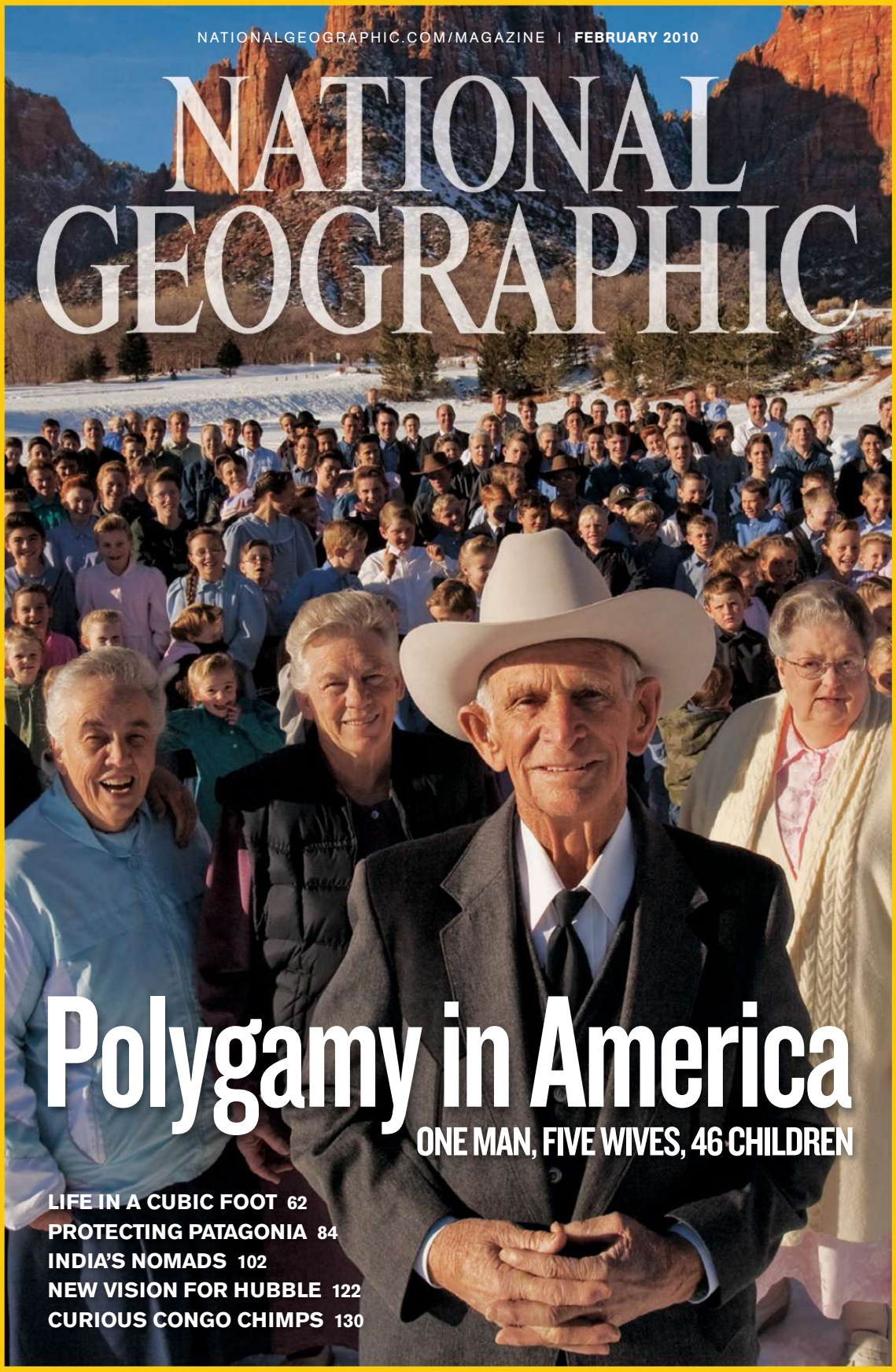
NATIONALGEOGRAPHIC.COM/MAGAZINE | **FEBRUARY 2010**

NATIONAL GEOGRAPHIC



Polygamy in America

ONE MAN, FIVE WIVES, 46 CHILDREN

LIFE IN A CUBIC FOOT 62
PROTECTING PATAGONIA 84
INDIA'S NOMADS 102
NEW VISION FOR HUBBLE 122
CURIOUS CONGO CHIMPS 130



Accord Crosstour

crosstour.honda.com





VERSATILITY MODERNIZED.

Introducing the all-new Accord Crosstour from Honda. Don't let its sleek, aerodynamic exterior fool you. Inside there's a world of smart, cargo-friendly design.* It's the perfect combination of style, amenities and space. So you can have your cake, and bring it too.







1-800-33-Honda *Carrying too much cargo or improperly storing it can affect the handling, stability and operation of this vehicle. Before carrying any cargo, be sure to consult the owner's manual for load limits and loading guidelines. 4WD EX-L model shown. ©2009 American Honda Motor Co., Inc.

NATIONAL GEOGRAPHIC

FEBRUARY 2010 • VOL. 217 • NO. 2

The Polygamists 34 A Mormon splinter group is neighborly—and notorious.
By Scott Anderson Photographs by Stephanie Sinclair

One Cubic Foot 62 Guess how many creatures you'll find in a cube of soil or sea.
By Edward O. Wilson Photographs by David Liittschwager

Protecting Patagonia 84 Threats include shifting glaciers and salmon farms.
By Verlyn Klinkenborg Photographs by Maria Stenzel

India's Nomads 102 They hunt. They herd. They charm snakes. And they're in crisis.
By John Lancaster Photographs by Steve McCurry

Hubble Renewed 122 The telescope now sees more clearly than ever.

Curious Chimps 130 In the Congo they seem as intrigued by us as we are by them.
By Joshua Foer Photographs by Ian Nichols



This fingernail-size Halimeda crab, from a Pacific coral reef, hides by grabbing algae of the same name and hue. Story on page 62.
DAVID LIITTSCHWAGER

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

NATIONAL GEOGRAPHIC

DEPARTMENTS

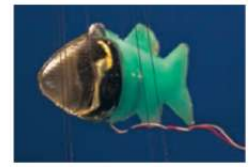
Editor's Note 4
Letters 8
Your Shot 12
Visions of Earth 14





HISTORY
Uncommon Cents
Since 1893 elongated pennies have commemorated fairs, wars, disasters, and more.

TECHNOLOGY
Robo-fish
The sleek swimmers are designed to patrol the water for pollution.



ENVIRONMENT
Lightning Up
Bolts flash over a Venezuelan lake 200 days a year, and the intensity is increasing.

SCIENCE
Name That Element
The periodic table welcomes its newest—and heaviest—addition, named for Copernicus.

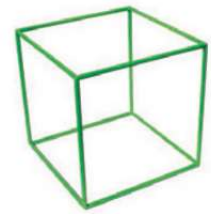
WILDLIFE
Epic Journey
A biologist thinks globe skimmer dragonflies go on a multigenerational, 11,000-mile trek.



THE BIG IDEA
Turning Mars Into Earth 30
Can we transform the frozen, thin-aired orb into a habitable planet?

Inside Geographic 146
Flashback
GeoPuzzle

ngm.com



The World in a Cube
There's a lot of life in a cubic foot of land or water. Watch as photographer David Liittschwager places a green, metal-framed cube over different habitats, then documents the many creatures that pass through.

PHOTO: DAVID LIITTSCHWAGER

On the Cover
On a bone-chilling day, Utah patriarch Joe Jessop poses with his wives and some of his well-behaved progeny.
Photo by Stephanie Sinclair

FOR SUBSCRIPTIONS, GIFT MEMBERSHIPS, OR CHANGES OF ADDRESS, CONTACT CUSTOMER SERVICE AT *NGMSERVICE.COM*, OR CALL 1-800-NGS-LINE (647-5463). OUTSIDE THE U.S. AND CANADA PLEASE CALL +1-813-979-6845.

