. Golomb in the 1950s.

If you make a set out of cardboard, you can test your ability to create different shapes, such as rectangles like the one in the center of this graphic. The rectangles must have an area of 60 units so that there is space



for all of the 12 figures, each of which consists of 5 squares. (The rectangles can be 6 by 10 squares as shown here, 3 by 20, 4 by 15, or 5 by 12.)



FROM TOP: SASI GROUP/M. NEWMAN; ISTOCK

VISIT OUR WEBSITE
TO VIEW SAMPLE
VIDEO CLIPS OF
EVERY COURSE



Having Math Problems? WE CAN HELP!

MATHTUTORDVD.COM

Press Play For Success

AWARD
WINNING
MATH & PHYSICS
TUTORIAL DVDS

SUBJECTS:

BASIC MATH	7 HOURS	-\$26.99
BASIC MATH WORD PROBLEMS	8 HOURS	-\$26.99
PRE-ALGEBRA/ALGEBRA 1	10 HOURS	-\$26.99
ALGEBRA 2	6 HOURS	-\$26.99
ALGEBRA WORD PROBLEMS	6 HOURS	-\$26.99
GEOMETRY	9 HOURS	-\$26.99
ADVANCED ALGEBRA	7 HOURS	-\$31.99
MATRIX ALGEBRA	7 HOURS	-\$31.99
TRIG/PRECALCULUS	5 HOURS	-\$31.99
CALCULUS 1&2	8 HOURS	-\$36.99
ADVANCED CALCULUS 2	14 HOURS	-\$49.99
CALCULUS 3, VOL 1	10 HOURS	-\$44.99
CALCULUS 3, VOL 2	11 HOURS	-\$49.99
PHYSICS	11 HOURS	-\$39.99
PROBABILITY & STATISTICS	10 HOURS	-\$39.99
UNIT CONVERSIONS	4 HOURS	-\$21.99



All topics taught
entirely through worked
example problems.

RECENT STUDENT FEEDBACK:

"Your methods are so clear that my seven year old son was grasping the trigonometry lessons. I'm picking up some new things as well." **Gary G.**

"Watching your videos is wonderful because, as you work the problems, you show and explain every step." **Marilyn D.**

"All of the instruction and examples on the DVDs are very clearly explained and your style of teaching definitely makes the viewer very comfortable with the material being presented." **Doug F.**

"I found the lectures very clear, straight to the point, and the pace was just right for me, who has not seen any calculus or trig in the past 10 years and needed to come up to speed fast." **Sophia A.**

"You have a serious teaching gift." **Dennis S.**

"I tell all my friends who have difficulty in algebra, calculus, or physics that there is help available at MathTutorDVD.com. It would be selfish to keep this information to myself! I have two words for you, "thank you!" **Les J.**

Raise grades or your money back

TO ORDER: 877-MATH-DVD or www.MathTutorDVD.com

Hands on Optics

The World's Best Science Dealer.

Telescopes for: Beginners, families, first time buyers, pros.

Call toll free! - 1.866.726.7371

Meade Binoculars



Celestron Microscopes



Celestron
Telescopes



We carry all the top brands at every price!

Celestron Coronado Meade Pentax Skywatcher Stellarvue Takahashi Vixen

Visit us online at www.HandsOnOptics.com

26437 Ridge Road, Damascus, Maryland 20872

DID YOU KNOW ...



INSECTS number 10 quintillion—that's a billion billion. Compare that to the 6,718,322,326 humans living on Earth (at press time).



COLOR BLINDNESS was first described in the late 1700s, when English chemist John Dalton published a scientific paper on the condition. Dalton himself was color-blind.



NORTHERN JACANAS, birds native to Central America and the Caribbean, have the world's longest toes in proportion to their bodies. The birds are eight to nine inches tall, but their toes can be as much as half that length. Jacanas forage for food by walking on water lilies.



This newly discovered species is the only frog known to have no lungs.

Nature's Curiosities

World's Coolest Frog?

In 1978 scientists in Borneo first spotted a small brown frog that they believed to be a previously unknown species. The frog, however, was dead, and a live one hadn't been captured—until now.

Recently, researchers tracked down the species close to where the specimen was seen 30 years ago, on the Indonesian side of the island. When the frogs were dissected, the scientists realized that they had stumbled upon a sensational discovery: frogs without lungs. These frogs, *Barbourula kalimantanensis*, absorb all their oxygen through their skin. Although most other frogs breathe, in part, through their skin, they also have lungs.

The researchers speculate that the absence of lungs may be beneficial in the fast-moving mountain streams where these frogs live. Without air-filled lungs, the frogs sink rather than float, which may protect them from being picked up and carried away by the current. The frog's flat body may have helped in the adaptation; the shape increases the surface area of the breathable skin, allowing the amphibian to take in more oxygen from the water.

