SPECIAL REPORT: DEMYSTIFYING THE MIND

www.sciencenews.org

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC ■ FEBRUARY 11, 2012

eye on I

Consciousness under the lens

Climate Quick Fix

Mapping Dark Matter

The Deep Biosphere

gravity defyer™

ADVANCED FOOTWEAR TECHNOLOGY

SHOES ON STEROIDS?

Scientifically Engineered to Defy Pain, Defy Aging & Defy Fatigue

This is my story

I used to be more active. I used to run, play basketball, tennis, football… I was more than a weekend warrior. I woke up every day filled with life! But now, in my late 30's, I spend most of my day in the office or sacked out in front of the TV. I rarely get to the gym –not that I don't like working out, it's the nagging pain in my knees and ankles. Low energy and laziness has got me down. My energy has fizzled and I'm embarrassed to admit that I've grown a spare tire (I'm sure it's hurting my love life). Nowadays I rarely walk. For some reason it's just harder now. Gravity has done a job on me.

Wear them and you'll know

That's what my doctor recommended. He said, "Gravity Defyer shoes are pain-relieving shoes." He promised they would change my life –like they were a fountain of youth. "They ease the force of gravity, relieving stress on your heels, ankles, knees and back. They boost your energy by propelling you forward." The longer he talked, the more sense it made. He was even wearing a pair himself!

Excitement swept through my body like a drug

I received my package from GravityDefyer.com and rushed to tear it open like a kid at Christmas. Inside I found the most amazing shoes I had ever seen –different than most running shoes. Sturdy construction. Cool colors. Nice lines… I was holding a miracle of technology. This was the real thing.

GDefy Benefits

- Relieve pain
- Ease joint & spinal pressure
- Reduce fatigue & tiredness
- Be more active
- Have more energy
- Appear taller
- Jump higher, walk and run faster
- Have instant comfort
- Cool your feet & reduce foot odor
- Elevate your performance

I put them on and all I could say was,"WOW!" In minutes I was out the door. I was invincible; tireless in my new Gravity Defyer shoes. It was as if my legs had been replaced with super-powered bionics. What the doctor promised was all correct. No more knee pain. I started to lose weight. At last, I was pain free and filled with energy! I was back in the game. Gravity had no power over me!

Customer Satisfaction Speaks for Itself!

4 out of 5 customers purchase a 2nd pair within 3 months.

Nothing to lose: Start your 30 Day Trial Today!

So, my friend, get back on your feet like I did. Try Gravity Defyer for yourself. You have nothing to lose but your pain.

Tell us your story! Login at Gravitydefyer.com and share your experience.

ABSORB SHOCK
Eliminate pain from every step.

REBOUND PROPELS YOU FORWARD
Reduce fatigue. Be more active

$129.95
MEN (Shown above)
TB902MWBS
sizes 7 - 13
Med/Wide and ExtraWide/ XXWide Widths

WOMEN (Silver with Navy)
TB902FWBS
sizes 5 - 11
Med/Wide and ExtraWide/XXWide Widths

EXCLUSIVE ONLINE OFFER

TRY THEM FREE* – PAY IN 30 DAYS

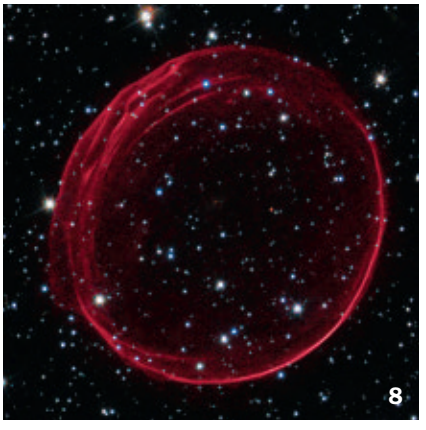
Go to **www.GravityDefyer.com/MM3BDB8** or call **(800) 429-0039** and mention the promotional code below.

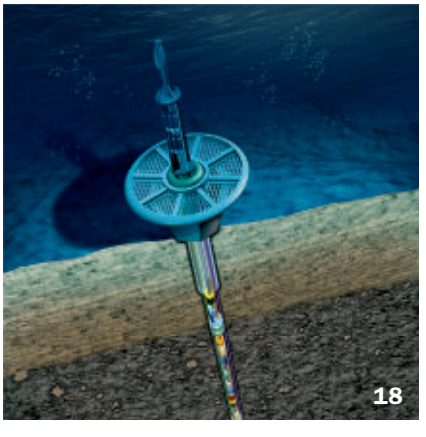
Promotional Code: MM3BDB8

*Offer not available in stores. Shipping & Handling not included.

BBB A+

FEBRUARY 11, 2012 • VOL. 181 • NO. 3





ScienceNews

In The News

5 STORY ONE
- Drying may shift Amazon from carbon sink to source

8 ATOM & COSMOS
- White dwarf–fed supernova
- New maps show dark matter clumps along with galaxies

9 HUMANS
- Volleyballers get hot hands
- Babies read lips

10 LIFE
- Sex appeal and aerodynamics: Male rhino beetle has it all
- Glowing fish eyes see the light

11 GENES & CELLS
- Octopuses adapt to different climes with some RNA editing

12 ENVIRONMENT
- Controlling methane and soot offers first aid for climate
- Currents kept microbes munching BP oil

14 BODY & BRAIN
- A bit of ganja no problem for the lungs
- Herb extract lessens alcohol's intoxicating powers in rats
- What Europeans don't know about heart attack and stroke
- Biomarkers may reveal those most at risk of kidney failure

16 SCIENCE & SOCIETY
- 2012 Intel Science Talent Search finalists named

Features

18 DEEP LIFE
A startling diversity of organisms make their homes in the mud and rock below the ocean floor.
By Alexandra Witze

Special Report

DEMYSTIFYING THE MIND
COVER STORY: The first installment of a three-part series on the mystery of consciousness.

22 EMBLEMS OF AWARENESS
FEATURE: The source of consciousness remains elusive, but the latest brain studies offer new insights.
By Laura Sanders

28 SELF AS SYMBOL
ESSAY: A strange loop emerges from the mind's efforts to understand itself.
By Tom Siegfried

Departments

2 FROM THE EDITOR

4 NOTEBOOK

31 BOOKSHELF

31 FEEDBACK

32 FROM THE ARCHIVE
Better produce and protecting food staples at the USDA.

COVER Consciousness has posed a special challenge to scientists, but new ways of studying the brain may finally yield deeper understanding.
Michael Morgenstern

ScienceNews
MAGAZINE OF THE SOCIETY FOR SCIENCE & THE PUBLIC

EDITORIAL, ADVERTISING AND BUSINESS OFFICES
1719 N Street NW, Washington, DC 20036 Phone (202) 785-2255
Audit Bureau of Circulations

Subscriptions subs@sciencenews.org Editorial/Letters editors@sciencenews.org
Advertising/Business snsales@sciencenews.org
Texterity Digital edition provided by Texterity, www.texterity.com
Science News (ISSN 0036-8423) is published biweekly, for $54.50 for 1 year or $98 for 2 years (international rate $80.50 for 1 year or $161 for 2 years) by Society for Science & the Public, 1719 N Street NW Washington, D.C. 20036.
Preferred periodicals postage paid at Washington, D.C., and an additional mailing office.

Subscription Department: PO Box 1205, Williamsport, PA 17703-1205. For new subscriptions and customer service, call 1-800-552-4412.

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

FROM THE EDITOR

Maybe consciousness will figure itself out someday

The human brain is very good at figuring things out, except about itself.

Think about it. A brain capable of sophisticated reasoning has to be very complicated — so complicated that it would take an even more sophisticated brain to figure out how it works. But an even more sophisticated brain would be even harder to figure out. As the brain gets smarter and smarter, and thus more and more complex, it becomes ever more difficult to explain how it works. The brain can never catch up. Human brains are amazing devices, just not amazing enough to explain all of their amazing abilities.

In truth, the human brain has figured out a lot about how it works. Much of the molecular and cellular machinery underlying thinking and learning and memory, and even emotion, has been outlined in elaborate detail. But dissecting the machinery has not enabled scientists to say why the machine has a persistent sense of itself, how it generates the feeling of self-awareness (and even the awareness of that self-awareness) that people generally refer to as consciousness.

For millennia, philosophers have grappled with consciousness, trying to discern the distinction between mind and body or to show that such a distinction is illusory. But only in the present millennium have scientists engaged these arguments in a serious way, equipped with substantial scientific data.

Starting in this issue (Page 22), Laura Sanders explores consciousness research in a three-part series describing the latest efforts to demystify the mind. Long regarded by neuroscientists as a taboo topic, consciousness has finally emerged as a legitimate realm of scientific inquiry. Research results have begun accumulating, and theorists have begun transforming explanations of consciousness from philosophical speculations into quantitative concepts and equations.

A common thread connecting much consciousness theorizing is the role of information. Using the mathematics of information theory, scientists have begun to get a grip on possible ways of measuring consciousness, making it easier to identify and perhaps, someday, easier to create in a nonbiological information-processing system. The prospect of a conscious computer may be terrifying to fans of the *Terminator* films (or, for older people, *Colossus: The Forbin Project*). But it would nevertheless be interesting to see if a conscious machine would be sufficiently sophisticated to figure out for itself how it works. —*Tom Siegfried, Editor in Chief*

JIM WEBB

Greek God Invents FREE Love

Inspired by a mythological romance, this stunning 170-carat amethyst bead necklace is yours for the taking!

She was Amethyst, a maiden devoted to virtue. He was Dionysus, the notorious Greek god of intoxication and revelry. He loved her, but she wanted to wait for someone more suitable. He was a god, used to getting what he wanted. The chase was on. But once Diana saw that Amethyst was serious about keeping her heart pure, the goddess transformed her into a statue of perfect stone. Dionysus stopped partying for a moment and wept. He spilled his wine and infused the statue with the rich violet color we now know as amethyst.

It's not what you would call a happy ending. Luckily we discovered that something good came from their ill-fated romance. Specifically, this spectacular 170-Carat ***Amethyst Maiden Necklace***. And the incredible price may just have you shedding tears of joy. For a limited time, you can get 170 carats of polished purple gems valued at $249...absolutely FREE (you pay only for basic shipping and processing).

The luxury myth has been busted. You're probably wondering why any luxury jewelry company would give away a perfectly beautiful genuine gemstone necklace. But I promise you that we have a reason. The simple answer is that we want to get your attention. Once you get a closer look at our quality and selection, we're certain you'll be back for more. And if you're already a devoted Stauer client, this is just another example of how we keep the incredible offers coming.

Drape yourself in purple perfection. This necklace is a knockout. Each rounded bead retains its own unique shape and just the right amount of translucence to let the light ignite the velvety, violet hues. Each gem is hand set on double-knotted jeweler's thread. The entire length secures with a .925 sterling silver lobster clasp layered in gold. The 18" necklace (with 2" extender) hangs with the same weight and elegance as similar strands that sell for hundreds more.

Extremely limited offer. The good news is that right now, you can get the 170-Carat ***Amethyst Maiden Necklace*** for **FREE** (you pay only the standard $24.95 shipping and processing fee). **We'll also include a $20 Stauer Gift Coupon** with your delivery, good towards your very next purchase. If you're interested in getting 170 carats of genuine amethyst for nothing...we recommend you reserve your necklace now. Because as Dionysus knows all too well, the party can't last forever. **This offer is strictly limited to one FREE necklace per shipping address.**

FREE Amethyst Necklace
Limited to the First 1500 Responders!

Buy NOW, pay NEVER.
An Exclusive FREE Jewelry Offer from Stauer®

JEWELRY SPECS:
- 170 ctw of genuine polished amethyst
- .925 sterling silver clasp layered in gold

Amethyst Maiden Necklace (170 ctw)—~~$249~~
Your Cost—**FREE** — pay only $24.95 shipping & processing.
Call now to take advantage of this extremely limited offer.

1-800-386-5195

Promotional Code ABN194-02
Please mention this code when you call.

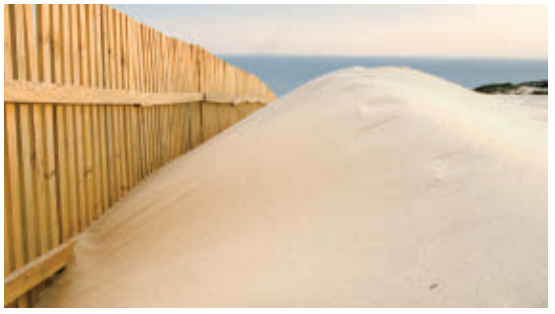
Stauer®

14101 Southcross Drive W.,
Dept. ABN194-02
Burnsville, Minnesota 55337
www.stauer.com

Stauer has a **Better Business Bureau Rating** of **A+**

Smart Luxuries—Surprising Prices

ADVERTISEMENT



Say What?

Echo dunes ***\EK-oh DOONS\ n.*** Steep dunes that form upwind of an object such as a fence or building. In windy, sandy landscapes, echo dunes can block or bury man-made structures. Using a wind tunnel that generates gusts up to 78 miles per hour, researchers in China are trying to better understand how echo dunes accumulate by looking at what happens to moving air when it encounters an immovable object. The team found that when wind wallops a slope of 60 degrees or more, the air bounces back, creating a vortex. This reversal, they report in the Dec. 9 *Journal of Geophysical Research*, could shape sand into echo dunes and may provide insight into how to protect desert architecture. —*Allison Bohac*

Science Past | FROM THE ISSUE OF FEBRUARY 10, 1962

EFFECT OF WEIGHTLESSNESS — Astronaut John H. Glenn Jr.'s experience in weightlessness during his coming orbital flight will not be long enough to cause him any undue stress such as that suffered by Cosmonaut Titov, a U.S. Air Force expert reported. "Experiments by the Russians with animals and men as well as our own experiments indicate that man can pretty well tolerate, with little, if any discomfort, a period of four to five hours in a weightless or zero-g environment," Col. John Paul Stapp, U.S. Air Force School of Aviation Medicine, Brooks Air Force Base, Texas, and internationally known authority on zero-g research, told SCIENCE SERVICE. Glenn's scheduled three whirls around the earth will take about four and a half hours.

The (-est)

Researchers scouring the tropical forests of southern New Guinea have found, hiding in leaf litter on the forest floor, the world's smallest frog. Averaging just 7.7 millimeters in length — about a third of an inch — the tiny *Paedophryne amauensis* may also edge out the former contender for the title of smallest vertebrate, a male anglerfish that lives as a parasite on females. Though small, *P. amauensis* can still make itself heard. The team, led by Louisiana State University researchers, reports online January 11 in *PLoS ONE* that an individual frog produced 355 high-pitched calls in just 5 ½ minutes. —*Allison Bohac*

Science Future

February 23
As part of National Engineers Week, talk to a child or group for Introduce a Girl to Engineering Day. Find resources at bit.ly/zXAZVP

March 1
Last day to submit entries to the 2012 Kavli "Save the World Through Science & Engineering" video contest for grades 6–12. See bit.ly/w3iCjM

SN Online

www.sciencenews.org

SCIENCE & THE PUBLIC BLOG
Imported primate meat hosts potentially dangerous viruses. See "Bush meat can be a viral feast."

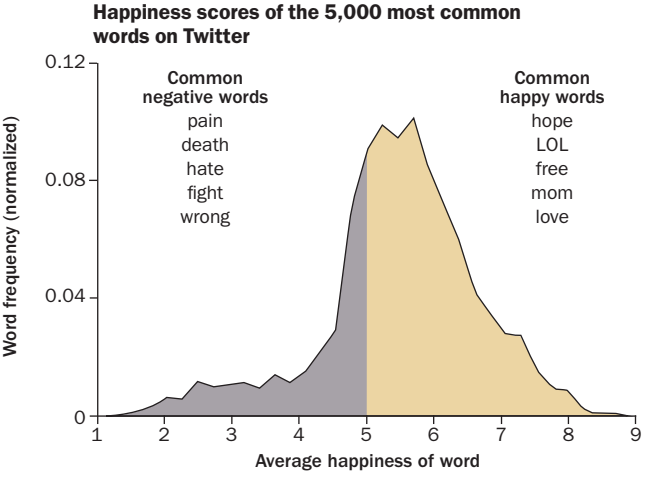
LIFE
A snake senses prey's last heartbeats. See "Boas take pulse as they snuff it out."

ATOM & COSMOS
A simulation hints at why space is 3-D. Read "String theorists squeeze nine dimensions into three."

BODY & BRAIN
Drinking alcohol releases morphinelike brain chemicals. See "Study tracks booze's buzz in the brain."

Science Stats | CHEERY CHAT

The English language is biased toward the use of positive, or "happy," words (shown below with happiness scores above 5) in books, music, Twitter and the *New York Times*. SOURCE: I.M. KLOUMANN *ET AL/PLOS ONE* 2012



CLOCKWISE FROM TOP LEFT: © BEN WELSH PREMIUM/ALAMY; SCOTT BOBACK; E.N. RITTMEYER *ET AL/PLOS ONE* 2012

“This is a confirmation of a decades-old belief, namely that a type 1a supernova comes from the explosion of a carbon-oxygen white dwarf.” —JOSHUA BLOOM, PAGE 8

In the News

Atom & Cosmos Dark matter megamaps
Humans Babbling babies read lips
Life Outsized horn no hindrance
Genes & Cells Octopuses adapt by editing
Environment Climate quick fix
Body & Brain Pot spares lung function
Science & Society Intel science finalists

STORY ONE

Amazon could become part of climate problem

Drying trend may release stored carbon to atmosphere

By Devin Powell

AP PHOTO/LUIZ VASCONCELOS, INTERFOTO, FILE/CORBIS

Drying climate threatens the stability of the Amazon rain forest, and its role in removing carbon from the atmosphere. In 2005, drought lowered water levels in Anama Lake (above), which lies 168 kilometers up the Amazon River from Manaus, Brazil.