THE SCIENTIST'S WATCH

The Oyster Perpetual Milgauss is the ultimate reference chosen by professionals in the pursuit of discovery. The perfectly designed magnetic shield, and other modifications like the Parachrom hairspring that protect the movement, help the Milgauss resist magnetic fields of up to 1,000 Gauss. Iconic since its introduction in 1956, today's Milgauss continues the same tradition and passion for science. Visit **ROLEX.COM**. And explore more.

THE MILGAUSS



FOR AN OFFICIAL ROLEX JEWELER CALL 1-800-367-6539.
ROLEX ♛ OYSTER PERPETUAL AND MILGAUSS ARE TRADEMARKS.

ROLEX

EDITOR'S NOTE



Office workers serve lunch during a meeting between FLDS leaders and the Utah attorney general's staff.

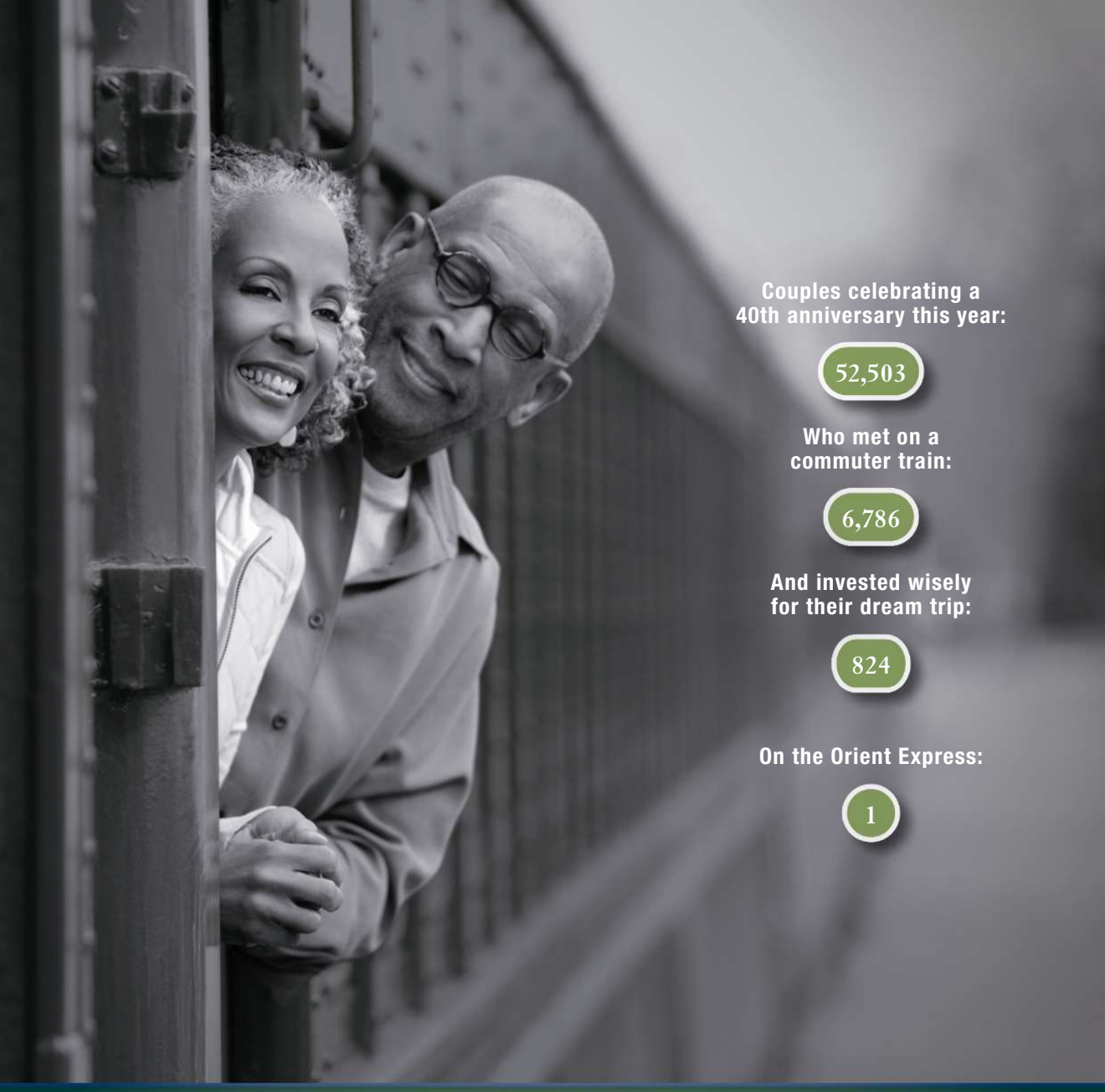
The room darkens, and Stephanie Sinclair's photographs flash on the screen. For months she has been photographing members of the Fundamentalist Church of Jesus Christ of Latter-Day Saints, the FLDS. Its members are known to most of us because they believe in polygamy, but Stephanie's photographs tell a deeper, broader story. They are able to do so because FLDS members trust her.

Stephanie has no agenda. She does not judge. There is nothing superficial or glib about her work. Her photographs are honest. They reflect her insatiable curiosity. They also reflect her compassion and sense of responsibility. The best photographers understand the obligation that comes with the privilege of access to otherwise hidden worlds and lives. Stephanie understands that others may want to pass judgment, but that is not her role. She photographs what she sees and provides the opportunity for insight. The rest is up to the reader.

In a world full of shrill voices and agendas, we at *National Geographic* are committed to an unbiased presentation of facts. Yes, we will cover controversial topics like the FLDS, and yes, we will devote time and resources to get the story right. It's what we've been doing for more than 120 years. Our commitment is to show the world in all its complexity—and to publish the work of photographers, like Stephanie Sinclair, who can present that complexity with compassion and fairness.



PHOTO: STEPHANIE SINCLAIR



There is no one exactly like you. Raymond James financial advisors understand that. You have your own set of goals, values and relationships that make your journey unique. That is why your Raymond James financial advisor listens closely to you and develops a long-term plan that is designed to adapt to your life changes, as well as changes in the market. Raymond James financial advisors enjoy a culture of independence with the complete freedom to give unbiased and tailored financial advice. By building a one-on-one relationship with you and your family, your advisor crafts a customized long-term strategy designed to keep you on track and help you reach your destination.

RAYMOND JAMES®

Individual solutions from independent advisors

raymondjames.com

©2010 Raymond James & Associates, Inc., member New York Stock Exchange/SIPC ©2010 Raymond James Financial Services, Inc., member FINRA/SIPC

NATIONAL GEOGRAPHIC

Inspiring people to care about the planet

The National Geographic Society is chartered in Washington, D.C., as a nonprofit scientific and educational organization "for the increase and diffusion of geographic knowledge." Since 1888 the Society has supported more than 9,000 explorations and research projects, adding to knowledge of earth, sea, and sky.

NATIONAL GEOGRAPHIC MAGAZINE

EDITOR IN CHIEF **Chris Johns**

DEPUTY EDITOR Victoria Pope
EXECUTIVE EDITORS Dennis R. Dimick *(Environment)*, Bill Marr *(Design/Art)*
MANAGING EDITOR Lesley B. Rogers
DIRECTOR OF PHOTOGRAPHY David Griffin
DIRECTOR OF PHOTO EDITING Kurt Mutchler
NGM.COM Rob Covey
MISSION PROJECTS Christopher P. Sloan

TEXT
DEPUTY DIRECTOR: Marc Silver. **ARTICLES EDITOR:** Oliver Payne
STORY DEVELOPMENT: Barbara Paulsen
SENIOR EDITORS: Lynn Addison *(Features)*, Don Belt *(Foreign Affairs)*, Robert Kunzig *(Environment)*, Peter Miller *(Expeditions)*, Jamie Shreeve *(Science)*. EDITOR AT LARGE: Cathy Newman
FEATURES EDITORS: Glenn Oeland, Jane Vessels. SENIOR WRITERS: Jennifer S. Holland, Tom O'Neill, A. R. Williams. WRITER: Peter Gwin. ADMINISTRATION: Valarie Cribb-Chapman, Nicholas Mott
CONTRIBUTING WRITERS: Caroline Alexander, Joel K. Bourne, Jr., Robert Draper, Cynthia Gorney, Peter Hessler, Mark Jenkins, David Quammen, Neil Shea
DEPARTMENTS DIRECTOR: Margaret G. Zackowitz
EDITORS: Jeremy Berlin, Hannah Bloch *(Mission Projects)*. ADMINISTRATION: Catherine L. Barker
COPYDESK DIRECTOR: David Brindley
ASSISTANT DIRECTOR: Alice S. Jones. COPY EDITOR: Kitry Krause. PRODUCTION: Sandra Dane
SCHEDULING DIRECTOR: Carol L. Dumont