Highs & Lows



The biggest primates...

Gorillas are the heaviest. Wild males can weigh up to 485 pounds and reach 5½ feet tall. (Females weigh half as much on average and reach only 4¾ feet.)

...and the smallest

Pygmy marmosets are the world's tiniest primates, weighing only three ounces. Their bodies, minus the tail, are about six inches long.



CLOCKWISE FROM TOP LEFT: MITSUHIKO IMAMORI/MINDEN PICTURES; D. BICKFORD/EPA/SCANPIX; NATURE P.L. SUZI ESZTERHAS/MINDEN PICTURES; HUMMEL/ALAMY; DAVID NICHOLLS/PHOTO RESEARCHERS



One day, his son would
speak to the world.

He wanted them
to understand.

Rosetta Stone. The fastest and
easiest way to learn CHINESE.

Arabic • Chinese (Mandarin) • Danish • Dutch • English (American) • English (British) • French • German • Greek • Hebrew • Hindi • Indonesian • Italian • Irish • Japanese • Korean • Latin • Pashto • Persian (Farsi) • Polish • Portuguese (Brazil) • Russian • Spanish (Latin America) • Spanish (Spain) • Swahili • Swedish • Tagalog (Filipino) • Thai • Turkish • Vietnamese • Welsh

Only Rosetta Stone® uses **Dynamic Immersion**® to teach you a language quickly and efficiently without tedious translation, mindless memorization and boring grammar drills. It's the world's leading language-learning software.

- You'll experience **Dynamic Immersion** as you match real-world images to words spoken by native speakers so you'll find yourself engaged, and learn your second language like you learned your first... for a faster, easier way to learn.
- Our proprietary **Speech Recognition Technology** evaluates your speech and coaches you on more accurate pronunciation. You'll speak naturally.
- And only Rosetta Stone has **Adaptive Recall**™, that brings back material to help you where you need it most, for more effective progress.

See the world in a whole new way. Get Rosetta Stone—**The Fastest Way to Learn a Language. Guaranteed**®.

SAVE 10%!

100% GUARANTEED
SIX-MONTH MONEY-BACK

Level 1	Reg. \$219 NOW \$197
Level 1&2	Reg. \$359 NOW \$323
Level 1,2&3	Reg. \$499 NOW \$449



©2008 Rosetta Stone Ltd. All rights reserved. Patent rights pending. Prices are subject to change without notice. Six-Month Money-Back offer is limited to product purchases made directly from Rosetta Stone and does not include return shipping. This offer does not apply to Rosetta Stone Online or Audio Companion™ purchased separately from the software product. All materials included with the product at the time of purchase must be returned together and undamaged to be eligible for any exchange or refund.

Call
(877) 278-1060

Online
RosettaStone.com/sws098

Use promotional code **sws098** when ordering.
Offer expires January 31, 2009.

RosettaStone® 



Earn more points by using fewer clues to answer each question.		5 points	4 points	3 points	2 points	1 point
ZOOLOGY	Name this animal	<i>Cimex lectularius</i> (its scientific name) was nearly eradicated in the U.S. in the 1950s.	It can live nearly a year without eating.	In the past few years, it has become more common across the U.S. in homes and hotels.	This flat bug might hide in luggage or furniture, or in cracks in floors and walls.	Good night, sleep tight, don't let the _____ bite!
ARCHITECTURE	Name this building	The design for this structure was chosen during an architectural competition held in 1792.	It was burned by the British in 1814. When it was rebuilt, a semicircular pillared portico was added to its south front.	Its street address is 1600.	Its current name, which became official in 1902, reflects the color of the sandstone from which it is built.	It was originally called the Executive Mansion.
MATHEMATICS	Name this number system	The 64 hexagrams found in the <i>I Ching</i> , the ancient Chinese "Book of Changes," are based on it.	Our number system—the decimal system—has a base of 10. This system, which we use indirectly, has a different base.	If we used this system for counting, we would get 0111 years of bad luck for breaking a mirror.	It is used in computer technology.	The name of this system comes from the Latin <i>bini</i> and means "consisting of two."
PERSONALITIES	Name this explorer	This Portuguese navigator was about 12 years old when Columbus "discovered" the Americas.	In 1519, he set sail on the first successful circumnavigation of the world, although he was killed before the expedition was completed.	He discovered the 350-mile-long strait linking the Atlantic Ocean with the Pacific Ocean. The strait now bears his name.	His first name in Portuguese was Fernão. He also sailed for the Spanish, who called him Fernando.	His full name was Fernão de Magalhães, but it is spelled differently in English.
MEDICINE	Name this symptom	Called <i>icterus</i> in Latin, it is caused by an excess of bilirubin, bile's brownish-yellow pigment.	It is often associated with liver problems.	Many people experience this after becoming infected with the hepatitis virus.	It sometimes occurs in newborns.	It turns the skin and whites of the eyes yellow.