In the struggle against global warming, the Amazon rain forest may be about to switch sides.

Its dense vegetation has long helped cool the planet by removing carbon dioxide from the atmosphere. But mass tree deaths brought about by recent droughts and deforestation may be pushing the region to a point at which it will give off more of the greenhouse gas than it absorbs.

“The Amazon might still be a sink for carbon, but if it is, it’s definitely moving towards being a source,” says Eric Davidson, director of the Woods Hole Research Center in Falmouth, Mass. Reporting in the Jan. 19 *Nature*, Davidson and 14 other researchers from the United States and Brazil weigh evidence that the world’s largest rain forest has become increasingly vulnerable to change.

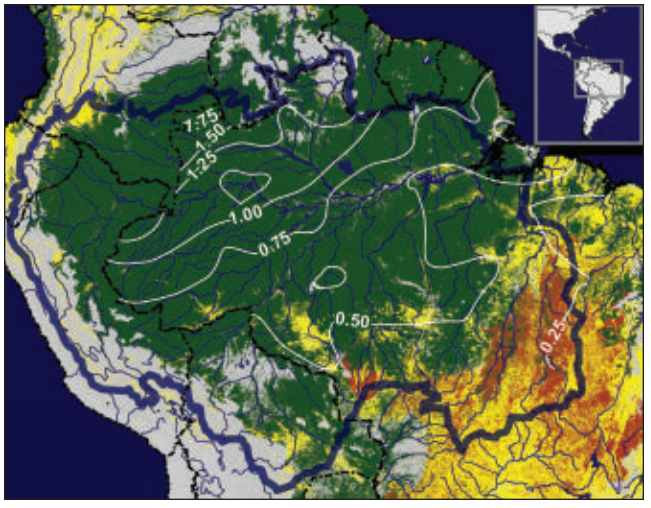
Thanks to regular measurements of 100,000 trees, scientists estimate that the Amazon was sucking up about 400 million tons of carbon annually at the turn of the century. Plants absorb the gas during photosynthesis, storing the carbon component as leaves, wood and roots and injecting it into the soil. The entire rain forest is thought to contain about 100 billion tons of carbon, equivalent to 10 years of global CO_2 emissions from burning fossil fuels.

It’s clear that much of this carbon is now being released at the Amazon’s southern and eastern edges, says Davidson, in places where forests have been cleared by loggers or burned to make room for cattle and crops.

Not only do these bald patches store little carbon, they also threaten remaining trees by reducing the amount of moisture that is released into the air and by pulling rain away from the surrounding forest.

Dry seasons in the southern and eastern fringes of the Amazon have gotten longer. And when the rains do come, precipitation that would have been captured by forest runs off into rivers instead. A 2003 study in the *Journal of Hydrology* found that water flowing through the Tocantins River in southeastern Amazonia increased by nearly

For today's top stories, visit
SN Today at **www.sciencenews.org**



Shrinking Amazon
Pastures and croplands (yellow) have steadily encroached on the Amazon's forests (green), as revealed in this map derived from satellite imagery. The labeled white lines indicate daily mean precipitation in millimeters during the dry season, showing a clear northwest-southeast moisture trend.

25 percent as croplands spread to encompass almost half of the land draining into the river.

For now, the impact of this deforestation will probably remain confined to parts of the Amazon. One computer simulation suggested that a surge in deforestation that cleared 40 percent of the Amazon basin could trigger a tipping point, a runaway conversion of forest to savanna. But Davidson's team argues that the uncertainties are too great to make such a prediction.

Climate change, rather than direct deforestation, may ultimately be the factor that threatens the Amazon as a whole. Rising global temperatures are predicted to warm waters in the Atlantic Ocean and stimulate Pacific El Niño weather patterns, making droughts more frequent and more severe.

"Our work suggests that as the planet gets warmer, places like the Amazon are probably going to lose carbon," says Kevin Gurney, an atmospheric scientist at Arizona State University in Tempe.

Trees in the Amazon's interior are naturally resilient against drought. Their roots reach far below the surface, tapping deep water sources that provide sustenance during lean times.

But even deep-drinking trees have their limits. In a study reported in 2010 in *New Phytologist*, scientists channeled away up to half of the rain falling on small plots of land in eastern Amazonia for seven years. By the third year, tree growth had slowed substantially and tree death had nearly doubled.

A severe dry spell in 2005 pushed many trees beyond what they could handle even faster. Rainfall decreased over a third of the Amazon, by as much as 65 percent in some places. At the time, scientists estimated that the forest released more than 1.5 billion tons of carbon as trees died off, and labeled the devastation a once-in-a-century event.

Then an even worse drought hit in 2010, when an even larger area released even more carbon. An analysis of satellite images reported last April in *Geophysical Research Letters* showed the forest turning brown.

"We've seen two climatologically unusual droughts in the last few years," says Oliver Phillips, a tropical ecologist at the University of Leeds in England. But while these droughts are consistent with the expected consequences of climate change, Phillips is quick to point out that they could be just a statistical fluke, a couple of bad years brought on by natural variability. "Distinguishing a trend from a natural cycle is difficult," he says.

As scientists continue to grapple with understanding what's happening to the Amazon's carbon, progress has been made in curbing deforestation in Brazil. Though setting fires to clear land remains a common practice, logging has decreased to less than a fourth of what it was in 2004. Ultimately, the scientists studying the region hope that human beings and the rain forest can find a way to remain allies.

"Brazil has the potential to move from an emerging-market country to a developed country without having destroyed its forests," says Davidson. "That's not something that most countries, including the United States, can say." ■

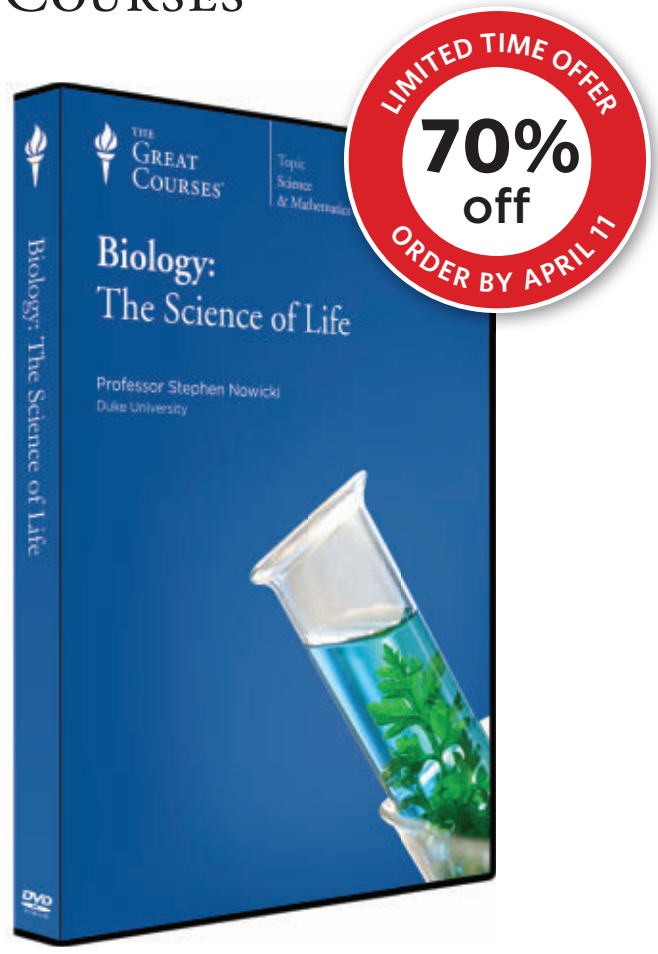
Back Story

GAS STATION

A 20-year project called the Large Scale Biosphere-Atmosphere Experiment in Amazonia has erected towers in the Brazilian rain forest up to 65 meters high to measure carbon dioxide absorption and emissions. These structures sample only a tiny amount of the enormous Amazon rain forest, which spans several countries and more than 5 million square kilometers. But this on-the-ground data is invaluable for providing detailed information that can then be extrapolated across the vast region.

FROM TOP: PAUL LEFEBVRE AND ERIC DAVIDSON/THE WOODS HOLE RESEARCH CENTER/*NATURE*; SCOTT SALESKA

THE GREAT COURSES®



Master the Most Important Science of Our Time

Biology: The Science of Life puts a remarkable body of scientific knowledge directly at your fingertips. In these 72 fascinating lectures, you'll experience what it's like to attend a complete introductory college biology course taught by a master educator; in this case, award-winning Professor Stephen Nowicki of Duke University.

Assuming no prior background in biology or science, award-winning Professor Nowicki lays out the intricate machinery of life—in all its breathtaking detail. You explore living systems at all levels, from the tiniest molecule to the largest ecosystem. Idea by profound idea, experiment by great experiment, you'll build a comprehensive view of life that is one of the greatest scientific achievements in history.

Offer expires 04/11/12

1-800-832-2412

WWW.THEGREATCOURSES.COM/5SN

Biology: The Science of Life

Taught by Professor Stephen Nowicki
DUKE UNIVERSITY

LECTURE TITLES

1. The Scope of "Life"
2. More on the Origin of Life
3. The Organism and the Cell
4. Proteins—How Things Get Done in the Cell
5. Which Molecule Holds the Code?
6. The Double Helix
7. The Nuts and Bolts of Replicating DNA
8. The Central Dogma
9. The Genetic Code
10. From DNA to RNA
11. From RNA to Protein
12. When Mistakes Happen
13. Dividing DNA Between Dividing Cells
14. Mendel and His Pea Plants
15. How Sex Leads to Variation
16. Genes and Chromosomes
17. Charles Darwin and "The Origin of Species"
18. Natural Selection in Action
19. Reconciling Darwin and Mendel
20. Mechanisms of Evolutionary Change
21. What Are Species and How Do New Ones Arise?
22. More on the Origin of New Species
23. Reconstructing Evolution
24. The History of Life, Revisited
25. From Cells to Organisms
26. Control of Gene Expression I
27. Control of Gene Expression II
28. Getting Proteins to the Right Place
29. Genetic Engineering and Biotechnology
30. How Cells Talk—Signals and Receptors
31. How Cells Talk—Ways That Cells Respond
32. From One Cell to Many in an Organism
33. Patterns of Early Development
34. Determination and Differentiation
35. Induction and Pattern Formation
36. Genes and Development
37. Homeostasis
38. Hormones in Animals
39. What is Special about Neurons?
40. Action Potentials and Synapses
41. Synaptic Integration and Memory
42. Sensory Function
43. How Muscles Work
44. The Innate Immune System
45. The Acquired Immune System
46. Form and Function in Plants I
47. Form and Function in Plants II
48. Behavior as an Adaptive Trait
49. Energy and Resources in Living Systems
50. How Energy is Harnessed by Cells
51. Enzymes—Making Chemistry Work in Cells
52. Cellular Currencies of Energy
53. Making ATP—Glycolysis
54. Making ATP—Cellular Respiration
55. Making ATP—The Chemiosmotic Theory
56. Capturing Energy from Sunlight
57. The Reactions of Photosynthesis
58. Resources and Life Histories
59. The Structure of Populations
60. Population Growth
61. What Limits Population Growth?
62. Costs and Benefits of Behavior
63. Altruism and Mate Selection
64. Ecological Interactions Among Species
65. Predators and Competitors
66. Competition and the Ecological Niche
67. Energy in Ecosystems
68. Nutrients in Ecosystems
69. How Predictable Are Ecological Communities?
70. Biogeography
71. Human Population Growth
72. The Human Asteroid

Biology: The Science of Life
Course no. 1500 | 72 lectures (30 minutes/lecture)

SAVE UP TO $520

DVD ~~$699.95~~ **NOW $179.95**
+$25 Shipping, Processing, and Lifetime Satisfaction Guarantee

CD ~~$499.95~~ **NOW $129.95**
+$20 Shipping, Processing, and Lifetime Satisfaction Guarantee

Priority Code: 63499

Designed to meet the demand for lifelong learning, The Great Courses is a highly popular series of audio and video lectures led by top professors and experts. Each of our more than 350 courses is an intellectually engaging experience that will change how you think about the world. Since 1990, over 10 million courses have been sold.

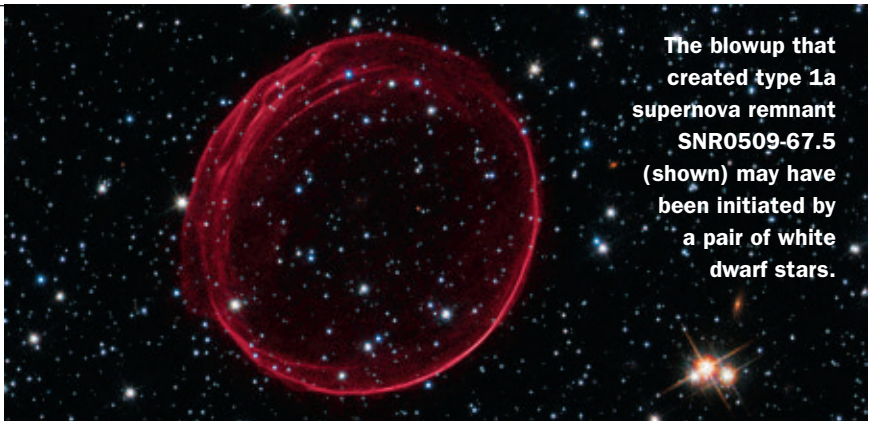
Atom & Cosmos

For longer versions of these and other Atom & Cosmos stories, visit **www.sciencenews.org**

Supernova birth illuminated

Astronomers pinpoint steps leading to type 1a blowups

By Nadia Drake



The blowup that created type 1a supernova remnant SNR0509-67.5 (shown) may have been initiated by a pair of white dwarf stars.

Scientists are beginning to sort out the stellar ingredients that produce a type 1a supernova, the kind of cosmic explosion that has been used to measure the universe's accelerating expansion.

Two teams of researchers presented data about these supernovas on January 11. One team confirmed a long-held suspicion about the kind of star that explodes, and the second provided new evidence for what feeds that star until it bursts.

"This is a confirmation of a decades-old belief, namely that a type 1a supernova comes from the explosion of a carbon-oxygen white dwarf," said Joshua Bloom, an astronomer at the University of California, Berkeley.

Bloom and his colleagues have been studying supernova 2011fe, an explosion 21 million light-years away near the Pinwheel Galaxy that became visible in August. The PIRATE telescope in Majorca, Spain, wasn't able to detect the supernova just hours after it exploded, enabling Bloom's team to set better limits on the size of the star that exploded. The researchers concluded it must have been a white dwarf. When a dwarf — fed by a companion star — gets too heavy, a runaway thermonuclear reaction ignites in its core, producing a fireball bright enough to outshine surrounding galaxies.

But the culprit behind the dwarf's mass gain is still a mystery: Although scientists know that a companion star is feeding the dwarf, they don't know what type of star that companion is. Now astronomers from Louisiana State University in Baton Rouge have answered that question for one explosion. The team focused on a bubble-shaped remnant — the leftovers of a type 1a explosion that appeared 400 years ago — in the nearby galaxy the Large Magellanic Cloud. The remnant, called SNR0509-67.5, now spans 23 light-years.

"It's a beautifully symmetric remnant," says graduate student Ashley Pagnotta, a coauthor on the team's paper in the Jan. 12 *Nature*.

The bubble's center is the probable site of the explosion, and, since a large companion star would have survived the explosion and been flung outward at a predictable speed, the team could calculate how far outward a companion might have traveled over the last 400 years.

But the researchers saw no stars within that region, suggesting that the star responsible for inflating the dwarf to explosive proportions was also destroyed. That result pointed to a second white dwarf as the companion, which instead of being chucked from the epicenter would have been shredded and destroyed.

"That's not what we'd expected," Pagnotta says. "This is the first supernova for which we've been able to make a definitive claim like that."

New maps of the cosmic dark

Probing galactic distortions reveals web of invisible matter

By Nadia Drake

Using telltale distortions in light from distant galaxies, scientists have mapped out clumps and strings of dark matter on a larger scale than ever before.

One set of maps comes from five years of observations made by the Canada-France-Hawaii Telescope in Hawaii. The work covers an area of sky roughly 1 billion light-years across that's populated by more than 10 million distant galaxies.

Teams from Lawrence Berkeley National Laboratory in California and Fermi National Accelerator Laboratory in Batavia, Ill., produced surveys with similar results using images taken by the Sloan Digital Sky Survey from 2000 to 2009. Both teams presented their results January 9.

Dark matter makes up an estimated 23 percent of the mass-energy content of the universe. For years, scientists have suspected that clumps of galaxies and clumps of dark matter coincide. The new maps confirm this pattern. The most massive peaks of dark matter host "giant monsters, clusters of galaxies," said Ludovic Van Waerbeke of the University of British Columbia in Vancouver. "We are very happy that this is very similar to what we've been expecting."