PHOTOGRAPHY
DEPUTY DIRECTOR: Susan A. Smith
SENIOR EDITORS: Bill Douthitt *(Special Editions)*, Ken Geiger *(Digital Systems)*, Kathy Moran *(Natural History)*, Susan Welchman *(Departments)*. EDITOR AT LARGE: Michael Nichols
SENIOR PHOTO EDITORS: Gail L. Fisher, Todd James, Elizabeth Krist, Sarah Leen, Sadie Quarrier. RESEARCH EDITOR: Mary McPeak. STAFF PHOTOGRAPHER: Mark Thiessen
STUDIO: Rebecca Hale. DIGITAL IMAGING: Edward Samuel, Evan Wilder
PHOTO ENGINEERING: Walter Boggs, David Mathews, Kenji Yamaguchi
RIGHTS MANAGER: Elizabeth Grady. ADMINISTRATION: Whitney Hall, Sherry L. Brukbacher, Trish Dorsey, Kate Napier, Elena Sheveiko, Cristen Wills

DESIGN/ART
DESIGN DIRECTOR: David C. Whitmore. **ART DIRECTOR:** Juan Velasco
MAPS DIRECTOR: William E. McNulty
SENIOR DESIGN EDITORS: John Baxter, Elaine H. Bradley. DESIGN EDITOR: Oliver R. Uberti
SENIOR GRAPHICS EDITORS: Fernando G. Baptista, Martin Gamache, Virginia W. Mason, Sean McNaughton. SENIOR CARTOGRAPHY EDITORS: Marguerite B. Hunsiker, Gus Platis. CARTOGRAPHY EDITOR: Lisa R. Ritter. ART RESEARCHER: Amanda Hobbs. GRAPHICS SPECIALISTS: Jerome N. Cookson, Mariel Furlong. SENIOR DESIGNER: Betty Clayman-DeAtley. DESIGNERS: Mollie Bates, Molly Snowberger. ADMINISTRATION: Cinde Reichard, Ruben D. Rodriguez

RESEARCH
DIRECTOR: Abigail A. Tipton
RESEARCH EDITORS: Marisa J. Larson, Kathy B. Maher, Heidi Schultz, Christy Ullrich, Barbara L. Wyckoff. SENIOR RESEARCHERS: Karen C. Font, Nora Gallagher, David A. Lande, Nancie Majkowski, Elizabeth Snodgrass. RESEARCHERS: Taryn Salinas, Brad Scriber
TRANSLATIONS: Camilla Bozzoli. ADMINISTRATION: Jacqueline Rowe

NGM.COM
SENIOR PRODUCERS: Paul Heltzel, Hans Weise *(Video)*. ASSOCIATE PRODUCER: Simran Chawla
DIRECTOR OF PHOTOGRAPHY: Melissa Wiley. ART DIRECTOR: Shawn Greene

ADMINISTRATION
Karen Dufort Sligh *(Asst. to the Editor in Chief)*, Julie Rushing *(Finance)*; Anne K. Du Vivier, K. Ressler Evans, Nikisha Long
COMMUNICATIONS VICE PRESIDENT: Mary Jeanne Jacobsen; Beth Foster, Barbara S. Moffet
IMAGE COLLECTION AND SALES VICE PRESIDENT: Maura A. Mulvihill; William D. Perry
LIBRARIES AND INFORMATION SERVICES VICE PRESIDENT: Susan Fifer Canby

PRODUCTION SERVICES
VICE PRESIDENT: Hans H. Wegner. **IMAGING** DIRECTOR: Thomas J. Craig; John Ballay, Neal Edwards, Steve Goldman, Gregory Luce, Bernard Quarrick. **PRINTING:** Joseph M. Anderson, Edward J. Holland. **ADVERTISING PRODUCTION:** Jennifer A. Darnell
QUALITY DIRECTOR: Ronald E. Williamson; Clayton R. Burneston, Michael G. Lappin, William D. Reicherts. **DISTRIBUTION** DIRECTOR: Michael Swarr

INTERNATIONAL EDITIONS
EDITORIAL DIRECTOR: Amy Kolczak
DESIGN EDITOR: Darren Smith. TEXT EDITOR: Justin Kavanagh
PHOTOGRAPHIC LIAISON: Laura L. Ford. PRODUCTION: Angela Botzer

EDITORS
BRAZIL Matthew Shirts • **BULGARIA** Krassimir Drumev • **CHINA** Ye Nan • **CROATIA** Hrvoje Prćić
CZECHIA Tomáš Tureček • **FRANCE** François Marot • **GERMANY** Erwin Brunner
GREECE Maria Atmatzidou • **HUNGARY** Tamás Schlosser • **INDONESIA** Yunas Santhani Azis
ISRAEL Daphne Raz • **ITALY** Guglielmo Pepe • **JAPAN** Hiroyuki Fujita • **KOREA** Kay Wang
LATIN AMERICA Omar López • **LITHUANIA** Frederikas Jansonas
NETHERLANDS/BELGIUM Aart Aarsbergen • **NORDIC COUNTRIES** Karen Gunn
POLAND Martyna Wojciechowska • **PORTUGAL** Gonçalo Pereira
ROMANIA Cristian Lascu • **RUSSIA** Andrei Doubrovski • **SERBIA** Igor Rill
SLOVENIA Marija Javornik • **SPAIN** Josep Cabello • **TAIWAN** Roger Pan
THAILAND Kowit Phadungruangkij • **TURKEY** Nesibe Bat

ADVERTISING 711 Fifth Avenue, New York, NY, 10022; Phone: 212-610-5500; Fax: 212-610-5505
SENIOR VICE PRESIDENT AND PUBLISHER: Claudia Malley
NATIONAL ADVERTISING DIRECTOR: Robert Amberg. MARKETING: Michele Murphy. BUSINESS AND OPERATIONS: Margaret Schmidt. MANAGERS: John Iavarone *(San Francisco)*, Karen Sarris *(Detroit)*
INTERNATIONAL VICE PRESIDENT AND PUBLISHER: Declan Moore. DIRECTORS: Charlie Attenborough *(Southeast Asia)*, Nadine Heggie *(International)*, Rebecca Hill *(Marketing)*, David Middis *(British Isles)*, Steve Middleton *(International)*
CONSUMER MARKETING VICE PRESIDENT WORLDWIDE: Terrence Day. DIRECTORS: Christina C. Alberghini *(Member Services)*, Anne Barker *(Renewals)*, Richard Brown *(New Business)*, John MacKethan *(Financial Planning and Retail Sales)*, John A. Seeley *(International)*

NATIONAL GEOGRAPHIC SOCIETY

PRESIDENT AND CEO **John M. Fahey, Jr.**

EXECUTIVE VICE PRESIDENTS
Terrence B. Adamson
PRESIDENT, ENTERPRISES: Linda Berkeley
MISSION PROGRAMS: Terry D. Garcia
PRESIDENT, PUBLISHING: John Q. Griffin
PRESIDENT, BOOK PUBLISHING GROUP: Nina D. Hoffman
COMMUNICATIONS: Betty Hudson
CFO: Christopher A. Liedel

BOARD OF TRUSTEES
CHAIRMAN: Gilbert M. Grosvenor
VICE CHAIRMAN: Reg Murphy
Joan Abrahamson, Michael R. Bonsignore, Alexandra Grosvenor Eller, Roger A. Enrico, John M. Fahey, Jr., Daniel S. Goldin, Maria E. Lagomasino, George Muñoz, Peter H. Raven, William K. Reilly, Rozanne L. Ridgway, Edward P. Roski, Jr., James R. Sasser, Gerd Schulte-Hillen, Ted Waitt, Tracy R. Wolstencroft

COUNCIL OF ADVISORS
CHAIRMAN: Edward P. Roski, Jr.
Darlene T. Anderson, Lucy Billingsley, Michael R. Bonsignore, Howard G. Buffett, Virginia Busch, Jean N. Case, David Court, Roger A. Enrico, Juliet C. Folger, Robert B. Haas, David H. Koch, Iara Lee, Sven-Olof Lindblad, Bruce L. Ludwig, David P. Margulies, Michael L. Matkins, Larry Mullen, Jr., Sally Engelhard Pingree, W. Russell Ramsey, Catherine B. Reynolds, Joseph E. Robert, Jr., Victoria P. Sant, B. Francis Saul II, Ted Waitt, Garry A. Weber, Tracy R. Wolstencroft, William Wrigley, Jr.