What year was it?

January 24, United States: Candy-store owner Christian K. Nelson patents the Eskimo Pie, which was originally called the I-Scream bar.

November 26, Egypt: English archaeologist Howard Carter discovers King Tutankhamen's tomb. The king ruled Egypt from 1333 to 1323 B.C. and died when he was around 18 years old.

December 30, Eurasia: Russia, the Ukraine, Belarus and the Transcaucasia ally to become the Union of Soviet Socialist Republics (USSR).

Your guess	Points
Correct year	5
± 2 years	4
± 4 years	3
± 6 years	2
± 8 years	1



Your score:

24–30 Good show, Sherlock
17–23 Not bad, Watson

9–16 Good enough, Paris
0–8 Hit the books, Homer!

GET OVER 100 MILES PER GALLON, EVEN WITH AN SUV!



We Are Developing A Relatively Inexpensive Modification That Will Give:

- Incredible Savings
- Better Performance
- More Horsepower
- Decrease pollution

**AS SEEN ON
NBC, ABC, CNN
and FOX News
NATIONWIDE!**



*Plus many local TV channels with hundreds
of vehicles beating our 50% minimal
mileage increase guarantee!*

THE SCIENCE BEHIND THE SOLUTION

We have a two-part process to modify vehicles. Our first step is to install a Hydro-Assist Fuel Cell Kit. Using electricity from your battery, it turns water into pure gas that is mixed with your gasoline in the combustion chamber. The water gas is so rich (5X the potential energy of gasoline) that the amount of gas used to get the same power needed can be leaned out. We use a Covalizer (to break down the covalent bonds of the fuel), heat, plus ionization to pre-treat the car's fuel as well. The combination can greatly decrease the amount of fuel needed. We have also invented a mini-computer that actually teaches the on board computer to operate our system. We absolutely guarantee to increase fuel economy by a minimum of 50% (and have experienced double mileage, even with SUVs) with this first step.

The second step is to install a customized Pre-Ignition Catalytic Converter (PICC) that will actually turn your fuel into plasma and burn it so clean that there is no pollution. Laboratory tests have shown us that it will soon be possible to get over 100 miles per gallon even with the larger SUVs and Pickups.

**Want to Know More? Go to
WWW.PICCTV.COM/SCNC**

Choose Life Grow Young with HGH

From the landmark book *Grow Young with HGH* comes the most powerful, over-the-counter health supplement in the history of man. Human growth hormone was first discovered in 1920 and has long been thought by the medical community to be necessary only to stimulate the body to full adult size and therefore unnecessary past the age of 20. Recent studies, however, have overturned this notion completely, discovering instead that the natural decline of Human Growth Hormone (HGH), from ages 21 to 61 (the average age at which there is only a trace left in the body) and is the main reason why the body ages and fails to regenerate itself to its 25 year-old biological age.

Like a picked flower cut from the source, we gradually wilt physically and mentally and become vulnerable to a host of degenerative diseases, that we simply weren't susceptible to in our early adult years.

Modern medical science now regards aging as a disease that is treatable and preventable and that "aging", the disease, is actually a complication of various diseases and pathologies, from everything, like a rise in blood glucose and pressure to diabetes, skin wrinkling and so on. All of these aging symptoms can be stopped and rolled back by maintaining Growth Hormone levels in the blood at the same levels HGH existed in the blood when we were 25 years old.

There is a receptor site in almost every cell in the human body for HGH, so its regenerative and healing effects are very comprehensive.

Growth Hormone first synthesized in 1985 under the Reagan Orphan drug act, to treat dwarfism, was quickly recognized to stop aging in its tracks and reverse it to a remarkable degree. Since then, only the lucky and the rich have had access to it at the cost of \$20,000 US per year.

Many in Hollywood's glamour sets, who never seem to age like you or I, have a special secret to tell, and even space pioneer and US Senator John Glen stays vital with HGH.

The next big breakthrough was to come in 1997 when a group of doctors and scientists, developed an all-natural source product which would cause your own natural HGH to be released again and do all the remarkable things it did for you in your 20's. Now available to every adult for about the price of a coffee and donut a day.

GHR now available in America, just in time for the aging Baby Boomers and everyone else from age 30 to 90 who doesn't want to age rapidly but would rather stay young, beautiful and healthy all of the time.

The new HGH releasers are winning converts from the synthetic HGH users as well, since GHR is just as effective, is oral instead of self-injectable and is very affordable.