The maps also reveal the presence of voids, enormous regions of empty space carved into the otherwise complex and knotty web of matter.

NASA, ESA, HUBBLE HERITAGE TEAM, J. HUGHES/RUTGERS UNIV.

Humans

"Infants respond to what they see and hear as a unified stimulus." —DAVID LEWKOWICZ

'Hot-hand' scoring runs beat chance

Such streaks mean hot players also get more opportunities

By Bruce Bower

Not only do top volleyball strikers go on scoring runs that can't be chalked up to chance, but players and coaches notice when a player is on a hot streak and funnel the ball his or her way, say psychologist Markus Raab of German Sport University Cologne and his colleagues. They studied the hot-hand phenomenon by analyzing playoff game data from a German volleyball league.

That strategy usually works, because players who on average score on a high percentage of shots tend to get hot hands. So getting them the ball during a scoring streak boosts a team's score, the researchers report in an upcoming *Journal of Experimental Psychology: Applied*.

Debate about whether hot hands are real or illusory has raged since a 1985 report that professional basketball players' shooting and free throw records contain no chance-defying streaks (*SN: 2/12/11, p. 26*).

An analysis of playoff data from the 1999–2000 season for 26 top scorers in Germany's first-division volleyball league identified 12 players as having had scoring runs that could not be chalked up to chance. Hot-handed players' shots contained fewer sequences of consecutive scores than expected by chance, the result of a small number of especially long scoring runs.

Raab's team thoroughly analyzed patterns of successful and failed shots in volleyball, but further work should examine players' neutral shots kept alive by the defense for evidence of streaks that may alter game strategy, says psychologist Alan Reifman of Texas Tech University in Lubbock.

Babbling babies read adults' lips

Infants shift focus from eyes to mouth as they learn to talk

By Bruce Bower

As infants start babbling at around age 6 months in preparation for talking, they shift from focusing on adults' eyes to paying special attention to speakers' mouths, a new study finds.

As tots become able to blurt out words and simple statements at age 1, they go back to concentrating on adults' eyes, say psychologist David Lewkowicz and graduate student Amy Hansen-Tift, both of Florida Atlantic University in Boca Raton. Whereas babbling babies match up what adults say with how they say it, budding talkers can afford to look for communication signals in speakers' eyes, the scientists propose online January 17 in the *Proceedings of the National Academy of Sciences*.

"Babies start to lip-read when they learn to babble," Lewkowicz says. "At that time, infants respond to what they see and hear as a unified stimulus."

Lewkowicz and Hansen-Tift tested 179 infants from English-speaking families at age 4, 6, 8, 10 or 12 months. Special devices tracked where babies looked when shown videos of women speaking English or a foreign language — in this case, Spanish.

From age 8 months to 1 year, babbling babies read the lips of both English and Spanish speakers, the researchers say. Nascent talkers shifted to looking mainly at the eyes of an English speaker, but continued to home in on the mouth of a woman speaking the unfamiliar language of Spanish.

The researchers also report that infants' pupils increasingly dilated between ages 8 months and 1 year in response to Spanish speakers, a sign of surprise at encountering unfamiliar speech.

By 2 years of age, children with autism avoid eye contact and focus on speakers' mouths. The new findings raise the possibility of identifying kids headed for this developmental disorder even earlier, Lewkowicz says.

But it hasn't yet been demonstrated that children who continue to look at the mouths of native-language speakers after age 1 develop autism or other communication problems more frequently than those who shift to looking at speakers' eyes, cautions autism researcher Rhea Paul of the Yale Child Study Center.

An 8-month-old focuses on the mouth of a talking woman shown on a video screen for a study that found that babies read the lips of talking adults starting at around age 6 months.

FLORIDA ATLANTIC UNIV.

Life

Beetle horns not so cumbersome

Males' outrageous head spikes don't impede flight

By Susan Milius

While the spiked horns on rhinoceros beetles may look like masculine sacrifice for the sake of huge weapons, the protrusions may not be such a drag after all.

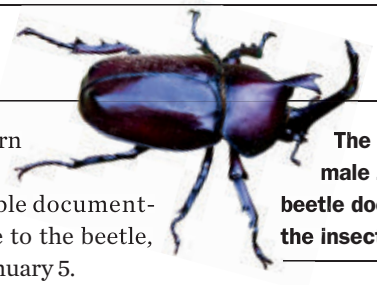
Male *Trypoxylus dichotomus* beetles grow rhino-style horns to flip rivals off trees where females feed. "Imagine a beetle flying around with a pitchfork on the front of its head," said Erin McCullough of the University of Montana.

Cumbersome as the horn looks, she and her colleagues are having trouble documenting much inconvenience to the beetle, McCullough reported January 5.

"It's surprising," said evolutionary biologist Christopher J. Clark of Yale University's Peabody Museum, who heard the presentation. "It just feels like there should be a large cost."

Even though rhinoceros beetles sport (proportionately) some of the largest male headgear among animals, the horns are hollow, and that of *T. dichotomus* typically increases body mass by about 2 percent, McCullough said.

Even the weird shape doesn't seem to matter that much in flight performance. Males fly about as fast as the females, which aren't encumbered by horns.



The outsized horn on a male Japanese rhinoceros beetle doesn't seem to affect the insect's flight speed.

Horns on beetles have become a classic example of a structure that arose through evolutionary pressures to win mates. What has intrigued biologists is that these structures don't have to be any good for promoting survival, and in some cases have turned out to be detrimental.

Perhaps some of these sex-related structures really don't inconvenience an animal much, McCullough speculated. That relative freedom could help explain why so many extravagant forms of beetle horns have evolved.

Green gleam helps fish see violet

Lenses in greeneye fish eyes translate hard-to-detect hues

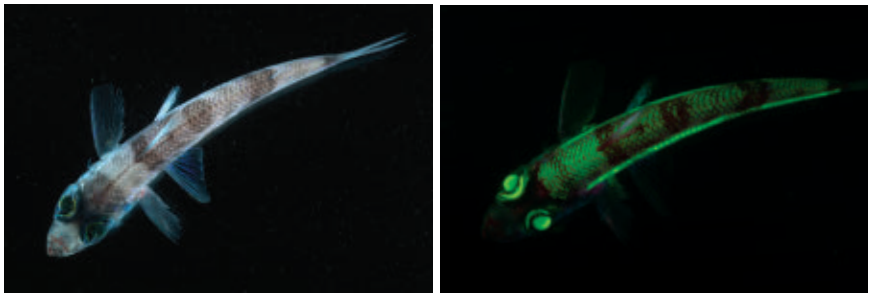
By Susan Milius

The greeneye fish views its stygian home through fluorescent lenses that turn one color into another, researchers propose, making glowing green images out of hard-to-see violet objects.

"Crazy" is what Yakir Gagnon of Duke University cheerfully called the fish-vision idea he and his colleagues presented January 4. Fluorescent materials known to science so far, he explained, respond to incoming light by glowing in a different color in all directions. Yet lenses on the upward-looking *Chlorophthalmus* fish appear to have materials that direct that fluorescent glow in the same direction and pattern as incoming light.

Greeneyes have only one kind of light-detecting pigment in the eye, optimized to pick up a particular green wavelength.

The Duke team has found that blue-violet light (with a short wavelength of 410 nanometers) zaps lens substances into fluorescing a blue-green that's just a twinkle away from the 488-nanometer wavelength the retinal pigment sees best. The lens also appears to cast its glow mostly in the same direction that incoming light is traveling, raising the possibility that the lens is transmitting something like a fluorescent image.



The greeneye fish's lenses (shown glowing at right) turn blue-violet light into a green glow that the fish can more easily detect with its single visual pigment.

Alison Sweeney, now at the University of California, Santa Barbara, removed a greeneye's lens and aimed light at it through a pattern of slits. Capturing what the lens would have projected on the retina, Sweeney found the lens produced a blue-green glow in roughly the same pattern as the incoming light. Even when ground up into soup, the lens material somehow still cast its glow in particular directions, Gagnon reported.

Just how a fluorescent substance might preserve light direction is itself extremely blurry. "This is all too new," Gagnon said.

The sea holds many violet things for a greeneye to see. The fish live up to 1,000 meters deep, where many creatures flash lights in the blue-violet range to attract prey or mates or startle predators.

"Really neat," said Geoffrey Hill of Auburn University in Alabama, who studies birds. Biologists have argued that bird fluorescence, such as the glow of budgerigars' heads, benefits the animals. So far, Hill said, the argument for benefits from the fluorescent fish lens looks tighter.

FROM THE TOP: JOI ITO/WIKIMEDIA; E. WIDDER

Genes & Cells

For more Genes & Cells stories, visit **www.sciencenews.org**

Octopus adjusts RNA to water temp

Tweaks to genetic messenger offer efficient way to adapt

By Rachel Ehrenberg

Frigid waters don't slow Antarctic octopuses down, even though their nervous systems are governed by the same genetic instructions as their tropical counterparts. Now scientists know why: Edits to genetic messengers alter octopuses' nerve cell construction for smooth operating in the numbing polar waters.

The discovery is the first report of such editing actually helping an organism adjust to its environment, scientists report online January 5 in *Science*.

Because nerve cells can't send signals as quickly in the cold, scientists decided to compare genes from *Pareledone*, an octopus that lives in the icy waters off Antarctica, with those of the warm-water species *Octopus vulgaris*. To the researchers' surprise, the genetic instructions were pretty much the same.

"We thought there was going to be a difference in their genes, but they were basically identical," says molecular neurobiologist Joshua Rosenthal of the University of Puerto Rico Medical Sciences Campus in San Juan.

DNA stays put in the nuclei of cells, and sections of it are copied when instructions for functioning or building parts are needed. So Rosenthal and graduate student Sandra Garrett looked at this genetic photocopy, the mRNA. It turns out that an enzyme that specializes in editing mRNA alters the photocopies for the octopuses' nerve cells in both polar and tropical species, the researchers discovered.

Nerve cells in the warm-water *Octopus vulgaris* work smoothly due to edits in the animal's RNA, while polar species have comparable tweaks for the cold.

The mRNA edits slightly change the way that nerve cells open and close gates to produce electrical impulses, speeding them up in the Antarctic species and slowing them down in the tropical one.

"This is amazing, wonderful work," says molecular biologist Yi-Tao Yu of the University of Rochester in New York.

ALBERT KOK/WIKIMEDIA

Environment

Controls offer climate quick fix

Cuts in soot, methane could slow warming temperatures

By Devin Powell

Carbon dioxide may be the top target in the long-term fight against global warming. But taking aim at methane and soot has a better chance of keeping the planet cooler in the short run, a new study finds.

Cutting emissions of these two pollutants would diminish warming by half a degree Celsius by 2050, researchers report in the Jan. 13 *Science*, potentially slowing sea level rise, glacial melting and other problems caused by rising temperatures.

"These are really the low-hanging fruit both for mitigating climate change and improving air quality," says study leader Drew Shindell, a climate scientist at the NASA Goddard Institute for Space Studies in New York City.

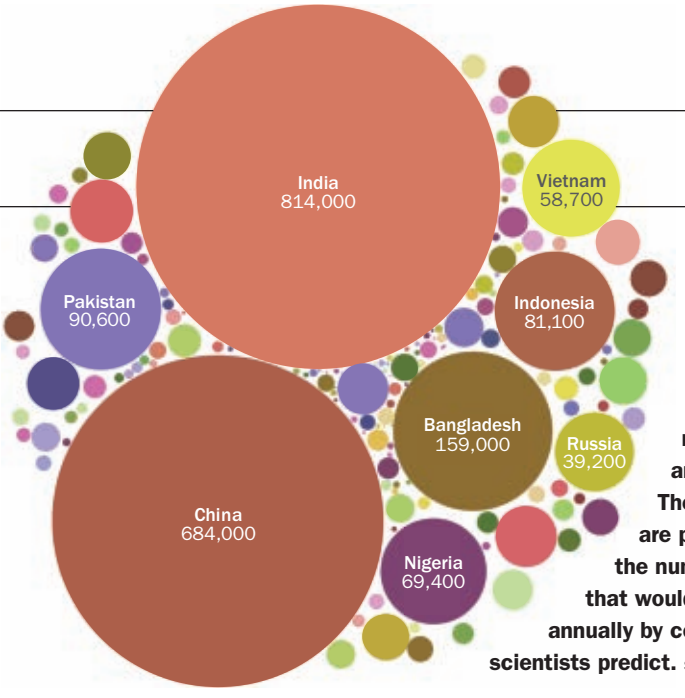
Shindell and his colleagues tested about 400 known pollution controls, selecting 14 interventions that had the greatest impact on warming in a computer simulation.

Seven of the proposed controls focus on methane. Implementing interventions already being used in some parts of the world can prevent methane from reaching the atmosphere by filtering it out of air rising from coal mines, livestock manure, landfills and other sources.

For soot, putting filters on cars that burn diesel, for instance, could trap these black flakes of carbon, which absorb sunlight and heat the atmosphere. Soot also darkens snow and glaciers, which hastens melting.

Piers Forster, a climate scientist at the University of Leeds in England, agrees that limiting methane emissions would affect climate. But he cautions that some sources of soot also give off other particles that reflect sunlight, cooling the planet.

"If you were to cut out these emissions, you might actually get a warming effect instead of a cooling effect," he says.



India and China would see the most deaths prevented by 14 measures reducing methane and soot. The circles at left are proportional to the number of deaths that would be prevented annually by country in 2030, scientists predict. SOURCE: D. SHINDELL

Recirculation degraded Gulf oil

Fueled by hydrocarbon plumes, bacteria feasted on crude

By Janet Raloff

A succession of hydrocarbon-noshing species of bacteria mushroomed throughout the months-long 2010 oil spill in the Gulf of Mexico because their movable feasts were repeatedly replenished, a new study finds. That explains the relatively speedy disappearance of giant plumes of subsea oil and gas that jetted from the wellhead and never surfaced.

Only about 15 percent of the BP crude floated up to form giant surface slicks, a second study reports. Natural gas constituents and dissolvable chemicals amounting to twice that mass remained near the seafloor, creating the roving, cloudlike hydrocarbon plumes on which the bacteria fed.

Both studies appeared online January 10 in the *Proceedings of the National Academy of Sciences*.

For the plume-degradation study, David Valentine of the University of California, Santa Barbara and his colleagues adapted a Navy computer program that predicted Gulf currents and incorporated information newly gleaned from the Gulf and lab studies. The program established which hydrocarbons were present, where plumes had been recorded and which Gulf bacteria had a propensity for eating plume compounds.

Then the researchers used the program to predict the bugs' feeding rates. Although bacteria should have depleted the available oxygen as they ate and reproduced, the computer program showed there would have been substantial water mixing, replenishing oxygen supplies.

Most parcels of the oiled water in which the bacteria were riding circled back to the seafloor wellhead multiple times, the Navy's current data indicate. This would have restocked the bacteria's hydrocarbon smorgasbord and further fueled mushrooming populations of these bugs.

"What happened in the deep plumes was far more complex than any of the initial papers had really acknowledged," says chemical oceanographer Benjamin Van Mooy of the Woods Hole Oceanographic Institution in Massachusetts.

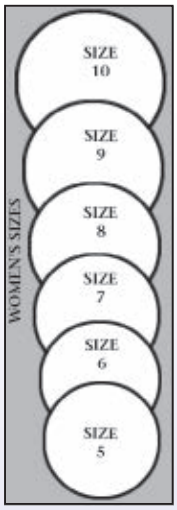
"…classic! The [Stauer] tanzanite are a beautiful shade of violet blue… full of color!"
— Praise for Stauer Tanzanite from C. of Missouri

Endangered Gem Disappearing

Tanzanite is found in only one remote spot on Earth, and it's 1,000 times rarer than diamonds. Experts say the mines will soon run dry forever, but today you can own more than 1 carat for ***less than $50!***

Time is running out. Geological experts predict the world's supply of tantalizing tanzanite will disappear in a matter of just a few years. Maybe sooner. High-end retailers are raising prices on this rare stone. And gem dealers are in a mad scramble to secure their claim before it's too late. Let them scramble.

Our buyer recently secured a huge cache of beautiful rare tanzanite, the precious stone loved for its vivid violet-blue color. Today you can own over 1 carat of this rare stone (1,000 times rarer than diamonds) in our spectacular ***1 1/5 ctw Tanzanite Cluster Ring*** with a suggested retail of $795 for only **$49.50**.



USING THE RING SIZE CHART
Place one of her rings on top of one of the circle diagrams. Her ring size is the circle that matches the inside diameter of the ring diagram. If her ring falls between sizes, order the next larger size.

It started with a lightning bolt. One strike set the African plains on fire and uncovered a secret that was buried for more than 585 million years. Tanzanite naturally occurs in only one place on Earth: Tanzania's remote Merelani Hills, in the shadow of Mount Kilimanjaro.

World's most endangered gem. Top-quality tanzanites can often fetch higher prices than diamonds. But, once the last purple gem is pulled from that remote spot beneath Kilimanjaro, that's it. No more tanzanite.

Reserve your piece of gem history. If you go online right now, you'll find one of the largest retailers selling tanzanite rings for well over $2,000 each. Ridiculous. Instead, you can secure your own piece of limited-edition tanzanite history at the right price.