RESEARCH AND EXPLORATION COMMITTEE
CHAIRMAN: Peter H. Raven
VICE CHAIRMAN: John M. Francis
Colin A. Chapman, Keith Clarke, Steven M. Colman, Philip Gingerich, Carol P. Harden, Nancy Knowlton, Jonathan B. Losos, Dan M. Martin, Scott E. Miller, Jan Nijman, Elsa M. Redmond, Thomas B. Smith, Wirt H. Wills, Melinda A. Zeder

EXPLORERS-IN-RESIDENCE
Robert Ballard, Wade Davis, Jared Diamond, Sylvia Earle, J. Michael Fay, Zahi Hawass, Beverly Joubert, Dereck Joubert, Louise Leakey, Meave Leakey, Johan Reinhard, Paul Sereno, Spencer Wells

MISSION PROGRAMS
VICE PRESIDENTS:
Mark Bauman, *Media Outreach*
Daniel Edelson, *Education*
John M. Francis, *Research, Conservation, and Exploration*
Sarah Laskin, *Public Programs*
Gregory A. McGruder, *NG Live and the Museum*
HUMAN RESOURCES SR. VICE PRESIDENT: Thomas A. Sabló
INTERNATIONAL SR. VICE PRESIDENT: Declan Moore
TREASURER SR. VICE PRESIDENT: H. Gregory Platts
DEVELOPMENT SR. VICE PRESIDENT: Jacqueline M. Hollister

NATIONAL GEOGRAPHIC GLOBAL MEDIA
PRESIDENT: Timothy T. Kelly
EXECUTIVE VICE PRESIDENT, OPERATIONS: Edward M. Prince, Jr.

NATIONAL GEOGRAPHIC VENTURES
CHAIRMAN: Dennis R. Patrick
NATIONAL GEOGRAPHIC CHANNEL PRESIDENT: David Haslingden
ENTERTAINMENT PRESIDENT: David Beal
DIGITAL MEDIA PRESIDENT: John Caldwell
TELEVISION PRESIDENT: Michael Rosenfeld

NATIONAL GEOGRAPHIC SCHOOL PUBLISHING GROUP
PRESIDENT AND CEO: Alison Wagner

Contributions to the National Geographic Society are tax deductible under Section 501(c)(3) of the U.S. tax code.

Copyright © 2010 National Geographic Society
All rights reserved. National Geographic and Yellow Border: Registered Trademarks ® Marcas Registradas. National Geographic assumes no responsibility for unsolicited materials. Printed in U.S.A.

Please recycle.



Darwin's Fox *(Pseudalopex fulvipes)*
Size: Head and body length, 48 - 55.7 cm (18.9 - 21.9 inches); tail, 17.5 - 25 cm (6.9 - 9.8 inches)
Weight: 2.9 - 3.3 kg (6.4 - 7.3 lbs) **Habitat:** Southern temperate rainforest and coastal dunes
Surviving number: Estimated at fewer than 250 breeding adults

Photographed by Kevin Schafer

WILDLIFE AS CANON SEES IT

A distant, distant cousin. Darwin's fox separated from its nearest relative, the South American grey fox, at least 275,000 years ago. Today it is little known and isolated into just two sub-populations. Generally solitary, the fox does sometimes join its fellows to scavenge, and eats everything from insects to small mammals and plants. It also forms pairs during mating season, with both parents then helping raise litters of two or three pups. But faced with the smallest distribution of any known canid, habitat loss due to deforestation, and predation by domestic dogs, only about 125 breeding pairs are left on this branch of the family tree.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit **canon.com/environment** to learn more.

Canon

©2010 Canon Inc. **canon.com**

LETTERS



October 2009

Redwoods

Regarding your paean to capitalist "forest management" as the solution to saving redwoods, forests already have a manager. It's nature itself, which has a head start of hundreds of millions of years on our wisdom. Conservation has become hubristic meddling, capitalism still is barely tamed greed, and the unholy alliance of the two is a scam masquerading as hipster realpolitik. Here's the truth: Redwood lumber is not a vital resource. It is a luxury item that no one has any need or right to cut. The key to an ecological future is reducing our own population by three-quarters, not turning even more people into luxury-slurping consumers. The key to ending global warming is paying people who don't drive cars at all, not paying forest companies. And anybody who kills any living thing more than a thousand years old is simply a jerk. Your article used the word "cut" a lot. What it meant is "kill."

JOHN RUCH
Boston, Massachusetts

Here in my county, north of San Francisco, folks love their redwoods. We nurture the old ones and plant new ones on parcels large and small, on school grounds and college campuses, in parks, along roadway medians and, of course, U.S. 101—the Redwood Highway. On my own site, about 25 years ago, I planted 20 or so. They are now 50 to 60 feet tall. While not a forest, this small-scale love of the great trees by my family and many others mitigates by a bit the catastrophes of the past 150 years. When I look at my trees, I smile to think I'm leaving a legacy for a thousand years or more. I only wish I could be around to see them when they're 300 feet tall.

EUGENE McCREARY
Penngrove, California

While it is true that the amount of trees harvested went up dramatically when the Pacific Lumber Company was acquired by Maxxam, your article did not say that the increase in harvest came about because the inventory of trees was discovered to be significantly higher than had previously been reported. While the amount of harvest increased, the rate of harvest did not increase appreciably. The article also failed to mention that no harvest can occur in California unless the California Department of Forestry approves. During the time Maxxam owned Pacific Lumber, it provided thousands of jobs, millions in contributions to Humboldt County institutions, and hundreds of scholarships for its employees' children. Everyone associated with Pacific Lumber was extremely proud of the company.

J. KENT FRIEDMAN
General Counsel, Maxxam
Houston, Texas

I lived in the Santa Cruz Mountains for many years, and the redwoods never stopped amazing me. Your article was very thorough, yet the Sempervirens Fund was hardly mentioned. Upon the death of my wife, her family and I had a redwood tree dedicated to her through the Sempervirens Fund. The proceeds are used to purchase additional redwood stands for protection. They guide you through the forest so you can select a tree, which is then marked by a small plaque at the base with your loved one's name and some meaningful phrase. A map is provided so you can find your way back on future visits. I'm happy to know that the tree dedicated to my beloved wife will be there for centuries—always there for me to visit and honor her life. My wife would be comforted to know that she is helping preserve something she loved.

JIM WIGGINS
Merritt Island, Florida

Please don't tell me that Mike Fay completed a transect of California's redwood range wearing those sandals!

JOHN CARTER
Atlantic Beach, Florida

"It was the only way to go for me," explains Fay, who spent 333 days on the trail. If he had worn boots and socks, he says, the combination of sand and dampness would have rendered his feet "hamburger in a week's time."

Contact Us

Email ngsforum@ngm.com
Write National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199. Include name, address, and daytime telephone. Letters may be edited for clarity and length.

For those who understand the value of luxury...