GHR is a natural releaser, has no known side effects, unlike the synthetic version and has no known drug interactions. Progressive doctors admit that this is the direction medicine is seeking to go, to get the body to heal itself instead of employing drugs. GHR is truly a revolutionary paradigm shift in medicine and, like any modern leap frog advance, many others will be left in the dust holding their limited, or useless drugs and remedies.

It is now thought that HGH is so comprehensive in its healing and regenerative powers that it is today, where the computer industry was twenty years ago, that it will displace so many prescription and non-prescription drugs and health remedies that it is staggering to think of.

The president of BIE Health Products stated in a recent interview, I've been waiting for these products since the 70's. We knew they would come, if only we could stay healthy and live long enough to see them! If you want to stay on top of your game, physically and mentally as you age, this product is a boon, especially for the highly skilled professionals who have made large investments in their education, and experience. Also with the failure of Congress to honor our seniors with pharmaceutical coverage policy, it's more important than ever to take pro-active steps to safeguard your health. Continued use of GHR will make a radical difference in your health, HGH is particularly helpful to the elderly who, given a choice, would rather stay independent in their own home, strong healthy and alert enough to manage their own affairs, exercise and stay involved in their communities. Frank, age 85 walks two miles a day, plays golf, belongs to a dance club for seniors, has a girl friend again and doesn't need Viagra, passed his drivers test and is hardly ever home when we call - GHR delivers.

HGH is known to reverse Hemorrhoids, Autoimmune Diseases, Macular Degeneration, Cataracts, Fibromyalgia, Angina, Chronic Fatigue, Diabetic-neuropathy, Hepatitis C, Chronic Constipation, High Blood Pressure, Sciatica, Asthma and Menopause symptoms, helps Kidney Dialysis, and heart and stroke recovery.

New! Doctor
Recommended

The Reverse Aging Miracle

RELEASE YOUR OWN GROWTH HORMONE AND ENJOY:

- Improved sleep & emotional stability
- Increased energy & exercise endurance
- Loss of body fat
- Increased bone density
- Improved memory & mental alertness
- Increased sexual potency
- Increased muscle strength & size
- Reverse baldness & color restored
- **Regenerates Immune System**
- Strengthened heart muscle
- Controlled cholesterol
- **Normalizes blood pressure**
- Controlled mood swings
- Wrinkle disappearance
- Reverse many degenerative disease symptoms
- Heightened five senses awareness
- Increased skin thickness & texture

All Natural
Formula

This program will make a radical difference in your health, appearance and outlook. In fact we are so confident of the difference GHR can make in your life we offer a 100% refund on unopened containers.

1-877-849-4777

www.biehealth.us

A Product of
Global Health
Products



BIE Health Products
3840 East Robinson Road
Box 139
Amherst, NY 14228

GHR

DIV 2037839 ON

For more information or to
order call **877-849-4777**
www.biehealth.us
©copyright 2000

These statements have not been evaluated by the FDA.

MEDICAL DISCOVERY!

Our home water machine is the only product in the world that increases blood flow by rapidly reheating water 100's of times/gal, breaking down the hydrogen bonds so your body doesn't have to...with fantastic results (Diabetics, MS Victims, etc.)!! Dr. Guy Abraham, M.D. (UCLA):

"We can measure the ability of blood (94% water) to go through a membrane and into the cells. Nothing comes close to your water! Instead of a 104° hydrogen bond angle, yours is 114°!" (See below)

Listen to a toll free recording at 1-800-433-9553

As word of this discovery spread, orders from the scientific community poured in. A major Washington newspaper said they had over 50 phone calls ranging from Los Alamos to Johns Hopkins: *"Those machines do the seemingly impossible!"* Livermore lab: *"We heard about this discovery over a year ago, but couldn't find you so we called the U.S. Patent Office. We want your E5 machine."* This man has PhD's in EE, Quantum Physics and Chemistry. Edmonton Hospital M.D.: *"I also have a PhD in Quantum Physics. You are light years ahead of everyone else. We are 1000% behind you!"*

Since we are engineers, not doctors, we keep the letters and medical reports. One of the worst cases (the report from the oncologist is on file): The man had inoperable colon cancer, tumors on the lung (lung cancer) and

lesions in the liver. This man was lucky because the man's wife is in the medical field and knew about our machines. You can see on the medical chart because of the increased energy and blood flow: The moment the water got into the blood stream the CEA marker went down even before they started to treat him and every time they gave him a CAT scan the tumors became smaller until they disappeared! After breaking down the hydrogen bonds, cancer cells can't survive in a high blood oxygen environment. Also, when you open up the bond angle your blood can circulate more oxygen coming into your lungs. Oxygen is coming in from two sources! That's why the CEA marker quickly drops! This also helps emphysema!