Our promise of absolute satisfaction is 100% guaranteed. Our offers are so consumer friendly that we have earned an **A+ Rating** with the Better Business Bureau. But, why less than $50 for a genuine 1 1/5 ctw tanzanite ring? It's simple. We want you to come back to Stauer for all of your jewelry and watch purchases. If you are not 100% delighted with your ring, send it back within 30 days for a full refund of the purchase price. Just remember that the odds of finding this stone at this price ever again is like waiting for lightning to strike the same place twice.

JEWELRY SPECS:
- 1 1/5 ctw tanzanite – Ring sizes 5–10
- Rhodium-layered .925 sterling silver setting

Offer Limited to First 2500 Respondents

Tanzanite Cluster Ring (1 1/5 ctw)—~~$795~~
***Now Only* $49.50** + S&P

Call now to take advantage of this limited offer.

1-888-870-7339

Promotional Code CTR364-06
Please mention this code when you call.

BBB ACCREDITED BUSINESS **Stauer has a Better Business Bureau Rating of A+**

Stauer®
14101 Southcross Drive W., Dept. CTR364-06
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices

Body & Brain

For longer versions of these and other Body & Brain stories, visit **www.sciencenews.org**

Pot not harsh on lung capacity

In 20-year study, light users had no loss of function

By Nathan Seppa

People who smoke marijuana for recreational or medical purposes might breathe a little easier. Scientists report in the Jan. 11 *Journal of the American Medical Association* that occasional users don't lose lung function.

The study is the longest ever conducted that measures cannabis smoking and lung function, uses standard lung measurements and includes thousands of volunteers, says Donald Tashkin, a pulmonologist at UCLA who was not involved in the study.

The data, he says, also suggest that marijuana is not a significant risk factor for chronic obstructive pulmonary disease, which includes emphysema. COPD is typically caused by tobacco smoking.

The researchers tapped into a health study of 5,115 young adults recruited in 1985 and given lung tests periodically until 2006. The volunteers revealed whether and how often they smoked tobacco, marijuana or both. Most marijuana users in the study reported light use — up to a few times a month on average during the two decades.

These light marijuana users had above-average scores for their ages on lung function tests. People averaging somewhat higher use fared no better or worse than peers their age, while those who used cannabis at least 20 times a month for years showed hints of slightly reduced lung capacity, says study coauthor Stefan Kertesz, an internist at the University of Alabama at Birmingham.

Occasional marijuana use appears to have no negative impact on lung function, a two-decade study finds.

ELDADCARIN/ISTOCKPHOTO

Rats given boozing superpowers

Drug makes rodents resistant to intoxication, aftereffects

By Laura Sanders

Rats dosed with a compound isolated from an ancient herbal remedy appear all but impervious to quantities of alcohol that put their compatriots under the table. Rodents on the drug can drink large amounts without passing out, show fewer signs of hangover and even fail to become addicted to alcohol after weeks of drinking, researchers report in the Jan. 4 *Journal of Neuroscience*.

If the compound has similar effects in humans, it may offer a way to combat alcohol's dizzying effects, the dreaded hangover and even alcohol dependence. "I think it's really pretty incredible that one study opens up avenues for so many angles," says neuroscientist A. Leslie Morrow of the University of North Carolina School of Medicine in Chapel Hill.

Researchers led by Jing Liang of UCLA began by surveying herbal compounds that reportedly have antialcohol effects. A promising candidate caught the researchers' eyes: an extract isolated from the seeds of the Asian tree *Hovenia dulcis*, first described as a primo hangover remedy in the year 659.

In the new study, Liang and her team tested one ingredient of *Hovenia* called dihydromyricetin, or DHM, on rats, which respond to alcohol in similar ways as humans do. After rats were given the human equivalent of 15 to 20 beers in under two hours, the animals passed out in a drunken stupor and lost the reflex to flip over when placed on their backs. The rats took about an hour after this binge to regain control of their bodies and flip themselves over.

But when the rats received a shot of DHM along with their alcohol, they tolerated booze better. These rats still lost the ability to flip themselves over, but the stupor took longer to take hold and lasted only about 15 minutes.

DHM had benefits beyond the inebriated period, too. A dose of the compound helped ease rat hangover symptoms two days after an alcohol binge by reducing anxiety and susceptibility to seizures.

The standout result, says Steven Paul of Weill Cornell Medical College in New York City, is that DHM also curbed alcohol consumption. Rats allowed to drink alcohol gradually start consuming more of it. But rats that drank DHM-laced alcohol didn't increase their consumption, the team found.

"When you drink alcohol with DHM, you never become addicted," Liang says.

Though the results are exciting, they don't mean that a hit of *Hovenia* extract can enable a night of consequence-free binge drinking, Morrow says. Alcohol has many effects in the brain, and DHM may not block them all.

Alcohol works in part by changing the behavior of proteins known as GABA receptors, which are involved in damping down brain excitation. DHM blocks alcohol's effects by latching onto these receptors in the brain. Another compound called RO15-4513, discovered by Paul and collaborators, also blocked alcohol by interfering with GABA receptors, but it caused seizures.

So far, Liang and her team have found no side effects from DHM. The researchers now plan to test the drug's effect on people. ■

"When you drink alcohol with DHM, you never become addicted." —JING LIANG

Cardiovascular omens little-known

Many Europeans don't recognize signs of stroke, heart attack

By Bruce Bower

A majority of people in nine European countries recognize few or no warning signs of a stroke or heart attack, a new study finds.

About half of Europeans don't realize that it's best to call an ambulance when someone displays stroke symptoms, psychologist Jutta Mata of the University of Basel in Switzerland and colleagues report in an upcoming *Health Expectations*.

The findings come from a survey of 10,228 inhabitants of Austria, France, Germany, Italy, the Netherlands, Poland, Russia, Spain and the United Kingdom.

Among six established warning signs of a heart attack, chest pain was the only symptom recognized by most people — 80 percent. Almost half the participants linked shortness of breath and arm or shoulder pain to heart attacks. That figure fell to 21 percent for anxiety and for intense nausea and dizziness, and dropped to 7.5 percent for stomach pain.

Among 14 stroke warning signs, volunteers most often recognized slurred speech, paralysis and a lopsided face. But no symptom was recognized by more than 44 percent of Europeans, and 19 percent didn't know any stroke symptoms.

Interviewers contacted set numbers of people in different economic and social groups within each country, a method that may not yield a truly representative sample, says internist Lisa Schwartz of the Dartmouth Institute for Health Policy and Clinical Practice in Lebanon, N.H.

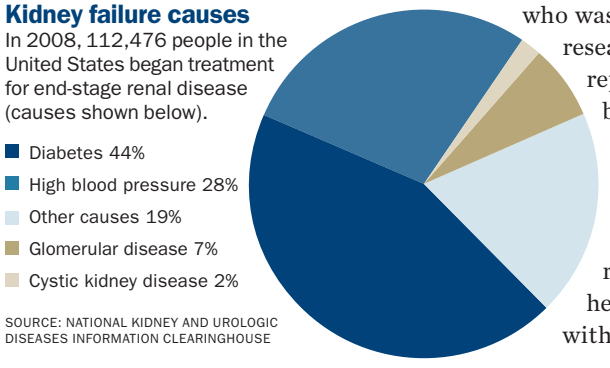
Proteins tied to kidney failure

Research could lead to predictive test for diabetics

By Nathan Seppa

A simple blood test might reveal which people with diabetes are most prone to kidney failure, two long-term studies show. Both studies linked high levels of proteins called tumor necrosis factor, or TNF, receptors with elevated incidence of kidney disease up to 12 years later. The association showed up in patients with type 1 and type 2 diabetes, the researchers report online January 19 in the *Journal of the American Society of Nephrology*.

Kidney failure causes
In 2008, 112,476 people in the United States began treatment for end-stage renal disease (causes shown below).



SOURCE: NATIONAL KIDNEY AND UROLOGIC DISEASES INFORMATION CLEARINGHOUSE

Study leader Andrzej Krolewski, a kidney researcher at Harvard Medical School and the Joslin Diabetes Center in Boston, says the findings may ultimately improve care for at-risk diabetes patients. "The most immediate application," says study coauthor Monika Niewczas, a researcher also at Harvard and Joslin, "will be a diagnostic test that we hope would be available soon."

TNF receptors serve as docking stations on cells. When their counterpart protein latches onto the receptor, the signal produced by that binding can instruct a cell to trigger inflammation or to take on other duties. Some TNF receptors also roam free, showing up in the blood, a characteristic the scientists measured in the new studies.

"These are good pilot studies, very well conducted," says Sankar Navaneethan, a nephrologist at the Cleveland Clinic who wasn't involved in the new research. "But they need to be replicated in future studies before we can embark on using this biomarker for predicting these outcomes in patients."

In one study, the researchers tracked the health status of 410 people with type 2 diabetes beginning in the early 1990s. Patients provided initial blood samples followed by information on their health over the next eight to 12 years. By the end of the study's follow-up period, 54 percent of patients with high concentrations of TNF receptors at the outset had developed kidney failure and needed dialysis or a transplant. Only 3 percent of patients with low levels of TNF receptors had such problems. After accounting for differences among the patients, the high-receptor group was still about six times more prone to kidney failure, Niewczas says.

The other study included 628 patients with type 1 diabetes, formerly called juvenile-onset diabetes. Over five to 12 years of follow-up, participants who had high TNF receptor levels at the start were three times as likely to develop chronic kidney disease as those with low receptor levels.

The researchers "provide very solid statistical and epidemiological evidence" linking TNF receptor abundance with kidney damage, says Klaus Ley, a physician at the La Jolla Institute for Allergy and Immunology in California. "But we don't know why the receptor levels are increased in these patients. This is just the beginning of a very exciting story."

Science & Society

For more about this year's Intel Science Talent Search finalists, visit **www.societyforscience.org/sts**

Science Talent Search picks top 40

Intel-sponsored competition drew more than 1,800 entries

By Devin Powell

Forty science-minded teens have made it to the final round of the nation's longest-running precollege science competition. As finalists in this year's Intel Science Talent Search, a program of Society for Science & the Public, the students are now vying for $630,000 in awards, including a top award of $100,000 from the Intel Foundation.

In March, the young researchers will travel to Washington, D.C., to meet with respected scientists and present their research projects to the public and a group of judges. One finalist developed a needle-free diabetes monitoring system. Others created flame retardants made of biodegradable plastic, studied how children with Down syndrome perceive themselves and worked on new ways to protect satellite communications.

"Tackling real-world challenges from cancer to Internet security to alternative energy solutions, this year's finalists are a true inspiration," says Elizabeth Marincola, publisher of *Science News* and president of Society for Science & the Public. "We join with Intel in congratulating them on this tremendous honor and commend the mentors, teachers, schools, parents and communities that have contributed to their success."

Each project was chosen from a pool of 1,839 entries submitted from across the country. The 2012 top winner will be announced March 13 at the National Building Museum in Washington, D.C. Last year, Evan O'Dorney, 17, of Danville, Calif., took first place for comparing two mathematical approaches to estimating the square root of an integer.

Many previous competitors have gone on to illustrious careers in science. Seven Science Talent Search finalists have won Nobel Prizes, and four have received the National Medal of Science. The competition, which started in 1942, was originally sponsored by the Westinghouse Foundation. Seventy years later, the competition's goal of supporting students with a talent for science, engineering and math hasn't changed.

"We must encourage science innovation by our youth to help their generation solve problems of today and tomorrow," Marincola says. ■

THE FINALISTS

CALIFORNIA **Jiacheng Li,** Arcadia, Arcadia High School; **Sayoni Saha,** Cerritos, Gretchen Whitney High School; **Clara Fannjiang,** Davis, Davis Senior High School; **Jack Li,** El Segundo, El Segundo High School; **Leon Yao,** Fullerton, Troy High School; **Meredith Lehmann,** La Jolla, La Jolla High School; **Jin Pan,** Palo Alto, Henry M. Gunn High School; **Saurabh Sharan,** San José, Bellarmine College Preparatory School; **Alissa Zhang,** Saratoga, Saratoga High School

CONNECTICUT **Zizi Yu,** Woodbridge, Amity Regional High School

FLORIDA **Neel Patel,** Oviedo, Oviedo High School

GEORGIA **Sitan Chen,** Duluth, Northview High School

ILLINOIS **Adam Kalinich,** Aurora, Illinois Mathematics and Science Academy; **Jordan Cotler,** Northbrook, Glenbrook North High School

INDIANA **Eric Fein,** South Bend, John Adams High School; **Anirudh Prabhu,** West Lafayette, West Lafayette Junior-Senior High School

MASSACHUSETTS **Xiaoyu He,** Acton, Acton-Boxborough Regional High School; **Fengning Ding,** Andover, Phillips Academy

MARYLAND **Frederic Koehler,** Silver Spring, Montgomery Blair High School

MICHIGAN **Siddhartha Jena,** Bloomfield Hills, International Academy; **Philip He,** Okemos, Okemos High School; **Nithin Tumma,** Port Huron, Port Huron Northern High School

MINNESOTA **Evan Chen,** Plymouth, Wayzata High School

NEW JERSEY **EunBe Kim,** Hackensack, Academy for Medical Science Technology

NEW YORK **Danielle Goldman,** Bronx, Bronx High School of Science; **Savina Kim,** Commack, Commack High School; **Anna Sato,** East Setauket, Ward Melville High School; **Juliana Coraor,** Huntington, Huntington High School; **Neil Mehta,** Jericho, Jericho Senior High School; **Angela Wang,** Latham, Shaker High School; **Huihui Fan,** New York, Stuyvesant High School; **Mimi Yen,** New York, Stuyvesant High School; **Rachel Davis,** St. James, Smithtown High School East; **Benjamin Van Doren,** White Plains, White Plains High School

PENNSYLVANIA **Marian Bechtel,** Landisville, Hempfield High School

TEXAS **Kurtis Carsch,** Denton, Texas Academy of Mathematics and Science; **Amy Chyao,** Plano, Plano East Senior High School; **Oliver Quintero,** The Woodlands, The John Cooper School

VIRGINIA **Ari Dyckovsky,** Sterling, Loudoun County Academy of Science

WASHINGTON **Andrey Sushko,** Richland, Hanford High School

Finalists are listed by state, name, city and high school.

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

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

The spy glass that made naval history…

ADMIRAL FARRAGUT'S TELESCOPE

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

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

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

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

The only universal optical instrument…

PANSCOPE

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

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

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

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

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

Hold the whole world in your hand with…

Jomirascope

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

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

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

jomira

division of jomira/advance
470 3rd St., #211, San Francisco, CA 94107

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

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

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

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

Deep Life

Teeming masses of organisms thrive beneath the seafloor

By Alexandra Witze

Forget E.T. It's time to meet the intraterrestrials.

They too are alien, appearing in bizarre forms and eluding scientists' search efforts. But instead of residing out in space, these aliens inhabit a dark subterranean realm, munching and cycling energy deep inside the Earth.

Most intraterrestrials live beneath the bottom of the ocean, in an unseen biosphere that is a melting pot of odd organisms, a sort of Deep Space Nine for microbes. Many make their homes in the tens of meters of mud just beneath the seafloor. Others slither deeper, along fractures into solid rock hundreds of meters down.

Scientists are just beginning to probe this undersea world. In the middle of the South Pacific, oceanographers have discovered how bacteria survive in nutrient-poor, suffocating sediment. Off the coast of Washington state, other researchers have watched microbes creep into and colonize a borehole 280 meters below the seafloor, flushed by water circulating through the ocean crust. And near the underwater mountain ridge that marks the middle of the Atlantic Ocean, scientists have yanked up organisms that may be unlike any known sub-seafloor residents.

Such discoveries are helping biologists piece together a picture of a deep, seething ecosystem. Knowing how this world arose, researchers say, will help them understand more about the origin of life on Earth. One day intraterrestrials could even tell scientists more about extraterrestrials, by helping sketch out

Explorations hundreds of meters into the seafloor are helping scientists study organisms living there. Instruments lowered into the holes create ongoing observation stations, called CORKs.

TONY RANDAZZO/AAREPS INC.

the extremes under which life can not only survive but even thrive.

Oceanic desert

Considering that oceans cover most of the planet, it's a no-brainer to try to figure out what's living in the mud and rock beneath them. "It's really the most massive potential habitat on Earth," says microbiologist Beth Orcutt of Aarhus University in Denmark.

By some estimates, as much as one-third of the planet's biomass — the sheer weight of all its living organisms — is buried beneath the ocean floor. Many of these bacteria and other microbes survive on food that drifts down from above, such as the remains of plankton that once blossomed in the sunlight of the ocean's upper reaches.

These hardy microbes manage to eke out an existence even where it shouldn't be possible. In the middle of the South Pacific, for instance, lies an oceanic vortex where water circulates in a huge eddy, or gyre, twice the size of North America. Because the gyre is so far from any landmasses — from which nutrients wash off and help spur plankton growth and other ocean productivity — it is essentially a giant oceanic desert, says Steven D'Hondt of the University of Rhode Island's oceanography school in Narragansett.

In some places in the gyre, seafloor mud builds up as slowly as eight centimeters per million years. That means if you wanted to plant a tulip bulb at the usual gardener's depth of about 16 centimeters, D'Hondt says, you'd be digging into mud that is 2 million years old.

Such low-productivity regions in the centers of oceans are far more common than nutrient-rich coastal zones, but scientists don't often visit the deserts because they are hard to get to. In the autumn of 2010, though, D'Hondt led a cruise to the South Pacific Gyre that drilled into the dull seafloor mud and pulled up cores. "We wanted to see what life was like in sediment in the deadest part of the ocean," he says.