COINS NOT TO SCALE

Silver American Eagles

2010 Early Strike Silver American Eagles
1oz. 99.9% Pure Fine Silver
BRILLIANT UNCIRCULATED

Limit two (2) coins per household
No Dealers Please

Silver Basis $18.50
Vault Verification # FNGS0110
Expires 2/28/2010

$21.00 *per coin*

FREE SHIPPING!

Coins will be shipped when we receive them from the U.S. Mint, estimated delivery date begins January 22, 2010.

Call 800-336-1630

A One-Time Only
DEALER COST VAULT INVITATION...

First Fidelity Reserve
First in Quality, Service & Expertise

As seen in Ducks Unlimited, Nascar Illustrated, Robb Report, Safari Club International, American Spirit and the Sportsman's Channel

PLEASE READ IMPORTANT TERMS AND CONDITIONS THAT ACCOMPANY PRODUCTS PURCHASED, INCLUDING ARBITRATION AGREEMENT. Texas residents add 8.25% sales tax to orders under $1000. All coin customers will receive a five (5) year subscription to our Exclusive Numismatic Newsletters, Coin Market Advisory, Prestige Report and Investor's Advisory Forecast ($200 value) at no charge with order. We may contact you from time to time regarding items of interest. If for any reason your not 100% satisfied with your purchase, then return up to 10 days after receipt of order for a refund. "Due to the changing price of metals, prices are subject to change. Dealer cost is formulated at time of transaction. No refund privilege on bullion. Please allow 2-3 weeks for delivery after receipt of good funds. This ad may not be reproduced or represented in any other medium with out the express written consent of the advertiser. Original hard copy must be in hand to place order. Opinions on statements herein may vary. Silver basis $18.50. Reserve First Partners Ltd., 130 Shakespeare, Beaumont, Texas 77706, firstfidelityreserve.com, 800-336-1630.

MONEY ORDERS ARE ALSO ACCEPTED

LETTERS

I was delighted by Fay's essay, "The Redwoods Point the Way." What a beautiful way to repair a damaged ecosystem. I especially loved the author's suggestion that timber owners who participate in the revival of the redwoods should be paid for the carbon accumulated in their trees. It's genius to have an incentive to make us cooperate with nature rather than compete with it. I wish more people would realize that we're just a tiny part in this enormous picture. Then we could truly value all the living things surrounding us.

PETER HODAK
Fairfield, Iowa

"Redwoods the size of Saturn rockets…" That is perhaps the greatest phrase ever to embody the reach of your magazine.

DOUGLAS L. MARTIN
Hamilton, Ontario

Indonesia: Facing Down the Fanatics

It's rather sad that any religion must bully its adherents to worship or to obey other rules of the faith. It makes you wonder how many actually believe and how many just go through the motions for the sake of peace. "He's a good Muslim. He prays every day and spends Friday at the mosque." Who wouldn't, when you consider the consequences? Sadly, because bullies are allowed and even encouraged in a given society, extreme fanaticism can become encouraged also.

MARK BREMER
Benicia, California

Islamist leader Abu Bakar Baasyir says, "There is no violence in Islam, but if there is hindrance by enemies, then we have the right to use violence in response." When translated from doublespeak, that means people are safe from him only so long as they submit to the dictates of his opinions. Theocratic fanatics must claim a right to control others by violence because their opinions about how everyone must dress, worship, et cetera, have no rational basis. Without violent enforcement, other people would simply ignore them. This only serves to confirm the wisdom and necessity of the First Amendment and the resulting separation of government and religion.

LEE HELMS
Hazel Park, Michigan

I've tried bubble gum, pinwheels, windmills, steel traps, poison pellets, and grub and worm pesticides. Moles are tearing up my $6,000 sod landscaping and driving me up the wall.

Unseen Sahara

Writer Charles Bowden evokes the desert's massive quietude. I have made only short forays into parts of the desert that are not remote, but enough to get a feel for it. ("Sahara" is derived from the Arabic word for desert.) Yes, there is peace, silence, and the overwhelming presence of what we call nature that puts our world into perspective. Most of all there is the sky, that thin layer of azure that makes everything possible.

NANCY ROBERTS-MONEIR
Cairo, Egypt

Wildlife: Fleet Eater

Thanks for the great picture of the star-nosed mole. Now tell me how to get rid of the critters! I've tried bubble gum, pinwheels, windmills, steel traps, poison pellets, and grub and worm pesticides. Moles are tearing up my $6,000 sod landscaping and driving me up the wall. In eight years I've trapped and killed only one. They are winning the war.

DENNISON MACDONALD
Tullahoma, Tennessee

Technology: A Grander K

Suppose we adopted a new standard? Something more elegant? And suppose in the year 2525 (reckoned by some Stonehenge-like plane of ecliptic method, or by some atomic-decay method, or by some other hitherto undetermined star-date method) some droll science officer raises his eyebrow and states with absolute certainty that Le Grande K sphere—that near-perfect silicon crystal object adopted in the early 21st century—was pitted and warped. It was not up to the task and needed to be scrapped. What then? Humans are very proud, but sometimes I wonder if we are little more than cavemen throwing rocks at the moon. At least the technology held firm enough so that I could send this missive via email.

ROBERT M. PETRICK
Keezletown, Virginia



People are not made of numbers. They are made of hopes and dreams, passions and partnerships, talent and tenacity. We strive to see beyond the numbers and understand what success means to our clients, to deliver what really matters. Credit Suisse, working to help its clients thrive since 1856.
credit-suisse.com

CREDIT SUISSE

Instant Composition Question: How do you make a candid animal even more photogenic? Answer: Find one backgrounded by something dramatic or majestic, like soaring jets or clouds and mountains. Whatever you shoot, send it to us; we want to see what you saw. Every month this page features two photographs: one chosen by our editors, one chosen by our readers via online voting. For more information, go to *ngm.com/yourshot.*



EDITORS' CHOICE

William Lascelles Redding, California

As the Blue Angels streaked over his parents' house before an air show, Lascelles, 24, and Dubbo, the family's quirky pet, teamed up for this "once in a lifetime" shot. Adds Lascelles: "And it couldn't have been any other dog!"

Colin Manuel Austin, Texas

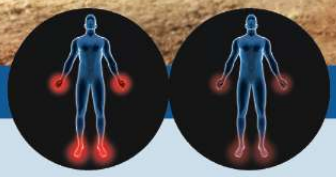
At Nam Lake in Tibet, 27-year-old Manuel captured a "serene and tranquil" scene. "My timing coincided perfectly with the yak's thirst," he explains. "Time froze as I knelt down to capture the big picture."



READERS' CHOICE

This is no walk in the park if you have Diabetic Nerve Pain.





*Nerves damaged by diabetes can send too many signals that cause pain.**

Lyrica is believed to help calm the damaged nerves† – reducing the signals and the pain.

Move towards relief with LYRICA® PREGABALIN capsules

Unlike some common over-the-counter pain relievers, Lyrica is FDA approved specifically to treat the **shooting, stabbing, burning sensations** of diabetic nerve pain. Lyrica is believed to help calm the damaged nerves† and help ease this pain – so a walk in the park can be just that.

Ask your doctor if Lyrica can help you.

*Diagram is illustrative of diabetic nerve pain.
† Exact mechanism of action and relevance to humans are unknown as studies were conducted on animal models.

Prescription Lyrica is not for everyone. Tell your doctor right away about any serious allergic reaction that causes swelling of the face, mouth, lips, gums, tongue or neck or any trouble breathing or that affects your skin. Lyrica may cause suicidal thoughts or actions in a very small number of people. Call your doctor right away if you have new or worsening depression, suicidal thoughts or actions, or unusual changes in mood or behavior. Lyrica may cause swelling of your hands, legs and feet. Some of the most common side effects of Lyrica are dizziness and sleepiness. Do not drive or work with machines until you know how Lyrica affects you. Other common side effects are blurry vision, weight gain, trouble concentrating, dry mouth, and feeling "high." Also, tell your doctor right away about muscle pain along with feeling sick and feverish, or any changes in your eyesight including blurry vision or any skin sores if you have diabetes. You may have a higher chance of swelling, hives or gaining weight if you are also taking certain diabetes or high blood pressure medicines. Do not drink alcohol while taking Lyrica. You may have more dizziness and sleepiness if you take Lyrica with alcohol, narcotic pain medicines, or medicines for anxiety. If you have had a drug or alcohol problem, you may be more likely to misuse Lyrica. Tell your doctor if you are planning to father a child. Talk with your doctor before you stop taking Lyrica or any other prescription medication.