Typical MS victims: *"In spite of medication, by the time I received your machine I was in a wheelchair and couldn't speak. Now, I am fine and they took me off medication!"*; *"You could put a needle in my foot and I wouldn't feel it. Blood flow came back in only two days!"*

ALS: *"I was told I was incurable. By the time I received your machine my fingers were frozen solid and they were spoon feeding me. Now, I am writing you this letter showing I can move my fingers!"*

It saves diabetics...blood flow. Since blood flow can easily be measured, you don't need double blind studies and we have no honest critics because all they have to do is these simple tests! 97% of all men will eventu-

TRY A BOTTLE OF WATER!

Just add a few drops to whatever you are drinking or buy a machine and make all of your own drinking water! Shipped in a glass bottle, corked and shrink wrapped like champagne!

Just \$29! (plus \$10 shipping)

Send your check, money order or credit card order for \$39 to:
Crystal Clear, 143 Old Quarry Road, Shohola, PA 18458
or call 570-296-0214 / fax 570-296-6912.

For information and machine orders:

call 845-754-8696 / fax 845-754-7866

*ALSO AVAILABLE AT BETTER HEALTH FOOD STORES!

ally have a swollen prostate and this water passes through very easily, eliminating stop-start morse code. Results are immediate unless there is a tumor blocking the flow, then it takes longer (above).

Our water also kills pathogens when the purest water won't! If you look at our website johnellis.com you will see signed letters from Organa and the State of Colorado with an "untreatable" municipal waste lagoon. Dole International knows it works better than chlorine that harms the environment! Dr. Guy Abraham M.D., his colleagues and others deserve a lot of credit for alerting the medical and scientific world about our machines!

Learn more! It may save your life!

**Call us for information 845-754-8696
or fax your name and address
to 845-754-7866.**

CLASS ACTION LAWSUIT!

With no medical warning labels, they hide blood/water flow problems (above) with disastrous consequences! Like cigarettes, don't miss out on industry billions! Even distillers are sold to the "Water Wise," in spite of a gov't recall, that ruins lives while the company "exposes water scams!"

Water Type	Hydrogen Bond Angle	Will it kill Pathogens?
Med Water	114°	Yes
Steam	120°	Yes
Ordinary Water	104°	No
Distilled Water	101°	No

Visit our Website www.JohnEllis.com

WRITE FOR FREE INFORMATION

I understand the information you are providing is for educational purposes only. As stated above, this information is not intended to diagnose, treat, cure or prevent disease. In all health-related situations, qualified healthcare professionals should always be consulted.

Name _____
Address _____
City/State/Zip _____

CRYSTAL CLEAR Dept. S1106, Westbrookville, NY 12785 **Visit our website: www.johnellis.com**

Did you ever get an answer as to why seemingly good people suffer a lifetime of problems and trouble and then, often painfully, depart this life? Consider that it is adversarial thinking that causes people to be subject to that result.



Richard W. Wetherill
1906-1989

Science tells us that people emit electronic brain waves so that six billion sources of adversarial thinking would exert a strong force for adversity, wouldn't it?

The earth's population is beset with unresolved problems of stress, depression, deprivation, and vicious assaults of nature to mention several serious problems.

If those facts are correct, then universal rational, honest thinking would eliminate such adversities, wouldn't it?

That is the message of our public service advertising.

If you continue reading, you will learn of a natural law that when conformed to provides a life of social, physical, and emotional well-being.

Whoever or whatever is the creator has provided laws of nature that when identified explain their function. Over the years those natural laws have enabled researchers to develop services, products, and procedures that have greatly improved people's lives.

Consider the functioning of gravity, for example. As long as people conform to the requirements of that natural law, they keep their balance, and no harm results. If while hurrying, they disregard gravity's requirements, the result could be trivial, serious, or even fatal.

As a young man in the 1920s, the late Richard W. Wetherill started publicizing a behavioral law of nature he had identified from insights and observations of his and other people's behavior. His understanding of this behavioral law answers the question as to why people experience problems and trouble with their relationships, their health, and their careers.

The law states: **Right action gets right results, whereas wrong action gets wrong results.**

Some people regard those words as axiomatic but fail to realize the power those words display in life's daily affairs. They forget that **every law of nature defines its function and is relentlessly self-enforcing.**

Because of conventional training, people often think

they already know what is right action, or question Wetherill's ability to know. The fact is that the law defines right action—no person. We use words to define it such as **action that is both rational and honest.** People's definitions of right action tend to be *their* definitions, which is why society is not trouble-free.

Unless a person is a scientist, inventor, or researcher, who thinks about natural laws? People conform to them with no awareness that a natural law is involved. In general, people unwarily make their own behavioral choices.