This basalt rock, pulled up during an expedition to a seamount off Hawaii's coast, is coated in iron oxides — a sign of microbial activity.

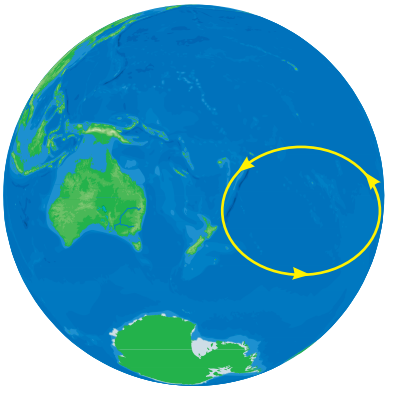
Among other things, the scientists discovered how microbes in the mud might cope. In other areas of the ocean, where more nutrients fall to the seafloor, oxygen is found only in the uppermost centimeter or two of mud; any deeper than that and it gets eaten up. But in the South Pacific Gyre, D'Hondt's team found that oxygen penetrates all the way through the seafloor cores, up to 80 meters of sediment. To the scientists, this finding suggests that these mud microbes breathe very slowly and so don't use up all the available oxygen. "That violates standard expectations," says D'Hondt, "but until we went out there and drilled, nobody knew."

Another possibility is that the microbes have a separate, unusual source of energy: natural radioactivity. Radioactive decay of elements in the underlying mud and rocks bombards the water with particles that can split H_2O into hydrogen and oxygen, a process known as radiolysis. Microbes can then consume those elements, sustaining themselves over time with a near-endless supply of food. "That's the most exotic interpretation," D'Hondt says, "that we have an ecosystem living off of natural radioactivity that is splitting water molecules apart."

Sub-seafloor searches Researchers are turning to diverse undersea worlds to try to understand how life survives beneath the ocean's floor. From nearby coastal zones to faraway mid-ocean deserts, these locales have their own brand of creatures and ecosystem dynamics.

Juan de Fuca Ridge
One of the best instrumented sub-seafloor sites, this underwater mountain range gets plenty of nutrients washing off of nearby coasts. Observing stations there have uncovered firmicutes, bacteria also known to be present at the bottom of the Arctic Ocean.

North Pond
This big pile of mud sits in an area of violent geologic activity. The waters are cold, 10° Celsius, so scientists who recently left rocky chips dangling in boreholes there expect to find life unlike what they've seen at other sub-seafloor locales.



South Pacific Gyre
In this region, far from any continents, currents (arrows) form a vast eddy with nutrient-poor waters. Bacteria may survive in this low-productivity zone by consuming oxygen very slowly or by relying on natural radioactivity for energy.

FROM TOP: WOODS HOLE OCEANOGRAPHIC INSTITUTION; MAPS: GEOATLAS/GRAPHI-OGRE, ADAPTED BY T. DUBÉ

Easy access

Thousands of miles north and east of drilling sites in the South Pacific Gyre, other scientists are exploring a very different alien realm in the Juan de Fuca Ridge, an underwater mountain range marking the convergence of several great plates of Earth's crust. Juan de Fuca is one of those coastal areas getting plenty of nutrients from nearby British Columbia and Washington state, and scientists can get there relatively quickly.

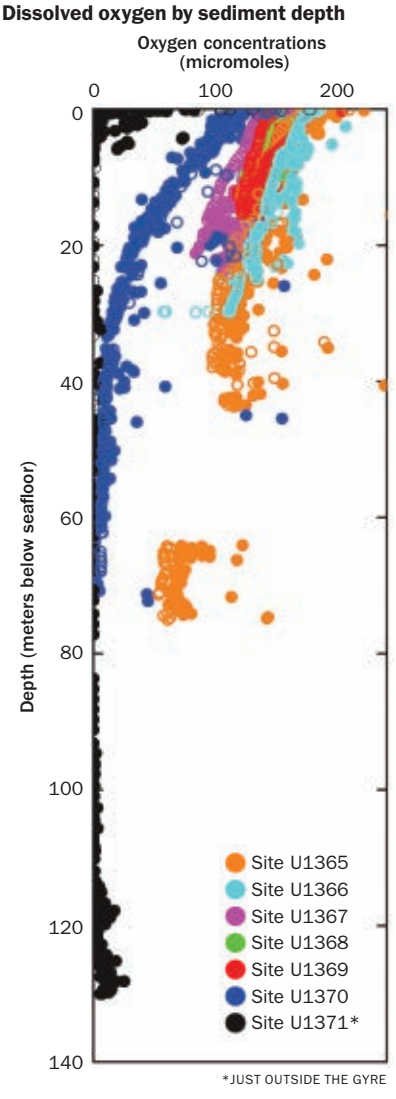
As a result, the Juan de Fuca area may be the world's best-instrumented seafloor. A network of observatories sprawls across the ocean bottom; in one spot, six borehole monitoring stations lie within about 2.5 kilometers of each other. One of the stations is hooked up to the shore via underwater cables, so that scientists sitting at their desks can track the data in real time. "We can do active experiments there that we can't do anywhere else in the ocean," says Andrew Fisher, a hydrogeologist at the University of California, Santa Cruz who helped set up much of the instrumentation.

Many of the stations are observatories known as CORKs, a tortured acronym for "circulation obviation retrofit kit," which essentially means a deep hole in the seafloor plugged at the top to keep seawater out. Researchers lower a string of instruments into the hole, then come back several years later to retrieve them. Data from CORKs can reveal what organisms live at what depths within the borehole, as well as how microbial populations change over time.

CORKs are technically challenging to install, but sometimes glitches can yield unexpected discoveries. At one Juan de Fuca site, researchers tucked experiments down a hole in 2004. After retrieving rock chips that had dangled in the hole for four years, the team saw twisted stalks that looked like rust coating the surfaces. It turned out that the CORK hadn't been properly sealed, and iron-oxidizing bacteria leaked in along with seawater.

Those bacteria initially colonized the borehole and built up the stalks, thriving on the cold and oxygen-rich conditions carried in by the seawater. But over the next few years the borehole began to warm up, thanks to volcanic heat percolating from below. Water from within the surrounding ocean crust began to rise and push out the seawater, reversing the flow within the hole. The iron-loving bacteria died and other types of organisms began to appear: bacteria known as firmicutes, which are found in similarly exotic environments such as the Arctic Ocean's bottom. "For us that's a really interesting finding and a kind of nice serendipitous experiment," says Orcutt, who published the work with her colleagues last year in the *International Society for Microbial Ecology Journal*.

Oxygen persists At nutrient-rich sites, oxygen is found only in the first centimeter or so of sediment. But at sites in the South Pacific Gyre, oxygen is present much deeper, suggesting life there may breathe differently.



Research at Juan de Fuca also shows how water flushes through the ocean crust, offering clues to the best places to look for microbes. People tend to think of water sitting on top of the seafloor, says Fisher, but in fact water zips through undersea rocks — cycling the equivalent of the ocean's entire volume through the crust every half-million years or so.

At Juan de Fuca, Fisher and colleagues have spotted two underwater volcanoes, about 50 kilometers apart, that help explain how such high rates of flow might happen. CORK observations reveal that water flows into one of the mountains and flushes out the other. "This is the first place anywhere on the seafloor where researchers have been able to put their finger on a map and say 'the water goes in here and out here,'" Fisher says.

Those two volcanoes are arranged along a north-south line that tends to control much of the undersea activity at Juan de Fuca, he says. Most of the fractures in the ocean crust here run north to south, making that the probable direction in which microbes also move. The cracks serve as a sort of microbial superhighway, allowing the microbes to flow along easily, carried by water. Scientists looking for more sub-seafloor microbes might want to also focus on these areas, Fisher says: "You'll see very different populations along the superhighways than along the back roads."

Pond swimmers

Far from being monolithic, the seafloor is home to a surprising range of different environments. One new target, much different from Juan de Fuca or the South Pacific Gyre, is a spot in the mid-Atlantic known as North Pond. Geologists have studied this place, at 22 degrees north of the equator, since the 1970s for what it can reveal about the processes that form young crust at mid-ocean ridges. Now microbiologists are also targeting North Pond for what it can say about deep life.

The "pond" of North Pond is a pile of undersea mud, cradled against the side of tall jagged mountains. It lies about five

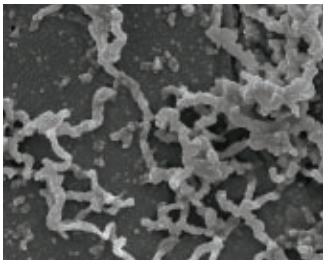
IODP/EXPEDITION 329 SCIENTIFIC TEAM

kilometers from where seafloor crust is actively being born; all that violent geologic activity pushes water quickly through the mud and rocks and out into the ocean above. Compared with Juan de Fuca, the water at North Pond is much cooler — roughly 10° Celsius, as opposed to 60° C to 70° C — but flows much faster. "Nature finds a balance between temperature and flow," says Fisher.

He and his colleagues, led by Katrina Edwards of the University of Southern California in Los Angeles and Wolfgang Bach of the University of Bremen in Germany, spent 10 weeks at North Pond last autumn. They installed two new CORKs, up to 330 meters deep, and pulled up samples of rock and water to test for any microbes that might be living there. The scientists also tucked long dangling strings of rock chips into the holes and plan to return in the years ahead to see what organisms might appear. "It was a great success," says Edwards. "We set ourselves up for a good decade's worth of work out at North Pond."

For now, it's up to microbiologists back on land to make sense of what's there. Researchers are just starting to culture the slow-growing microbes pulled up at North Pond, but already they suspect they'll find surprises.

Overall, studies at different locales reveal that deep-sea microbes are far more diverse than scientists had thought even a decade ago, says microbiologist Jennifer Biddle of the University of Delaware in Newark. Rather than just a couple of broad classes, researchers have found a rich diversity of bacteria along with archaea — other single-celled organisms with an older evolutionary history — plus fungi, viruses and more. "We were shocked it was so complicated," says Biddle. "We thought there was maybe five Bunsens and 10 Beakers, and it turns out there's the entire cast of the Muppets in there."



These particles, found on rocks dangling in boreholes at Juan de Fuca, were probably left by iron-oxidizing bacteria.

By comparing microbes from different seafloor sites, Biddle has found surprisingly high amounts of archaea compared with bacteria in some places. She thinks that archaea may be thriving on organic matter in seafloor mud, so nutrient-rich coasts have more archaea than sediments in the middle of the ocean. "The jury's still out on that one," she says.

A new project known as the Census of Deep Life will help Biddle and others analyze and compare more of the subseafloor microbes. The census could take as long as a decade; the idea is to find overarching rules — if they exist — that describe where and how organisms thrive in the seafloor. "Right now you can get some idea of that by looking at the sorts of energy sources that are present in the subsurface," says census leader Rick Colwell, a microbiologist at Oregon State University in Corvallis. "But do fractures in various subsurface environments, worldwide, contain certain types of microorganisms consistently?"

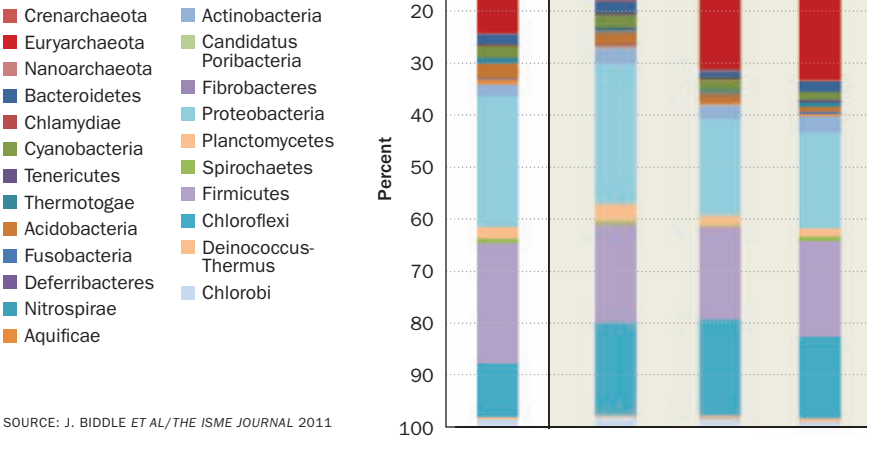
Plenty of data should be forthcoming. "We're not suffering from a lack of things to do," Orcutt says. Edwards and her team plan to return to North Pond in April to retrieve their first set of instruments. Fisher will go back to Juan de Fuca next summer, in what may be a final visit before turning his attention elsewhere. Next on his wish list: a site off Costa Rica where water flows through the crust some thousands of times faster than at Juan de Fuca.

One day, analyzing the deep biosphere may help NASA and other space agencies in their hunt for life elsewhere in the solar system. At North Pond, expedition scientists have tested out a new tool that, once lowered into a borehole, illuminates the hole's walls using ultraviolet light. Because living cells turn fluorescent at specific wavelengths, the light can be used to spot films of organic matter coating the hole. This probe, or some elaboration on it, could end up flying on future space missions. And then the intraterrestrials could help scientists find extraterrestrials. ■

Explore more

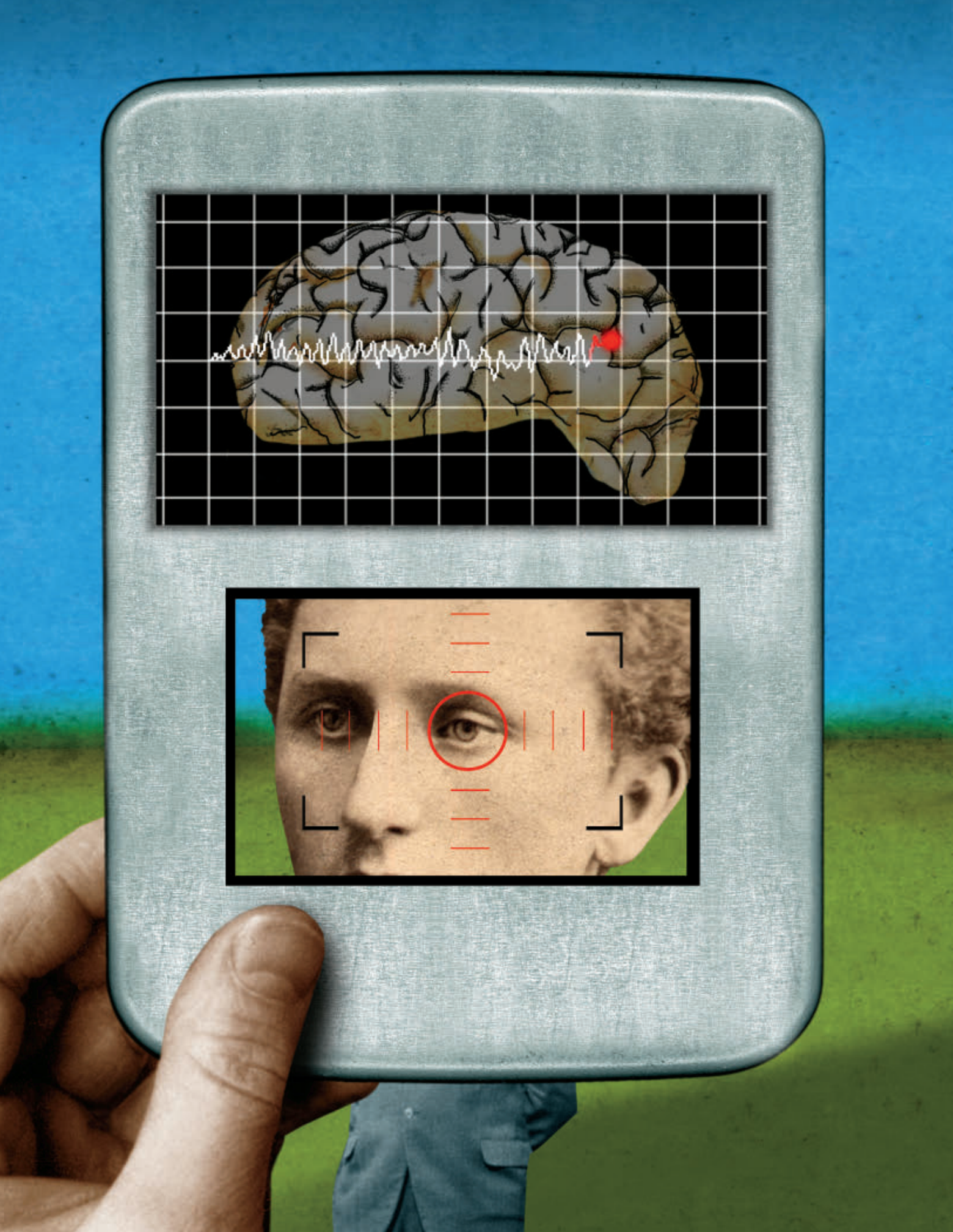
- Visit the Center for Dark Energy Biosphere Investigations website: www.darkenergybiosphere.org

Name that life A recent study looked at biological molecules extracted from sediments at Brazos-Trinity Basin on the slope of the Gulf of Mexico to determine what types of organisms live there. Though the residents were similar to those previously found at the Pacific's Peru Margin, abundances varied.