Please see Important Facts Brief Summary on adjacent page.

To learn more visit www.lyrica.com or call toll-free 1-888-9-LYRICA (1-888-959-7422).

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

© 2009 Pfizer Inc. All rights reserved. PBP00369C

IMPORTANT FACTS

LYRICA® PREGABALIN capsules (LEER-i-kah)

IMPORTANT SAFETY INFORMATION ABOUT LYRICA

LYRICA may cause serious, even life threatening, allergic reactions. Stop taking LYRICA and call your doctor right away if you have any signs of a serious allergic reaction:
- Swelling of your face, mouth, lips, gums, tongue or neck
- Have any trouble breathing
- Rash, hives (raised bumps) or blisters

Like other antiepileptic drugs, LYRICA may cause suicidal thoughts or actions in a very small number of people, about 1 in 500.
Call your doctor right away if you have any symptoms, especially if they are new, worse or worry you, including:
- New or worsening depression
- Suicidal thoughts or actions
- Unusual changes in mood or behavior

Do not stop LYRICA without first talking with your doctor.

LYRICA may cause swelling of your hands, legs and feet.
This swelling can be a serious problem with people with heart problems.

LYRICA may cause dizziness or sleepiness.
Do not drive a car, work with machines, or do other dangerous things until you know how LYRICA affects you. Ask your doctor when it is okay to do these things.

ABOUT LYRICA

LYRICA is a prescription medicine used in adults 18 years and older to treat:
- Pain from damaged nerves that happens with diabetes or that follows healing of shingles
- Partial seizures when taken together with other seizure medicines
- Fibromyalgia (pain all over your body)

Who should NOT take LYRICA:
- Anyone who is allergic to anything in LYRICA

BEFORE STARTING LYRICA

Tell your doctor about all your medical conditions, including if you:
- Have had depression, mood problems or suicidal thoughts or behavior
- Have or had kidney problems or dialysis
- Have heart problems, including heart failure
- Have a bleeding problem or a low blood platelet count
- Have abused prescription medicines, street drugs or alcohol in the past
- Have ever had swelling of your face, mouth, tongue, lips, gums, neck, or throat (angioedema)
- Plan to father a child. It is not known if problems seen in animal studies can happen in humans.
- Are pregnant, plan to become pregnant or are breastfeeding. It is not known if LYRICA will harm your unborn baby. You and your doctor should decide whether you should take LYRICA or breast-feed, but not both.

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal supplements.
LYRICA and other medicines may affect each other causing side effects. Especially tell your doctor if you take:
- Angiotensin converting enzyme (ACE) inhibitors. You may have a higher chance for swelling and hives.

BEFORE STARTING LYRICA, continued

- Avandia® (rosiglitazone)*, Avandamet® (rosiglitazone and metformin)* or Actos® (pioglitazone)** for diabetes. You may have a higher chance of weight gain or swelling of your hands or feet.
- Narcotic pain medicines (such as oxycodone), tranquilizers or medicines for anxiety (such as lorazepam). You may have a higher chance for dizziness and sleepiness.
- Any medicines that make you sleepy

POSSIBLE SIDE EFFECTS OF LYRICA

LYRICA may cause serious side effects, including:
- See "Important Safety Information About LYRICA."
- Muscle problems, pain, soreness or weakness along with feeling sick and fever
- Eyesight problems including blurry vision
- Weight gain. Weight gain may affect control of diabetes and can be serious for people with heart problems.
- Feeling "high"

If you have any of these symptoms, tell your doctor right away.

The most common side effects of LYRICA are:
- Dizziness
- Blurry vision
- Weight gain
- Sleepiness
- Trouble concentrating
- Swelling of hands and feet
- Dry mouth

If you have diabetes, you should pay extra attention to your skin while taking LYRICA and tell your doctor of any sores or skin problems.

HOW TO TAKE LYRICA

Do:
- Take LYRICA exactly as your doctor tells you. Your doctor will tell you how much to take and when to take it. Take LYRICA at the same times each day.
- Take LYRICA with or without food.

Don't:
- Drive a car or use machines if you feel dizzy or sleepy while taking LYRICA.
- Drink alcohol or use other medicines that make you sleepy while taking LYRICA.
- Change the dose or stop LYRICA suddenly. You may have headaches, nausea, diarrhea, or trouble sleeping if you stop taking LYRICA suddenly.
- Start any new medicines without first talking to your doctor.

NEED MORE INFORMATION?

- Ask your doctor or pharmacist. This is only a brief summary of important information.
- Go to **www.lyrica.com** or call **1-866-459-7422 (1-866-4LYRICA).**

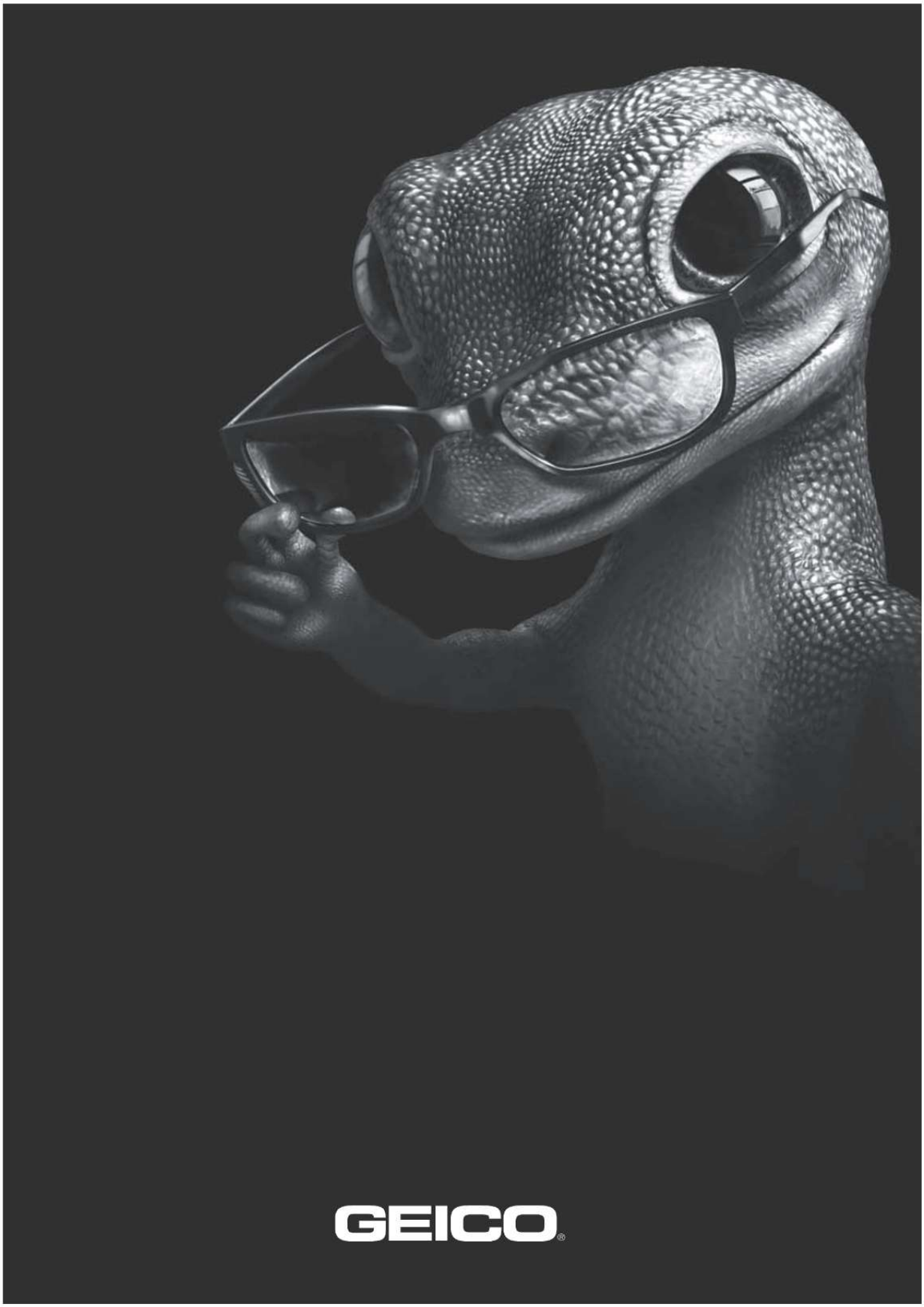
Uninsured? Need help paying for Pfizer medicines? Pfizer has programs that can help. Call **1-866-706-2400** or visit www.PfizerHelpfulAnswers.com.