For example, they repeatedly form critical thoughts about what happens and who is involved, thereby reacting emotionally rather than responding to situations rationally and honestly.

Nature's behavioral law unerringly penalizes personal choices, and that is why people who do not conform deprive themselves of the law's protection.

Those people need help. They need descriptions of the behavioral law, as it provides that help. Read and reread our inexpensive books. When people intend to be right for right's sake, past trouble-making thoughts are released, and a picture is revealed of the opportunity for a trouble-free future intended by whoever or whatever is the creator of life.

Visit our Website www.alphapub.com to learn more. To speak with someone about books or request a free mailing or discuss the law, call 800.992.9124. If you reach voice mail, *slowly* spell your name, address, and name the specific publication where you learned about The Alpha Publishing House. Write to us at 1101 Enterprise Dr., PO Box 255, Royersford, PA 19468-0255. Our mailing list is never distributed.

Text by E. Marie Bothe, President of The Alpha Publishing House.

Dino-Lite USB Digital Microscope



Practical, Portable, Versatile



Adjustable
focus and magnification
1.3MP

BigC.com
See more, Do more

**FREE
Report**

**\$10⁰⁰
Value**

Exposes Water Scams

Shocking truths revealed about:

- ✓ tap
- ✓ alkalized
- ✓ bottled
- ✓ clustered
- ✓ filtered
- ✓ oxygenated
- ✓ mineral
- ✓ reverse osmosis
- ✓ spring
- ✓ steam distilled...

Which one should you drink?

FREE Report & Catalog

1-800-874-9028

www.waterwise.com

LASERGLOW TECHNOLOGIES

Rigel-2
yellow laser pointer
\$399

Aquarius-2
blue laser pointer
\$499

Galileo-3
green laser pointer
\$79

Higher Powered
models available up to 400mW!
See website for current specials.

**MAKES A GREAT
CHRISTMAS
GIFT!**

Use discount code
410120102 to save **10%**
on any purchase.

416.729.7976
sales@laserglow.com
www.laserglow.com

*Photos of actual Laserglow lasers in use.

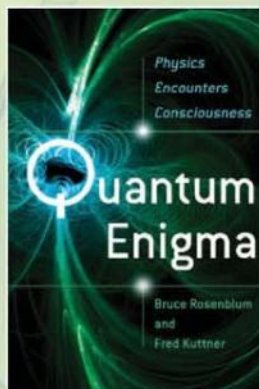
New from

**OXFORD
UNIVERSITY
PRESS**

QUANTUM ENIGMA

Physics Encounters
Consciousness

Bruce Rosenblum and Fred Kuttner



2008 224 pp.
978-0-19-534250-5 paper \$15.95

Forget String Theory!
The quantum mystery is
much closer to you.

And also reject the
quantum pseudo-science!
The *real* quantum mystery
is more profound.

The quantum science basic to
one-third of our economy
encounters consciousness.

**"A remarkable and readable
presentation..."**—Charles Townes,
winner of the Nobel Prize
in Physics

**"the clearest expositions I have
ever seen."**—George Greenstein,
Professor of Astronomy,
Amherst College

Much more at
quantumenigma.com

**OXFORD
UNIVERSITY PRESS**

Prices are subject to change and apply
only in the US. To order, please contact
customer service at: 1-866-445-8685,
or visit us online at www.oup.com/us

The Slide and Negative to Digital Picture Converter



**FREE STANDARD
SHIPPING**

on The Slide and
Negative to Digital
Picture Converter

when you order by Jan. 31, 2009.

This device converts 35mm slides and film negatives into digital images, allowing you to easily preserve your memories without having to rely on a conversion service. Slides and negatives are placed into a tray that aligns each properly; the touch of a button scans the image instantly. It has a 5MP CMOS sensor that provides 10 bits per color channel for data conversion and uses fixed focus and automatic exposure control and color balance, resulting in clear digital images. It can scan images up to 1,800 dpi and uses three white LEDs as a back light source. It is powered by a USB cable (requires USB 2.0) that plugs into a PC running Windows XP (not Vista) and includes software that allows you to edit slides. 6½" H x 3½" W x 3½" D. (1 lb.)
Item 74083 \$99.95

1-800-543-3366

www.hammacher.com/slide
Use special offer code 500835

**Lifetime Guarantee
of Complete Satisfaction.**

America's Longest Running Catalog
Hammacher Schlemmer
Offering the Best, the Only and the Unexpected for 160 Years

INVIS-ID™
Professional Property Marking Kit



Mark your valuables with
INVISIBLE INK

INVIS-ID is a professional quality marking solution which safely marks virtually any surface permanently with invisible security ink. Markings are only visible under a UV Light (included w/ kit)