SOURCE: J. BIDDLE *ET AL*/*THE ISME JOURNAL* 2011

TOP: B.N. ORCUTT *ET AL*/*THE ISME JOURNAL* 2011



Emblems of Awareness

Brain signatures lead scientists to the seat of consciousness

By Laura Sanders

Humankind's sharpest minds have figured out some of nature's deepest secrets. Why the sun shines. How humans evolved from single-celled life. Why an apple falls to the ground. Humans have conceived and built giant telescopes that glimpse galaxies billions of light-years away and microscopes that illuminate the contours of a single atom. Yet the peculiar quality that enabled such flashes of scientific insight and grand achievements remains a mystery: consciousness.

Though in some ways deeply familiar, consciousness is at the same time foreign to those in its possession. Deciphering the cryptic machinations of the brain — and how they create a mind — poses one of the last great challenges facing the scientific world.

For a long time, the very question was considered to be in poor taste, acceptable for philosophical musing but outside the bounds of real science. Whispers of the C-word were met with scorn in polite scientific society.

Toward the end of the last century, though, sentiment shifted as some respectable scientists began saying the C-word out loud. Initially these discussions were tantalizing but hazy: Like kids parroting a dirty word without knowing what it means, scientists speculated on what consciousness is without any real data. After a while, though, researchers developed ways to turn their instruments inward to study the very thing that was doing the studying.

Today consciousness research has become a passion for many scientists, and not just for the thrill of saying a naughty word. A flood of data is sweeping brain scientists far beyond their intuitions, for the first time enabling meaningful evidence-based discussions about the nature of consciousness.

"You're not condemned to walk around in this epistemological fog where it's all just sort of philosophy and speculation," says neuroscientist Christof Koch of Caltech and the Allen Institute for Brain Science in Seattle. "It used to be the case, but now we can attack this question experimentally, using the tools of good old science to try to come to grips with it."

Knowledge emerging from all of this work has ushered researchers into a rich cycle of progress. New experimental results have guided theoretical concepts of consciousness, which themselves churn out predictions that can be tested with more refined experiments. Ultimately, these new insights could answer questions such as whether animals, or the Internet, or the next-generation iPhone could ever possess consciousness.

Though a detailed definition remains elusive, in simplest terms, consciousness is what you lose when you fall into a deep sleep at night and what you gain when you wake up in the morning. A brain that is fully awake and constructing experiences is said to be fully conscious. By comparing such brains with others that are in altered states of awareness, researchers are identifying some of the key ingredients that a conscious brain requires.

In the hunt for these ingredients, "we decided to go for big changes in consciousness," says Giulio Tononi of the University of Wisconsin–Madison. He and others are studying brains that are deeply asleep, under anesthesia or even in comas, searching for dimmer switches

Demystifying the Mind

A three-part series on the scientific struggle to explain the conscious self.

IN THIS ISSUE

"Emblems of awareness"
A flood of brain data may yield the recipe for consciousness.

"Self as symbol," PAGE 28
A mind's attempts to understand itself generate a strange loop.

IN THE FEBRUARY 25 ISSUE

"Consciousness emerges"
Conscious experience coalesces from sensory inputs traveling through the brain.

IN THE MARCH 10 ISSUE

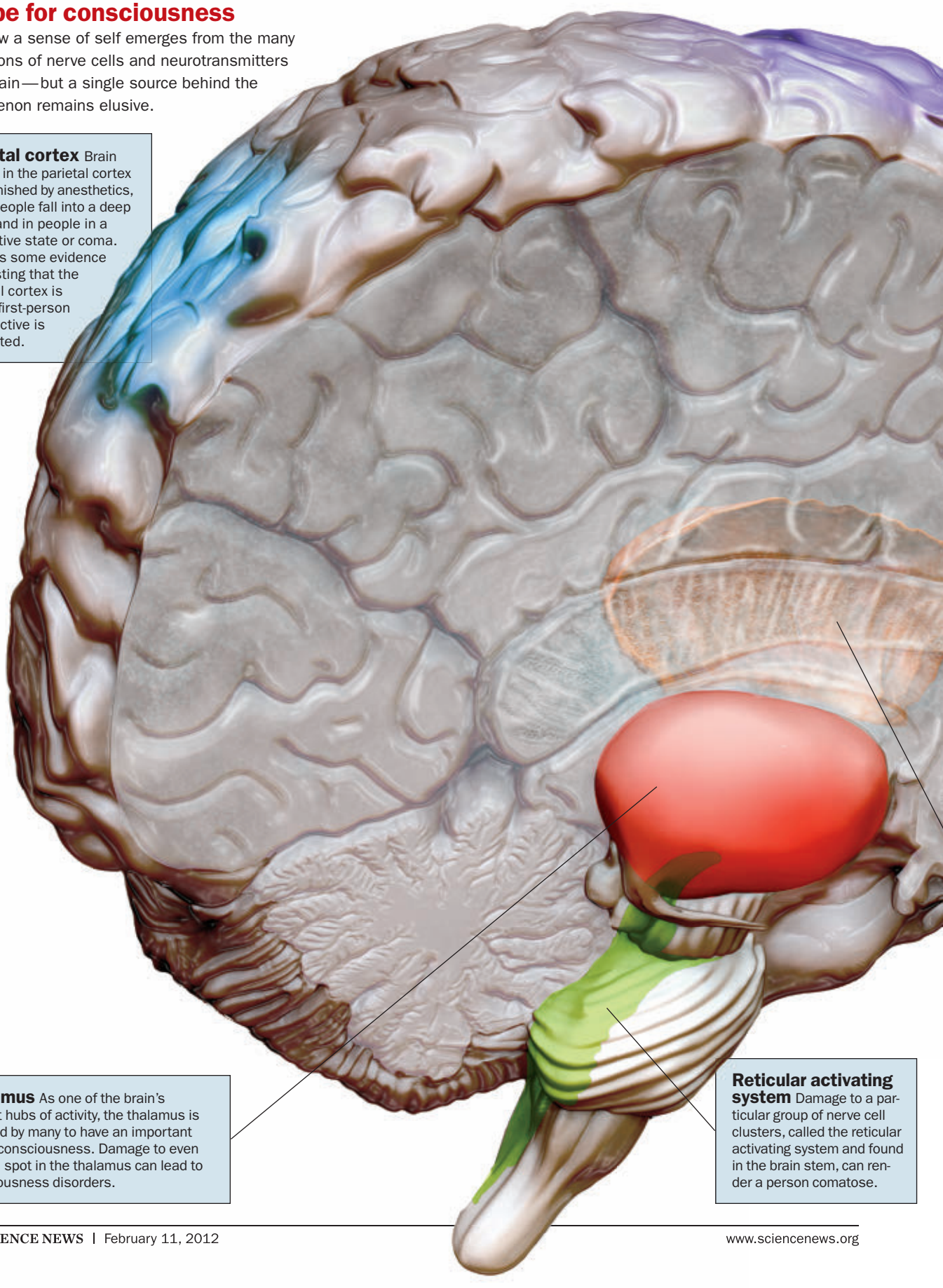
"Enriched with information"
Rich, deeply connected information may be the defining feature of consciousness.

OPPOSITE PAGE: MICHAEL MORGENSTERN

Recipe for consciousness

Somehow a sense of self emerges from the many interactions of nerve cells and neurotransmitters in the brain—but a single source behind the phenomenon remains elusive.

Parietal cortex Brain activity in the parietal cortex is diminished by anesthetics, when people fall into a deep sleep and in people in a vegetative state or coma. There is some evidence suggesting that the parietal cortex is where first-person perspective is generated.



Thalamus As one of the brain's busiest hubs of activity, the thalamus is believed by many to have an important role in consciousness. Damage to even a small spot in the thalamus can lead to consciousness disorders.

Reticular activating system Damage to a particular group of nerve cell clusters, called the reticular activating system and found in the brain stem, can render a person comatose.

NICOLLE RAGER FULLER

Frontal cortex Some researchers argue that parts of the frontal cortex (along with connections to the parietal cortex) are required for consciousness. But other scientists point to a few studies in which people with damaged frontal areas retain consciousness.

Claustrum An enigmatic, thin sheet of neural tissue called the claustrum has connections with many other regions. Though the structure has been largely ignored by modern scientists, Francis Crick became keenly interested in the claustrum's role in consciousness just before his death in 2004.

that dial global levels of consciousness up or down.

Scrutinizing brain changes that correspond to such levels has led some scientists to a central hub deep in the brain. Called the thalamus, this structure is responsible for constantly sending and receiving a torrent of neural missives. Other clues to consciousness come from a particular kind of electrical signal that the brain produces when it becomes aware of something in the outside world. But rather than one kind of signature, or one strategic brain structure, consciousness depends on many regions and signals working in concert. The key may be in the exquisitely complicated ebb and flow of the brain's trillions of connections.

Hub of activity

A profoundly damaged thalamus turned out to be at the center of one of the first right-to-die battles in the United States. A heart attack in 1975 left 21-year-old Karen Ann Quinlan in a nonresponsive, unconscious vegetative state for a decade. After she ultimately died of natural causes, an autopsy revealed surprising news: Quinlan's cerebral cortex, the outer layer of the brain where thoughts are formed, appeared relatively unscathed. But the thalamus was destroyed.

The thalamus is made up of two robin's egg–sized structures that perch atop the brain stem, a perfect position to serve as the brain's busiest busybody. It is the first stop for many of the stimuli that come into the brain from the eyes, ears, tongue and skin. Like a switchboard operator, after gathering information from particular senses, the thalamus shoots the signals along specific nerve fibers, connecting the right signal to the right part of the brain's wrinkly cortex.

These strong connections, along with evidence from vegetative state patients, make the thalamus a prime suspect in the hunt for the seat of consciousness. A 2010 study in the *Journal of Neurotrauma*, for example, found atrophy of the thalamus in people in a vegetative state.

Not only is the thalamus itself compromised, but also its connections — white-matter tracts that carry nerve signals — seem to be dysfunctional in people who aren't fully conscious, researchers reported last year in *NeuroImage*.

"I can't help but think there's something fundamental about the functional circuitry," says neuroscientist David Edelman of the Neurosciences Institute in San Diego. "There's a fundamental loop between ... the thalamus and the cortex. If those connections are cut or if you've damaged them, that individual will not be aware by any measure, forever."

One of the most startling pieces of evidence implicating the thalamus came from a patient who had existed in a minimally conscious state for six years, drifting in and out of awareness. After surgery in which doctors implanted electrodes that stimulated his thalamus, the man began responding more consistently to commands, moved his muscles and even spoke.

But the part the thalamus plays in consciousness is not straightforward. Its role may be as complex as the intricate spidery connections linking it to the rest of the brain.

"The thalamus has two souls," says Martin Monti, a neuroscientist at the University of California, Los Angeles. One of the souls receives information directly from the outside world, and one receives information from other parts of the brain. "It turns out that there are many more connections going from cortex back to thalamus," he says. "There's a lot of chitchat."

This huge influx of messages from the cortex may mean that the thalamus is simply a very sensitive readout of cortical behavior, as work reported in 2007 in *Anesthesiology* hints.

As anesthesia took hold of participants in the study, activity in the cortex wavered, yet the thalamus kept chugging away normally for about 10 minutes. If the thalamus were the ultimate arbiter of consciousness, its behavior should have changed before that of the cortex.

Instead of being a driver, the thalamus may be a consciousness gauge. In the same way that a thermometer can tell you to grab a coat but doesn't actually

make it cold, the thalamus may tell you a person is conscious without making it so.

Reading waves

Rather than studying the thalamus, some researchers focus on long-range brain waves that ripple over the cortex. One such ripple, a fast electrical signal called a gamma wave, has garnered a lot of attention. These waves, which in some cases emanate from the thalamus, are generated by the combined electrical activity of coalitions of nerve cells behaving similarly. Gamma waves spread over the brain at about 40 waves per second; other brain waves — such as those thought to mark extreme concentration or attention — are slower.

Gamma waves have been spotted along with mental processes such as memory, attention, hearing noises and seeing objects. And studies have even found that the waves are present in REM sleep, the stage marked by intense dreams.

Such associations have led some researchers to propose that gamma waves bind disparate pieces of a scene, tying together the rumble of a boat's outboard, the crisp breeze and a memory of a black lab into a unified lake experience.

But some new data call gamma waves' role in consciousness into question, by finding that the signal can be present when consciousness is not. Researchers, including Tononi, monitored electrical signals in brains of people as anesthesia took hold. When eight healthy people were anesthetized with propofol (the powerful anesthetic that Michael Jackson used to sleep), gamma waves actually increased, the team reported last year in *Sleep*. Consciousness was clearly diminished, yet the gamma waves persisted.

Specific brain signals, such as gamma waves, might be important aspects of consciousness, but not the main driving forces in the brain. "I can put gamma waves into any machine," says Tononi. But doing so won't give the machine a conscious mind.

The same may be true for structures such as the thalamus, as well as other regions that have been scrutinized by scientists, including the parietal and frontal cortices, the reticular activating system in the brain stem and a thin sheetlike structure called the claustrum.

Increasingly nuanced views of the ingredients at work in a conscious brain have led some scientists to a new suspicion: Perhaps the thing in the brain that underlies consciousness is not a thing at all, but a process. Messages constantly zing around the brain in complex patterns, as if trillions of tiny balls were simultaneously dropped into a pinball machine, each with a prescribed, mission-critical path. This constant flow of information might be what creates consciousness — and interruptions might destroy it.

Crucial connections

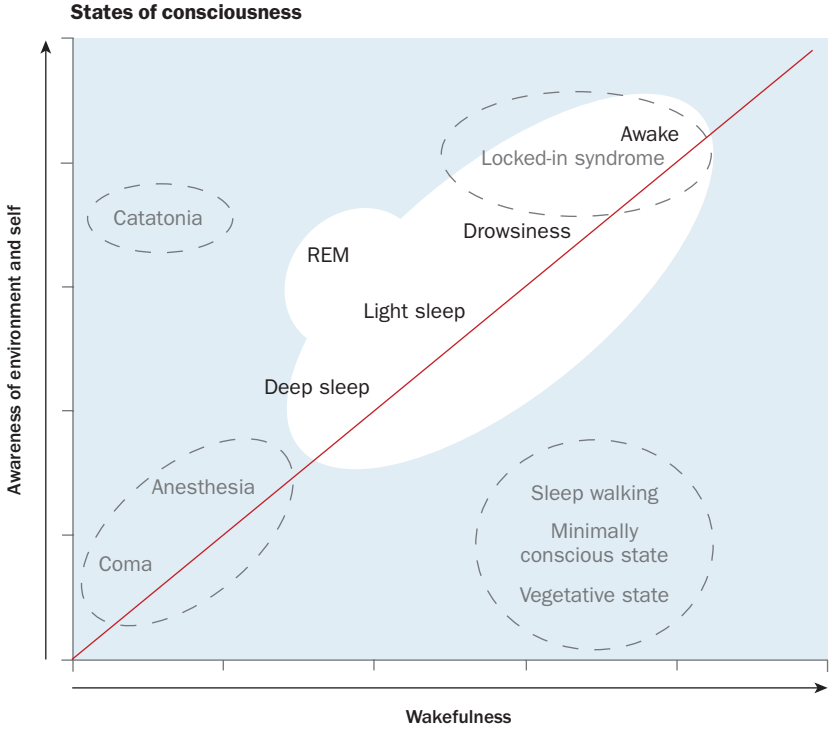
One way to look for signs of interrupted information flow is by conducting brain scans as propofol takes effect. In a study published last July in *NeuroImage*, 18 healthy volunteers were administered the anesthetic while in a functional MRI brain scanner. fMRI approximates a brain region's activity by measuring blood flow: The busier the brain region, the more blood flows there.

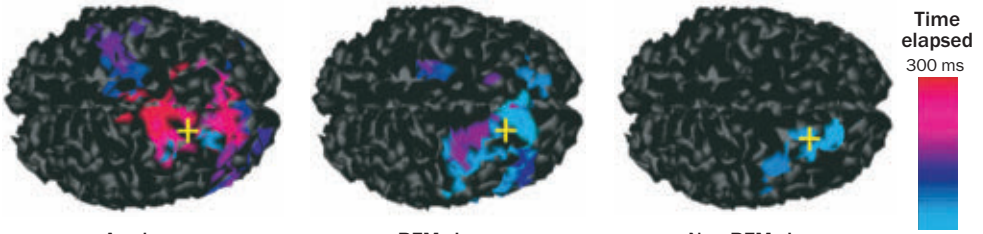
While deeply anesthetized, some brain regions that normally operate in tandem fell out of sync, Jessica Schrouff of the University of Liège in Belgium and colleagues reported. Conversations within particular brain areas, and also between far-flung brain areas, fell apart.

People in vegetative states also appear to have interruptions in brain connections, Mélanie Boly of the University of Liège and colleagues found after comparing these patients with healthy volunteers. Participants listened to a series of tones, most of which were similar, but every so often, a strange "oddball" tone would play, spurring a big reaction in the brain. The initial brain reaction in vegetative state patients was normal, as measured by EEG monitors.

Degrees of thought Awareness typically tracks with wakefulness — especially in normal states of consciousness (bold). People in coma or under general anesthesia score low on both measures, appearing asleep with no signs of awareness. Sometimes, wakefulness and awareness become uncoupled, such as among people in a persistent vegetative state. In this case, a person seems awake and is sometimes able to move but is unaware of the surroundings.

SOURCE: STANFORD UNIV.