Pfizer helpful answers®

PARKE–DAVIS, Division of Pfizer Inc., New York, NY 10017
©2009 Pfizer Inc. All rights reserved. Printed in the USA.
Version April 2009

*Avandia and Avandamet are registered trademarks of GlaxoSmithKline.
**Actos is a registered trademark of Takeda Chemicals Industries, Ltd., and is used under license by Takeda Pharmaceuticals of America, Inc., and Eli Lilly and Co.

Rx only



Some discounts, coverages, payment plans, and features are not available in all states or in all GEICO companies. GEICO is the third-largest private passenger auto insurer in the United States based on 2008 market share data as reported by the National Association of Insurance Commissioners, March 2009. Customer satisfaction based on an independent study conducted by Alan Newman Research, 2009. Government Employees Insurance Co. • GEICO General Insurance Co. • GEICO Indemnity Co. • GEICO Casualty Co. These companies are subsidiaries of Berkshire Hathaway Inc. GEICO: Washington, D.C. 20076. GEICO Gecko image © 1999 – 2010. © 2010 GEICO



United Arab Emirates In Dubai natural and man-made electricity illuminate the night. As jagged needles of lightning darn an overcast sky, the sail-shaped, 1,053-foot-tall Burj al Arab hotel glows green on the edge of the Persian Gulf.

PHOTO: MAXIM SHATROV



United States Looking like a lemon torte on a plate of petals, a lotus blooms in a Maryland garden pool. The chartreuse circle, three inches in diameter, is dotted with 23 seed holders and ringed by immature pollen sacs.

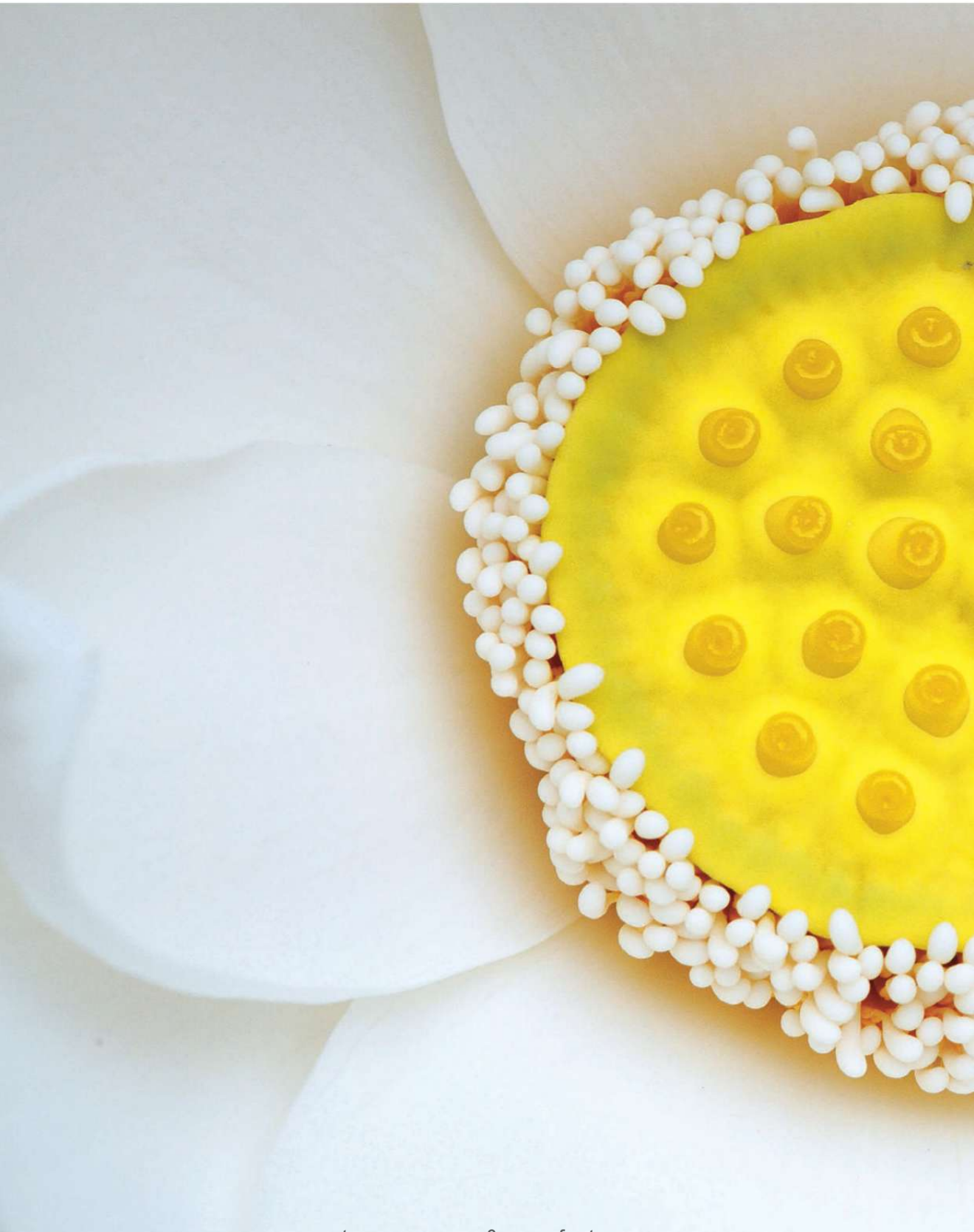


PHOTO: STEPHANIE LANE



Iraq Some 160 miles northeast of Baghdad, in a Sulaymaniyah music hall ravaged by war, looting, and neglect, a violin-playing boy sounds a note of hope. His teacher, Azad Maaruf, lives there, instructing scores of students.



Order prints of *National Geographic* photos online at **PrintsNGS.com.**

PHOTO: JULIE ADNAN, REUTERS





IF YOU'VE EVER HAD CHICKENPOX, YOU COULD GET SHINGLES NOW.

The chickenpox virus is still in your body. It can resurface as Shingles, a painful, blistering rash. And your chances of developing Shingles increase substantially after age 60.

ZOSTAVAX is a vaccine that can help prevent Shingles.

Once you reach age 60, the sooner you get vaccinated, the better your chances of protecting yourself. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it.

ZOSTAVAX is used to prevent Shingles in adults 60 years of age or older.

ZOSTAVAX is given as a single shot. Talk to your health care professional to see if ZOSTAVAX is right for you.

For more information, visit www.zostavax.com or call 1-877-9 SHINGLES.
Please see Important Safety Information on the right-hand page.

MERCK

Having trouble paying for your Merck medicine?
Merck may be able to help. Visit www.merck.com/merckhelps.

IF YOU'RE 60 OR OLDER, THE PAINFUL, BLISTERING RASH OF SHINGLES COULD BE CLOSER THAN YOU THINK.

IMPORTANT SAFETY INFORMATION

- ZOSTAVAX may not protect everyone who gets the vaccine.
- You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin or neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant.
- Possible side effects include redness, pain, itching, swelling, warmth, or bruising at the injection site, as well as headache.
- You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.
- Before getting vaccinated, talk to your health care professional about situations you may need to avoid after getting ZOSTAVAX. Please see the Patient Product Information on the adjacent page.