Receive 20% off your online purchase
using coupon code: **SCI2008**
or call us at (877) 504-6286

www.conceptek.com

KLEEN GREEN ENZYMES

- Safe, Effective, Nontoxic
- Children and Pet Safe
- Pesticide Free!
- Eliminates Germs,
Bacteria, Odor and Pests



- Satisfaction Guaranteed
- Fast Delivery

**800.807.9350
615.790.6122**

www.KleenGreen.com



- ✓ Huge Selection
- ✓ Everyday Low Prices
- ✓ Fast Shipping
- ✓ Easy To Use Website
- ✓ Excellent Customer Service



GO TO WWW.ROCKAUTO.COM 1-866-ROCKAUTO (762-5288) 1999-2008 ROCKAUTO, LLC - MADISON, WI USA

Answer Key

2. Clockwise from the top, the numbers are 3, 17 and 6. The middle numbers decrease by 30 each time, suggesting that in each corner the numbers also decrease uniformly. The first two top numbers are 15 and 9, so we expect another decrease of 6, leaving 3 at the top. At the lower right, the numbers are 19 and 18, so we expect another decrease by 1, leaving 17. In the lower left, the 12 and 9 lead us to expect 6.

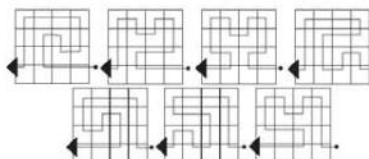
3. 2, 1, 5, 3, 4.

4. One solution is $16^2 + 17^2 = 20^2$. To check this, observe that $256 + 144 = 400$. Another possibility is $63^2 + 16^2 = 65^2$.

HEADBREAKERS ANSWERS:

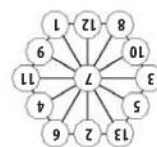
1. Alice can guarantee a win by taking six coins on her first turn, leaving 44. On each of her next turns, the number of coins she takes should equal 11 when added to the number Bob took on his previous turn. (For example, if Bob takes eight coins on his first turn, Alice should next take three). After her second turn, 33 coins will remain; then 22; then 11. Because Bob can take no more than 10 coins, the last coin will be left for Alice.

5. There are several ways to do this, for example, $99 \div 99 = 100$ or $(999 - 99) \div 9 = 100$ or $(9 \times 9) + 9 + 9 + 9 = 100$.



4. 7 paths. See diagram:

3. Robert Johnson, William Robertson and John Williamson.



2. See diagram:

1. A: The second clock shows a time 50 minutes later than the first, and the third clock shows a time 40 minutes later than the second. This suggests that the fourth clock should show a time 30 minutes later than the third clock.

BRAIN TRAINERS ANSWERS:

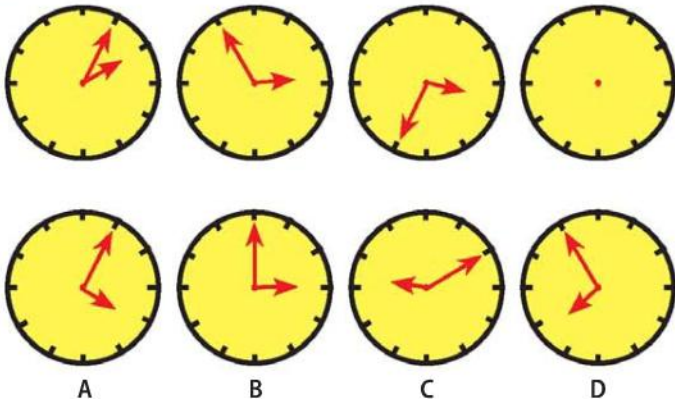
Zoology: Bedbugs
 Architecture: The White House
 Mathematics: Binary numbers
 Personalities: Ferdinand Magellan
 Medicine: Jaundice
 History: 1922

TRIVIA COUNTDOWN ANSWERS:

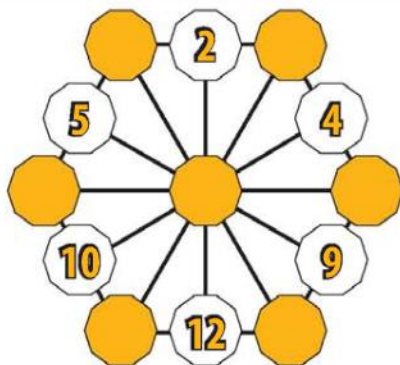
SCIENCE ILLUSTRATED (VOLUME 1, ISSUE 6) (ISSN 1890-7539, USPS 074820088890) IS PUBLISHED SIX TIMES A YEAR, J/F, M/A, M/J, J/A, S/O AND N/D, BY BONNIER CORPORATION, 2 PARK AVENUE, NEW YORK, NY 10016. APPLICATION TO MAIL AT PERIODICALS POSTAGE RATES IS PENDING AT NEW YORK, NY AND ADDITIONAL MAILING OFFICES. NO PART OF THIS MAGAZINE MAY BE REPRODUCED WITHOUT THE EXPRESS WRITTEN PERMISSION OF SCIENCE ILLUSTRATED MAGAZINE. POSTMASTER: SEND ADDRESS CHANGES TO SCIENCE ILLUSTRATED, P.O. BOX 420235, PALM COAST, FL 32142-0235. SUBSCRIPTIONS: IN THE U.S., \$24 PER YEAR, ADD \$6 PER YEAR FOR DELIVERY TO CANADA AND \$16 PER YEAR FOR DELIVERY TO ALL OTHER FOREIGN COUNTRIES. ALL PAYMENTS IN U.S. FUNDS ONLY. FOR SUBSCRIPTION INFORMATION, CALL 866-429-0139 IN THE U.S. AND 386-597-4388 FROM CANADA AND INTERNATIONALLY. PUBLICATION AGREEMENT NUMBER 40612608. CANADA RETURN MAIL, P.O. BOX 25542, LONDON, ON N6C 6B2.



- 1** Which of the clock faces below is the fourth in the top series?

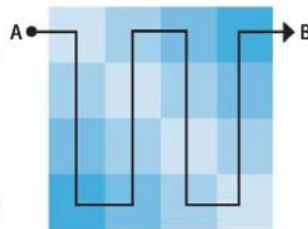


- 2** Insert the numbers 1, 3, 6, 7, 8, 11 and 13 in the empty fields, so that the sum along every straight line is 21.



- 3** There are three men: Mr. Johnson, Mr. Robertson and Mr. Williamson. Their first names are John, Robert and William, but not necessarily in that order. None of their last names begins with their first name. Mr. Johnson's first name is not William. What are the men's full names?

- 4** A path leads from the upper left-hand corner to the upper right-hand corner of this 4x4 pattern of squares. How many different paths are there (other than the one shown) that have the same starting and ending points and that pass through each square one time?



- 5** Write the number 100 using six 9s and no other digits—you can use +, -, x or ÷.

Headbreakers



- 1** There are 50 coins on a table, and Alice and Bob take turns removing coins. On each turn, a player must take at least one coin but no more than 10, and the player who takes the last coin is the winner. If Alice goes first, how can she be sure of winning?

- 2** What three numbers are missing in the last triangle?



- 3** Find all possible ways to place the numbers 1 through 5 in the hexagons below in such a way that:

- (a) The sum of 4 and 1 and the numbers between them is 13.
 (b) The sum of 3 and 2 and the numbers between them is 11.
 (c) The number 1 lies to the right of 2 and the left of 4.



- 4** Three positive integers, a , b and c , are said to be a Pythagorean triple if $a^2 + b^2 = c^2$.

For example: 16, 30 and 34 are a Pythagorean triple because $16^2 + 30^2 = 34^2$.

Can you think of another Pythagorean triple in which $a = 16$?

THIS CHILLER HELPED SAVE FOUR MILLION DOLLARS. YOU GO, CHILLER.

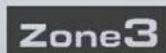


And a prestigious hospital in Toronto is forever grateful. Johnson Controls helped save the hospital \$4 million over three years with an ingenious and energy-efficient cooling system that uses YORK® chillers. It's ingenuity at work, and good for everyone's bottom line. Just another way we're making this world a more comfortable, safe, and sustainable place. Want to make your world better? We'll help you figure it out at ingenuitywelcome.com

**Johnson
Controls** 
INGENUITY WELCOME

OUR NEW HD RECEIVERS

ARE FULLY LOGOED



Z SERIES



900 SERIES



63 SERIES

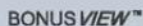
We know what really matters: Logos and lots of them. Some you know, some you kinda know, and some you might not even know existed. Logos equal technology, and at Yamaha we take technology very seriously—that's why our new line of receivers are loaded to the max. With our receivers you'll even see a few logos you can't find anywhere else. That's because our receivers are packed with exclusive Yamaha technology, bringing your audio experience to a whole new level. YPAO, Cinema DSP, Compressed Music Enhancer. You name it, we've got it. Whether you're an A/V newbie or a bona fide audiophile, Yamaha has the perfect receiver to fit your life, perfectly.

To learn what receiver is right for you, or to learn what all these logos mean, visit Yamaha.com/hometheater

THE BLU-RAY IS HERE.



BD-S2900/ RX-V3900



And with it, more logos. Nothing is sweeter than hooking up your Yamaha-logo-loaded receiver with our logo-loaded Yamaha Blu-ray. The result? The perfect entertainment experience.



YAMAHA