Brain jolt In a recent study, a team injected a signal (cross) into the brain via a technique called transcranial magnetic stimulation. In fully awake volunteers (brain of one shown), a long-lasting response flooded the cortex. Dreaming patients showed some reverberation, but the response was stunted during deep non-REM sleep.

M. MASSIMINI *ET AL/COGN. NEUROSCI.* 2010

The signal seemed to travel from the auditory regions of the brain to other areas in the cortex. But the signal stopped there. Unlike in healthy people, the pinball-like motion of information traveling from different sites in the cortex didn't make its way back down to the auditory regions that first responded to the tone, the team reported last May in *Science*.

It's not clear just what causes these disconnects. One possible culprit, as counterintuitive as it seems, may be an overload of synchrony, Gernot Supp of the University Medical Center Hamburg-Eppendorf in Germany and colleagues reported in December in *Current Biology*. As an anesthetic kicks in, huge swaths of the brain adopt slow, uniform behavior. This hypersynchrony, as it's called, may be one way that anesthesia stamps out the back-and-forth of information in the brain.

Instead of just observing the brain's behavior and inferring connectivity, Tononi, Marcello Massimini of the University of Milan in Italy and colleagues decided to manipulate the brain directly. The team figured out how to use a technique called transcranial magnetic stimulation, or TMS, to jolt a small part of the brain and monitor the resulting signals with electrodes.

"Basically you trigger a chain of reactions in the cerebral cortex," Massimini says. "It's like we're knocking on the brain with this pulse, and then we see how this knocking propagates."

Like ripples on a pond, the reverberation from the TMS in a healthy, alert person was a complex, widely spreading pattern lasting about 300 milliseconds.

This complex entity became much simpler, though, when the brain was deeply asleep. Instead of morphing from one shape to another like a drop of food coloring that roils around in water before dissipating, the signal sits right where it started, and it fades faster, disappearing after about 150 milliseconds. The same simple pattern is found in anesthetized brains.

"If you knock on a wooden table or a bucket full of nothing, you get different noises," Massimini says. "If you knock on the brain that is healthy and conscious, you get a very complex noise."

Massimini, Tononi and colleagues have recently found the same stunted response in patients in a vegetative state. The team tested five vegetative state patients, five minimally conscious patients and two people who were fully conscious but unable to move (a condition called locked-in syndrome). For the most part, locked-in patients and minimally conscious patients showed complex and long-lasting signals in the brain, similar to fully conscious people. But vegetative state patients' brains showed a brief, stagnant signal, the team reported online in January in *Brain*.

Such clear-cut differences in the brain could one day help in diagnosing people who have some level of consciousness but are unable to interact with doctors. When researchers performed the test on five new patients who shifted to a vegetative state in the months after coming out of a coma, three of the five regained consciousness. Before the doctors saw clinical signs of improvement, the method picked up increases in brain connectivity.

"If you knock on a wooden table or a bucket full of nothing, you get different noises. If you knock on a brain that is healthy and conscious, you get a very complex noise."
MARCELLO MASSIMINI

At this stage, the measurement is somewhat coarse, Massimini says. But further refinements may allow doctors to better assess levels of consciousness.

Looking at these large-scale changes in the brain may also provide some new leads to scientists puzzling over what consciousness means. Other ideas will probably come from scientists studying a different facet of consciousness: how the brain builds whole experiences out of many small pieces, such as the crisp taste of an apple, the rustle of fall leaves and a feeling of joy.

Approaching consciousness from a lot of different angles is the best bet for ultimately understanding it, says neuroscientist Anil Seth of the Sackler Centre for Consciousness Science in Brighton, England.

In the same way that "life" evades a single, clear definition (growth, reproduction or a healthy metabolism could all apply), consciousness might turn out to be a collection of remarkable phenomena, Seth says. "If we can explain different aspects of consciousness, then my hope is that it will start to seem slightly less mysterious that there is consciousness at all in the universe." ■

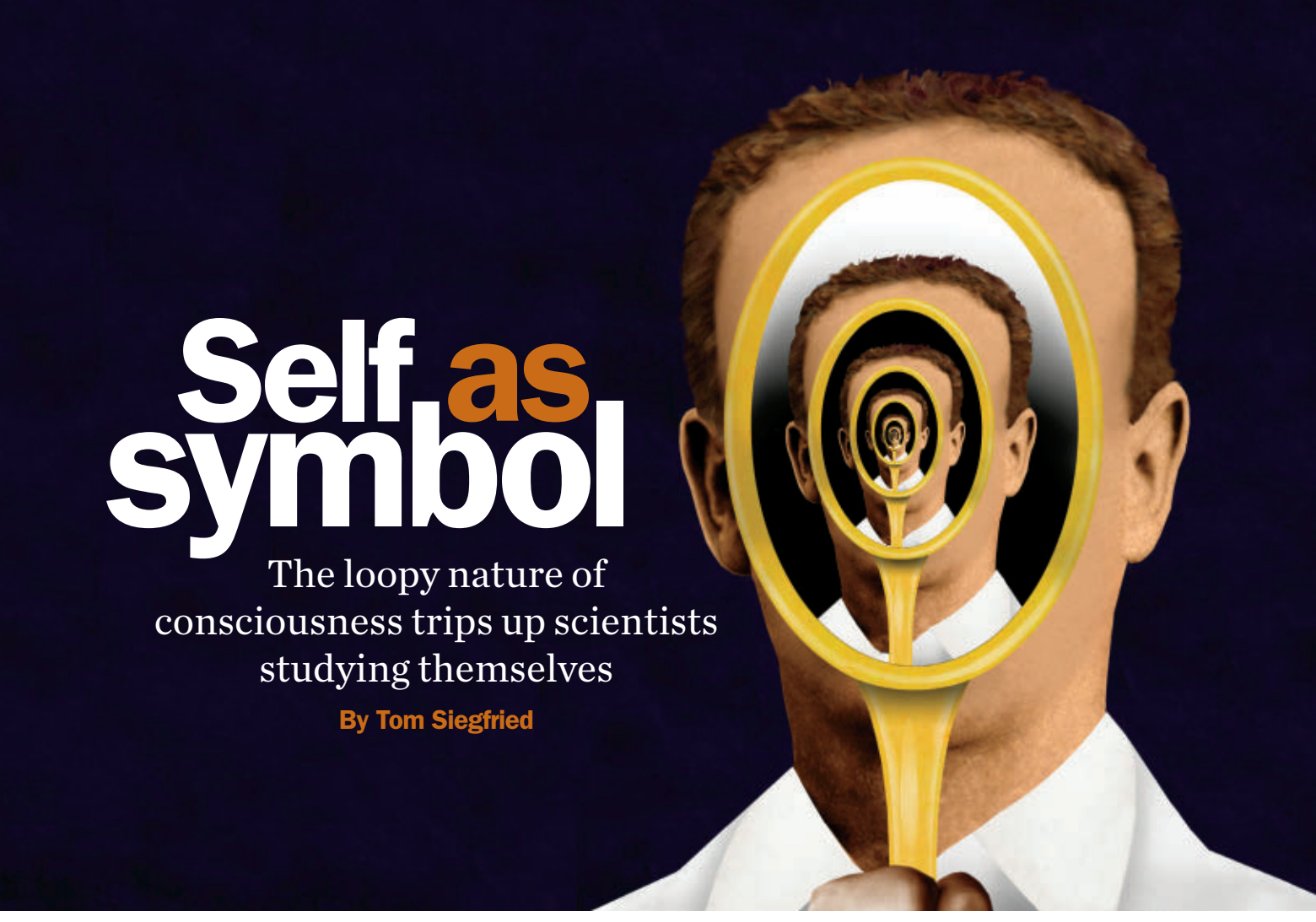
Explore more

- The Sackler Centre for Consciousness Science website: www.sussex.ac.uk/sackler
- M. Rosanova *et al*. "Recovery of cortical effective connectivity and recovery of consciousness in vegetative patients." *Brain*. January 6, 2012.

Self as symbol

The loopy nature of consciousness trips up scientists studying themselves

By Tom Siegfried



MICHAEL MORGENSTERN

When Francis Crick decided to embark on a scientific research career, he chose his specialty by applying the "gossip test." He'd noticed that he liked to gossip about two especially hot topics in the 1940s — the molecular basis for heredity and the mysteries of the brain. He decided to tackle biology's molecules first. By 1953, with collaborator James Watson (and aided by data from competitor Rosalind Franklin), Crick had identified the structure of the DNA molecule, establishing the foundation for modern genetics.

A quarter century later, he decided it was time to try the path not taken and turn his attention to the brain — in particular, the enigma of consciousness.

At first, Crick believed the mysteries of consciousness would be solved with a striking insight, similar to the way the DNA double helix structure explained heredity's mechanisms. But after a while he realized that consciousness posed a much tougher problem. Understanding DNA was easier because it appeared in life's history sooner; the double helix template for genetic replication marked the beginning of evolution as we know it. Consciousness, on the other hand, represented evolution's pinnacle, the outcome of eons of ever growing complexity in biochemical information processing.

"The simplicity of the double helix ... probably goes back to near the origin of life when things had to be simple," Crick said in a 1998 interview. "It isn't clear there will be a similar thing in the brain."

In fact, it has become pretty clear that deciphering consciousness will definitely be more difficult than describing the dynamics of DNA. Crick himself spent more than two decades attempting to unravel the consciousness riddle, working on it doggedly until his death in 2004. His collaborator, neuroscientist Christof Koch of Caltech, continues their work even today, just as dozens of other scientists pursue a similar agenda — to identify the biological processes that constitute consciousness and to explain how and why those processes produce the subjective sense of persistent identity, the self-awareness and unity of experience, and the "awareness of self-awareness" that scientists and philosophers have long wondered about, debated and sometimes even claimed to explain.

So far, no one has succeeded to anyone else's satisfaction. Yes, there have been advances: Understanding how the brain processes information. Locating, within various parts of the brain, the neural activity that accompanies certain conscious perceptions. Appreciating the fine distinctions between awareness, attention and subjective impressions. But yet with all this progress, the consciousness problem remains

popular on lists of problems that might never be solved.

Perhaps that's because the consciousness problem is inherently similar to another famous problem that actually has been proved unsolvable: finding a self-consistent set of axioms for deducing all of mathematics. As the Austrian logician Kurt Gödel proved eight decades ago, no such axiomatic system is possible; any system as complicated as arithmetic contains true statements that cannot be proved within the system.

Gödel's proof emerged from deep insights into the self-referential nature of mathematical statements. He showed how a system referring to itself creates paradoxes that cannot be logically resolved — and so certain questions cannot in principle be answered. Consciousness, in a way, is in the same logical boat. At its core, consciousness is self-referential awareness, the self's sense of its own existence. It is consciousness itself that is trying to explain consciousness.

Self-reference, feedback loops, paradoxes and Gödel's proof all play central roles in the view of consciousness articulated by Douglas Hofstadter in his 2007 book *I Am a Strange Loop*. Hofstadter is (among other things) a computer scientist, and he views consciousness through lenses unfamiliar to most neuroscientists. In his eyes, it's not so bizarre to compare math and numbers to the mind and consciousness. Math is, after all, deeply concerned with logic and reason — the stuff of thought. Mathematical paradoxes, Hofstadter points out, open up "profound questions concerning the nature of reasoning — and thus concerning the elusive nature of thinking — and thus concerning the mysterious nature of the human mind itself."

At its core, consciousness is self-referential awareness, the self's sense of its own existence. It is consciousness itself that is trying to explain consciousness.

Enter the loop

In particular, Hofstadter seizes on Gödel's insight that a mathematical formula — a statement about a number — can itself be represented by a number. So you can take the number describing a formula and insert that number into the formula, which then becomes a statement about itself. Such a self-referential capability introduces a certain "loopiness" into mathematics, Hofstadter notes, something like the famous Escher print of a right hand drawing a left hand, which in turn is drawing the right hand. This "strange loopiness" in math suggested to Hofstadter that something similar is going on in human thought.

So when he titled his book "I Am a Strange Loop," Hofstadter didn't mean that he was personally loopy, but that the concept of an individual — a persistent identity, an "I," that accompanies what people refer to as consciousness — is a loop of a certain sort. It's a feedback loop, like the circuit that turns a whisper into an ear-piercing screech when the microphone whispered into is too close to the loudspeaker emitting the sound.

But consciousness is more than just an ordinary feedback loop. It's a *strange* loop, which Hofstadter describes as a loop capable of perceiving patterns in its environment and assigning common symbolic meanings to sufficiently similar patterns. An acoustic feedback loop generates no symbols, just noise. A human brain, though, can assign symbols to patterns. While patterns of dots on a TV screen are just dots to a mosquito, to a person, the same dots evoke symbols, such as football players, talk show hosts or NCIS agents. Floods of raw sensory data trigger perceptions that fall into categories designated by "symbols that stand for abstract regularities in the world," Hofstadter asserts. Human brains create vast repertoires of these symbols, conferring the "power to represent phenomena of unlimited complexity and thus to twist back and to engulf themselves via a strange loop."

Consciousness itself occurs when a system with such ability creates a higher-level symbol, a symbol for the ability to create symbols. That symbol is the self. The I. Consciousness. "You and I are mirages that perceive themselves," Hofstadter writes.

This self-generated symbol of the self operates only on the level of symbols. It has no access to the workings of nerve cells and neurotransmitters, the microscopic electrochemical machinery of neurobiological life. The symbols that consciousness contemplates don't look much like the real thing, the way a map of Texas conveys nothing of the grass and dirt and asphalt and bricks that cover the physical territory.

And just like a map of Texas remains remarkably stable over many decades — it doesn't change with each new pothole in a Dallas street — human self-identity remains stable over a lifetime, despite constant changes on the micro level of proteins and cells. As an individual grows, matures, changes in many minute ways, the conscious self's identity remains intact, just as Texas remains Texas even as new skyscrapers rise in the cities, farms grow different crops and the Red River sometimes shifts the boundary with Oklahoma a bit.

If consciousness were merely a map, a convenient shortcut symbol for a complex mess of neurobiological signaling, perhaps it wouldn't be so hard to figure out. But its mysteries multiply because the symbol is generated by the thing doing the symbolizing. It's like Gödel's numbers that refer to formulas that represent truths about numbers; this self-referentialism creates unanswerable questions, unsolvable problems.

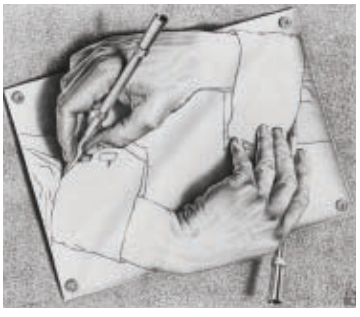
A typical example of such a Gödelian paradox is the following sentence: *This sentence cannot be true.*

Is that sentence true? Obviously not, because it says it isn't true. But wait — then it is true. Except that it can't be. Self-referential sentences seem to have it both ways — or neither way.

And so perceptual systems able to symbolize themselves — self-referential minds — can't be explained just by understanding the parts that compose them. Simply describing how electric charges travel along nerve cells, how small molecules jump from one cell to another, how such signaling sends messages from one part of the brain to another — none of that explains consciousness any more than knowing the English alphabet letter by letter (and even the rules of grammar) will tell you the meaning of Shakespeare's poetry.

Hofstadter does not contend, of course, that all the biochemistry and cellular communication is irrelevant. It provides the machinery for perceiving and symbolizing that makes the strange loop of consciousness possible. It's just that consciousness does not itself deal with molecules and cells; it copes with thoughts and emotions, hopes and fears, ideas and desires. Just as numbers can represent the complexities of all of mathematics (including numbers), a brain can represent the complexities of experience (including the brain itself). Gödel's proof showed that math is "incomplete"; it contains truths that can't be proven. And consciousness is a truth of a sort that can't be comprehended within a system of molecules and cells alone.

That doesn't mean that consciousness can never be understood — Gödel's work did not undermine human understanding of mathematics, it enriched it. And so the realization that consciousness is self-referential could also usher in a deeper understanding of what the word means — what it symbolizes.



Self-referential capability introduces a certain "loopiness" … something like the famous Escher print of a right hand drawing a left hand, which in turn is drawing the right hand.

Information handler

Viewed as a symbol, consciousness is very much like many of the other grand ideas of science. An atom is not so much a thing as an idea, a symbol for matter's ultimate constituents, and the modern physical understanding of atoms bears virtually no resemblance to the original conception in the minds of the ancient Greeks who named them. Even Francis Crick's gene made from DNA turned out to be much more elusive than the "unit of heredity" imagined by Gregor Mendel in the 19th century. The later coinage of the word *gene* to describe such units long remained a symbol; early 20th century experiments allowed geneticists to deduce a lot about genes, but nobody really had a clue what a gene was.

"In a sense people were just as vague about what genes were in the 1920s as they are now about consciousness," Crick said in 1998. "It was exactly the same. The more professional people in the field, which was biochemistry at that time, thought that it was a problem that was too early to tackle."

It turned out that with genes, their physical implementation didn't really matter as much as the information storage and processing that genes engaged in. DNA is in essence a map, containing codes allowing one set of molecules to be transcribed into others necessary for life. It's a lot easier to make a million copies of a map of Texas than to make a million Texases; DNA's genetic mapping power is the secret that made the proliferation of life on Earth possible. Similarly, consciousness is deeply involved in representing information (with symbols) and putting that information together to make sense of the world. It's the brain's information processing powers that allow the mind to symbolize itself.

Koch believes that focusing on information could sharpen science's understanding of consciousness. A brain's ability to find patterns in influxes of sensory data, to send signals back and forth to integrate all that data into a coherent picture of reality and to trigger appropriate responses all seem to be processes that could be quantified and perhaps even explained with the math that describes how information works.

"Ultimately I think the key thing that matters is information," Koch says. "You have these causal interactions and they can be quantified using information theory. Somehow out of that consciousness has to arrive." An inevitable consequence of this point of view is that consciousness doesn't care what kind of information processors are doing all its jobs — whether nerve cells or transistors.

"It's not the stuff out of which your brain is made," Koch says. "It's what that stuff represents that's conscious, and that tells us that lots of other systems could be conscious too."

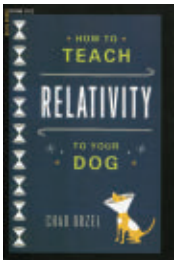
Perhaps, in the end, it will be the ability to create unmistakable features of consciousness in some stuff other than a biological brain that will signal success in the quest for an explanation. But it's doubtful that experimentally exposing consciousness as not exclusively human will displace humankind's belief in its own primacy. People will probably always believe that it can only be the strange loop of human consciousness that makes the world go 'round.

"We … draw conceptual boundaries around entities that we easily perceive, and in so doing we carve out what seems to us to be reality," Hofstadter wrote. "The 'I' we create for each of us is a quintessential example of such a perceived or invented reality, and it does such a good job of explaining our behavior that it becomes the hub around which the rest of the world seems to rotate." ■

How to Teach Relativity to Your Dog

Chad Orzel

My dog has never shown any particular interest in relativity. Orzel, an atomic physicist, apparently has a more high-minded canine companion. The book is a clever introduction to the often intimidating concepts of special and general relativity, couched as a series of conversations between the author and his dog, Emmy.



It may sound like a strange setup, but the somewhat kooky concept works well for explaining a field of physics that can sound, well, kooky to the uninitiated. Emmy is the stand-in for the everyman (or everydog) who has never quite managed to grasp the idea of spacetime, or why moving clocks tick slower than stationary ones. The imagined back-and-forth banter between author and dog keeps the book engaging while Orzel lays out the theoretical framework of particle physics, explains why neither dogs nor neutrinos can move faster than light and describes what happens to cats that get sucked into black holes.

Relativity has a rich history, and while Einstein (rightly) gets the credit, it took the work of many mathematicians and physicists to make the theory possible. Orzel gives a number of them their due, especially Albert Michelson and Edward Morley, whose experiments starting in the 1880s gave credence to the idea that light moves at a constant velocity, no matter how fast an observer is moving.

While keeping the math to a minimum, Orzel provides a clear and thorough primer. It might take some practice to start equating subatomic particles to running bunnies, but the reader will find that puzzling through the details is worth the effort.

— Allison Bohac

Basic Books, 2012, 316 p., $16.99

Memory

Alison Winter

With examples from police interrogators to hypnotized housewives, a historian describes changing views of memory — what it is, how it's formed and what it means. *Univ. of Chicago, 2012, 310 p., $30*

A Great Aridness

William deBuys

A look at how global warming could affect the American Southwest reveals a landscape in peril. *Oxford Univ., 2011, 369 p., $27.95*

How to Order To order these books or others, visit www.sciencenews.org/bookshelf. A click on a book's title will transfer you to Amazon.com. Sales generated through these links contribute to Society for Science & the Public's programs to build interest in and understanding of science.

Finding parasitic behavior

Two adjacent stories, both by Tina Hesman Saey, at first glance may appear to be unrelated but in actuality show examples of a well-known phenomenon: parasites adversely affecting the behavior of the host so that the parasite can get to its next victim.

The article "Belly bacteria can boss the brain" (*SN: 10/8/11, p. 9*) is an example of such behavior. A stressed-out wild mouse that clings to walls and avoids swimming is a mouse that lives to breed another day. Being relaxed is no more beneficial to it than climbing to the top of the tree is for the caterpillars in "Virus gene turns gypsy moth caterpillars into climbers" (*SN: 10/8/11, p. 9*).

Can human apathy — or any behavioral extreme — be a symptom of a parasitic infection (bacterial, viral or other)? Perhaps instead of finding a solution to problems, researcher John Bienenstock found an explanation.

Fran Tabor, Kalispell, Mont.

An editorial gem

I am sure I speak for others when I say the thing I most look forward to in each *Science News* issue is Tom Siegfried's perspective. Always a first read, I'd never have guessed an editor could play as big a role in what I choose to read. He is a real down-to-earth multifaceted gem who makes your publication great.

Mark Carr, Brinnon, Wash.

Water makes geology slippery

The article "Weather affects geologic activity" (*SN: 12/31/11, p. 8*) seems to ignore the possibility that the increase in geologic activity may be due to something besides the lightening and drying of the upper crust with the reduction of the winter snow-and-ice pack.

That mechanism certainly makes excellent sense; however, another paradigm leaps to my mind: While the weight of the ice is being reduced — and before drying can commence to any great extent — the ground below the ice is being saturated with water.

Water, as schoolchildren who pay attention know, is the "universal solvent"; a tiny bit of thought also reveals water to be the "universal lubricant." As the ice pack is being lightened, it is simultaneously lubricating the ground below — as deeply as the fissures allow, which may be very, very deep.

Scott McCleve, Douglas, Ariz.

Water can indeed act as a geological lubricant. In fact, this was the first idea that researcher Thomas Ader and his colleagues considered when they noticed a link between monsoons and earthquakes in the Himalayas. But computer simulations of water lubricating the fault simply could not reproduce the back-and-forth motions recorded by the GPS stations. — Devin Powell

Send communications to: Editor, Science News, 1719 N Street, NW, Washington, D.C. 20036 or **editors@sciencenews.org**. Letters subject to editing.

From the Archive

For the full 1951 article, visit
www.sciencenews.org/archive_garden

Plant something new

The best home gardens this year will include a few of the new vegetable varieties along with the old favorites.

Radishes, beets and peppers will be pretty much the same old stand-bys; some of the beans, tomatoes, onions, and squash will be recent developments. In addition, many back-yard and vacant-lot gardens will have a vegetable or two not previously planted, such as endive, broccoli and kohlrabi.

New vegetable varieties for your garden are constantly being developed by the U.S. Department of Agriculture, state research stations and commercial seedsmen. Sometimes these are noteworthy because of their overall high quality or high productivity — these you will want to try. Sometimes they are tailor-made to lick some particular disease, or to grow specially well in certain climates or in certain soils — consider local conditions before planting these.

Tomatoes will be grown in almost every garden, be it large or small, in every state of the union. A number of good wilt-resistant varieties have been introduced within the past several years.

Snap beans are among the most profitable crops that can be grown in the small garden, being generally quite productive at one or more seasons of the year.

Sprouting broccoli, a comparatively new crop to American home gardens, is relatively easy to grow except during the hot summer months in the warmer parts of the country.

Endive is good as a fall salad plant for areas too warm for summer sowing of lettuce. A few dozen plants will keep a family well supplied with raw green stuff for weeks in the fall. *—By Martha G. Marrow*

Tangerine Dream peppers are an edible ornamental variety developed by the U.S. Agricultural Research Service.

PEPPER: STEPHEN AUSMUS/USDA ARS; PAPER: PAPHIA/ISTOCKPHOTO

UPDATE

Veg developers still full of ideas

Green thumbs at the U.S. Department of Agriculture haven't stopped rolling out new plant varieties. Recently, the gardener's bounty has included a plethora of peppers that please the eye as well as the palate. The Black Pearl has dark shiny leaves and produces a spicy, red fruit, while the Tangerine Dream (a cross between a red pepper and a squash-type pepper) has a sweet taste. Lil' Pumpkin and Pepper Jack add a kick to any dinner and Halloween hues to a fall floral arrangement.

For fruit lovers, the Gulfking and Gulfcrest peaches remain firm and spot-free even after handling. And large, aromatic Northeaster strawberries grow easily in light or heavy soils.

But scientists at the Agricultural Research Service, the USDA's in-house research arm, do much more than encourage aspiring cultivators seeking some diversity. The majority of research focuses on global food staples, such as wheat and corn — how to grow the grains sustainably and how to overcome emerging pests.

One such menace is a fungus called wheat rust, which turns wheat stalks into black messes of broken stems (*SN: 9/25/10, p. 22*). Though the fungus had been under control for decades, a new strain recently swept through Africa, Asia and the Middle East, overcoming resistance bred into existing wheat varieties. Because the strain hasn't yet invaded the United States, the USDA has created test nurseries in Kenya where researchers can see how well newly developed varieties fare against the fungus.

The more defensive plants may not end up in your backyard soil patch, but they'll probably make it (in some form) to your breadbox or pantry. *—Elizabeth Quill*

To vote for one of these topics to appear on From the Archive, visit www.sciencenews.org/vote021112

A. Ousted German scholars still shape post-war science
B. Artificial radioactivity made
C. Smithsonian scientists explain away "giant" reports

REVEALED: Massive Hoard Makes Silver Dollar History

American Entrepreneur Sells off Silver Fortune

Actual size is 38.1 mm

When miners found silver in Virginia City in 1857, they knew they'd struck the mother lode. For the next twenty years, silver flowed faster than water out of the Nevada desert. It was a Wild West bonanza. After years of frenzied mining, the vein began to dry up and the town slowly died with it. It seemed like there was no more silver to be found in those hills.

Until I got a call from a Wild West friend.

He was sitting on a collection of silver coins, minted just after silver was found in Virginia City. With the silver market as strong as it is, he decided that it was time to sell off his collection. We had hit the mother lode again.

A 'few bags' become *thirty!*

To call my friend a coin collector is an understatement. When he said he had a few 1000-coin bags of silver coins I was interested. When those silver coins turned out to be New Orleans Mint Morgan Silver Dollars from the 1880's I was intrigued. And when those few bags turned out to be thirty, I was astounded. My buddy wasn't sitting on a collection, he had a hoard!

For a man who loves only the best things in life, I guess I shouldn't have been so surprised.

One of the largest Silver Dollar hoards in decades

For serious numismatists, hoards can come around once in a lifetime. Silver hoards are enormous collections of coins that have been stored away, often secretly, for safekeeping. With silver prices steadily rising over the past few years, many silver hoards have been sold off.

Most assumed that hoards of Morgan Silver Dollars were a thing of the past… until now.

Morgan Dollars are some of the most coveted coins on the market today. And with the hot silver market, most dealers cannot keep Morgan Dollars around for long. Due to this heavy demand, especially for the finest quality pieces, the price of many Morgan dollars has gone up dramatically in the last six months alone. But because of the sheer scale of this massive hoard, we have been able to keep the price at a pre-frenzy level.

120-year-old Silver Dollars for as little as $85!

Each of these silver dollars from the McClaren Collection Hoard (named for my friend's beloved Mercedes SLR McLaren Supercar) are Brilliant Uncirculated Morgan dollars that look as fresh as they did when they were struck by the U.S. Mint in New Orleans over 120 years ago. The coins were submitted to the Professional Coin Grading Service (PCGS) for certification, grading and encapsulation. Once inspected, they were given a Choice Uncirculated grade for their superior quality.

My Wild West friend worked for 25 years to amass this huge collection. He scoured the country looking for the finest Morgan Silver Dollars. He did that work for you—and this hidden silver treasure is now within your reach. These coins are over 100 years old—but they can now be yours for a little as $85!

These Morgan Dollars have been extraordinary pieces of American history for over 120 years. The remarkable McClaren Hoard has added another chapter to their amazing story. And now you can share in that history. We all want the finest things in life. It's time to start your collection today.

Order Today Risk Free

While they last, reserve your McClaren Hoard New Orleans Morgan Silver Dollar MS62 for only $99.00 + S&H. Each coin will bear the New Orleans mintmark and be dated 1883-1888 (dates our choice.)

You must be 100% satisfied with your order, or simply return it within 30 days by insured mail for a prompt refund of the purchase price.

McClaren Hoard New Orleans Morgan Choice Uncirculated $99.00 *plus s/h*

Order more and SAVE!

Half Banker Roll (10 coins)
$95.00 ea. *plus s/h* **SAVE $50**
Full Banker Roll (20 coins)
$85.00 ea. *plus s/h* **SAVE $280!**

Toll-Free 24 hours a day
1-888-201-7071

Offer Code MCH142-02
Please mention this code when you call.

GovMint.com
YOUR ONE BEST SOURCE FOR COINS WORLDWIDE

14101 Southcross Drive W.
Dept. MCH142-02
Burnsville, Minnesota 55337
www.GovMint.com

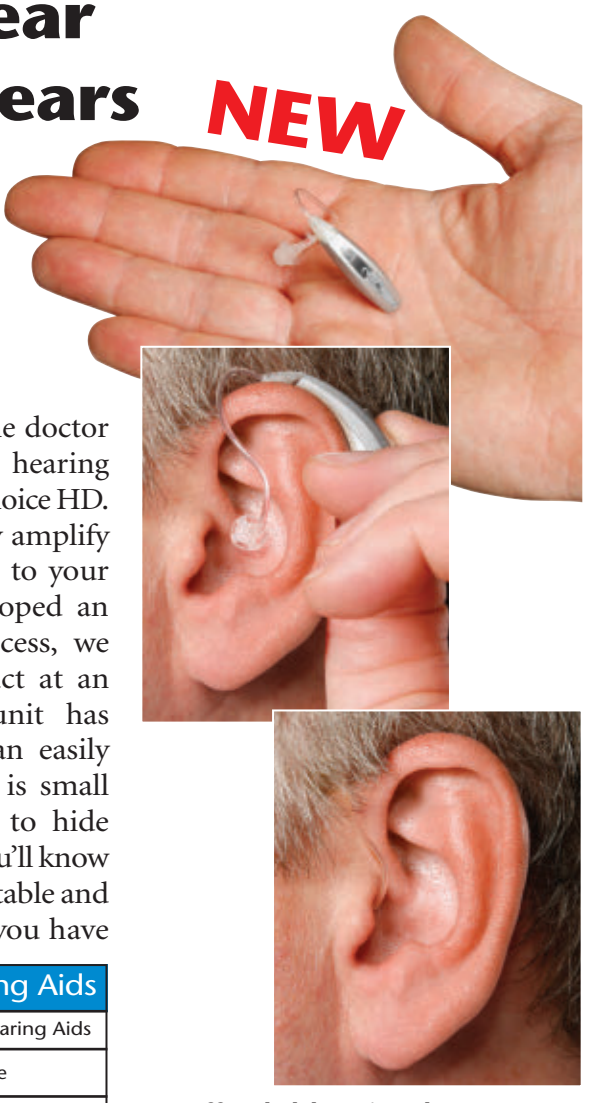
Prices and availability subject to change without notice. Past performance is not a predictor of future performance.
Note: GovMint.com is a private distributor of worldwide government coin issues and is not affiliated with the United States government.
Facts and figures were deemed accurate as of December 2011. ©GovMint.com, 2012

BBB ACCREDITED BUSINESS

The invention of the year is great news for your ears

Perfect Choice HD™ is easy to use, hard to see and costs far less than hearing aids… it's like reading glasses for your ears™!

New Personal Sound Amplification Product is an affordable alternative



Over the years, technology has made the way we live easier, safer and more convenient. In many cases, it's even made many products more affordable… (remember how much the first VCRs used to cost?). Unfortunately, the cost of hearing aids never seemed to come down. Now, a new alternative has been invented… it's called Perfect Choice HD™.

"Reading glasses for your ears"

Perfect Choice HD is NOT a hearing aid. Hearing aids can only be sold by an audiologist. In order to get a hearing aid, you had to go to the doctor's office for a battery of tests and numerous fitting appointments. Once they had you tested and fitted, you would have to pay as much as $5000 for the product. Now, thanks to the efforts of the doctor who leads a renowned hearing institute, there is Perfect Choice HD. It's designed to accurately amplify sounds and deliver them to your ear. Because we've developed an efficient production process, we can make a great product at an affordable price. The unit has been designed to have an easily accessible battery, but it is small and lightweight enough to hide behind your ear… only you'll know you have it on. It's comfortable and won't make you feel like you have something stuck in your ear. It provides high quality audio so sounds and conversations will be easier to hear and understand.

Perfect Choice HD vs Traditional Hearing Aids

	Perfect Choice HD	Traditional Hearing Aids
Lightweight and Inconspicuous	YES	Some
Easy Toggle Switch Adjustment	YES	Few
Intelligent Setting Memory	YES	Few
Tests and Fittings Required	NO	Yes
Affordable	YES	as much as $5000
Friendly Return Policy	**YES**	**rarely**

Try it for yourself with our exclusive home trial. Some people need hearing aids but many just need the extra boost in volume that a PSAP gives them. We want you to be happy with Perfect Choice HD, so we are offering to let you try it for yourself. If you are not totally satisfied with this product, simply return it within 60 days for a refund of the full product purchase price. Don't wait… don't miss out on another conversation… call now!

Affordable, Simple to use, Virtually impossible to see

Are you or a loved one frustrated in these situations?

• Restaurants • Dinner parties
• Outdoor conversations
• Lectures • Sermons
• Meetings
…and other times where you need to turn up the volume

Perfect Choice HD™

Call now for the lowest price ever.

Please mention promotional code 43648.

1-888-609-4729

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

80325