Before you get Shingles, get vaccinated.

ZOSTAVAX®
Zoster Vaccine Live

Patient Information about
ZOSTAVAX® (pronounced "ZOS tah vax")
Generic name: Zoster Vaccine Live

9815609

You should read this summary of information about ZOSTAVAX[1] before you are vaccinated. If you have any questions about ZOSTAVAX after reading this leaflet, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?
ZOSTAVAX is a vaccine that is used for adults 60 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles. If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people.

ZOSTAVAX may not protect everyone who gets the vaccine. ZOSTAVAX cannot be used to treat shingles once you have it.

What do I need to know about shingles and the virus that causes it?
Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?
You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?
ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?
You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including nonprescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

What are the possible side effects of ZOSTAVAX?
The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, warmth, or bruising where the shot was given.
- headache.

The following additional side effects have been reported in general use with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- fever
- hives at the injection site
- joint pain
- muscle pain
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX.

What are the ingredients of ZOSTAVAX?
Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

What else should I know about ZOSTAVAX?
Vaccinees and their health care providers are encouraged to call (800) 986-8999 to report any exposure to ZOSTAVAX during pregnancy.

This leaflet summarizes important information about ZOSTAVAX.

If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

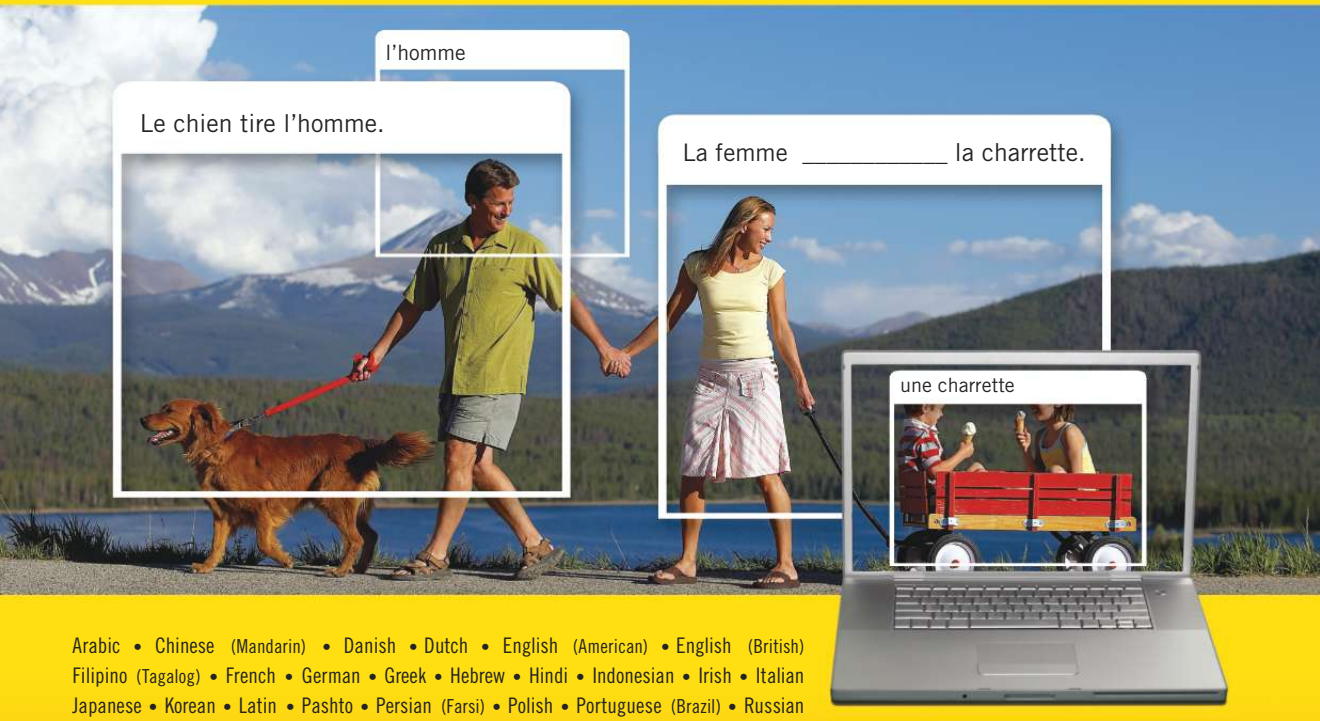
Rx only

Issued July 2009

[1]Registered trademark of Merck & Co., Inc.
Copyright © 2006 Merck & Co., Inc.
Whitehouse Station, NJ, USA
All rights reserved

Distributed by:
MERCK & CO., INC.
Whitehouse Station, NJ 08889, USA
20903484(7)(609)-ZOS-CON

Learn The Language By Living It. Only With Rosetta Stone.



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

With Rosetta Stone,® you'll learn a new language effectively and quickly without translating or memorizing, just like you learned your first.

- Learn naturally with **Dynamic Immersion**,® by matching real-world images to words spoken by native speakers.
- Speak accurately and confidently when you're coached to success with our **Speech Recognition Technology**.
- Retain the language you're learning through **Adaptive Recall,**® which brings back review material when you need it.
- Take the Rosetta Stone experience on the go with **Audio Companion**® and enhance your learning anywhere you use a CD or MP3 player.

Innovative software. Immersive method. Complete mobility. The total solution.

Rosetta Stone. The Fastest Way to Learn a Language. Guaranteed.®



SAVE 10%

SIX-MONTH, NO-RISK
MONEY-BACK GUARANTEE.*

Level 1	Reg. ~~$229~~	**NOW $206**
Level 1&2	Reg. ~~$409~~	**NOW $368**
Level 1,2&3	Reg. ~~$539~~	**NOW $485**

©2008 Rosetta Stone Ltd. All rights reserved. Offer applies to Personal Edition only. Patent rights pending. Offer cannot be combined with any other offer. Prices subject to change without notice. *Six-Month Money-Back Guarantee is limited to product purchases made directly from Rosetta Stone and does not include return shipping. Guarantee does not apply to an online subscription or to Audio Companion purchased separately from the CD-ROM product. All materials included with the product at the time of purchase must be returned together and undamaged to be eligible for any exchange or refund.

Pick Up A Language Today!

Call
(877) 247-0144

Online
RosettaStone.com/ngs020

To get this offer, use promotional code ngs020 when ordering.
Offer expires May 31, 2010.

RosettaStone®



THE PLEDGE OF ALLEGIANCE
Prayers and pledges are popular. This penny predates the 1954 addition of "under God."



1893 · COLUMBIAN EXPOSITION
The first elongated penny is from this Chicago fair, held in honor of Columbus's arrival in America.



1904 · ST. LOUIS WORLD'S FAIR
This rare coin plays on words. A "pike" is a fair midway. At a 1994 auction, one sold for $4,000.

Uncommon Cents

In 1893 the ultimate cheap souvenir was born. That's when a Chicago jeweler used a metal-rolling machine to stretch coins and press the words "Columbian Exposition" onto them. Today coins are flattened and impressed with an image at thousands of U.S. tourist spots and as far away as China, says George Strang, whose Press-A-Penny firm manufactures rolling machines. American customers put in two or four quarters plus a penny. Collectors design and press coins to trade online, while entrepreneurs squish them to hype products, say "Merry Christmas," and sell as wedding favors. Few of the coins are worth a lot in dollars, but they can harbor priceless memories. Collector Ray Dillard recalls a souvenir penny with a Hawaiian king on the front and a hand-scratched list of Pacific battles a WWII soldier had added to the back. *—Marc Silver*



1927 · LINDBERGH'S FLIGHT
In this era, elongated coins often had a punched hole or two for a key chain or necklace.



1935 · WORLD SERIES
Sports became a popular topic as a collecting craze swept the nation in the 1930s.



1963 · OSWALD SHOT
The coin is a dime. The image is taken from the famous photo of Jack Ruby shooting JFK's assassin.



1977 · HINDENBURG
A detailed anniversary design—bursts of lines, clouds of smoke—pops off the penny.

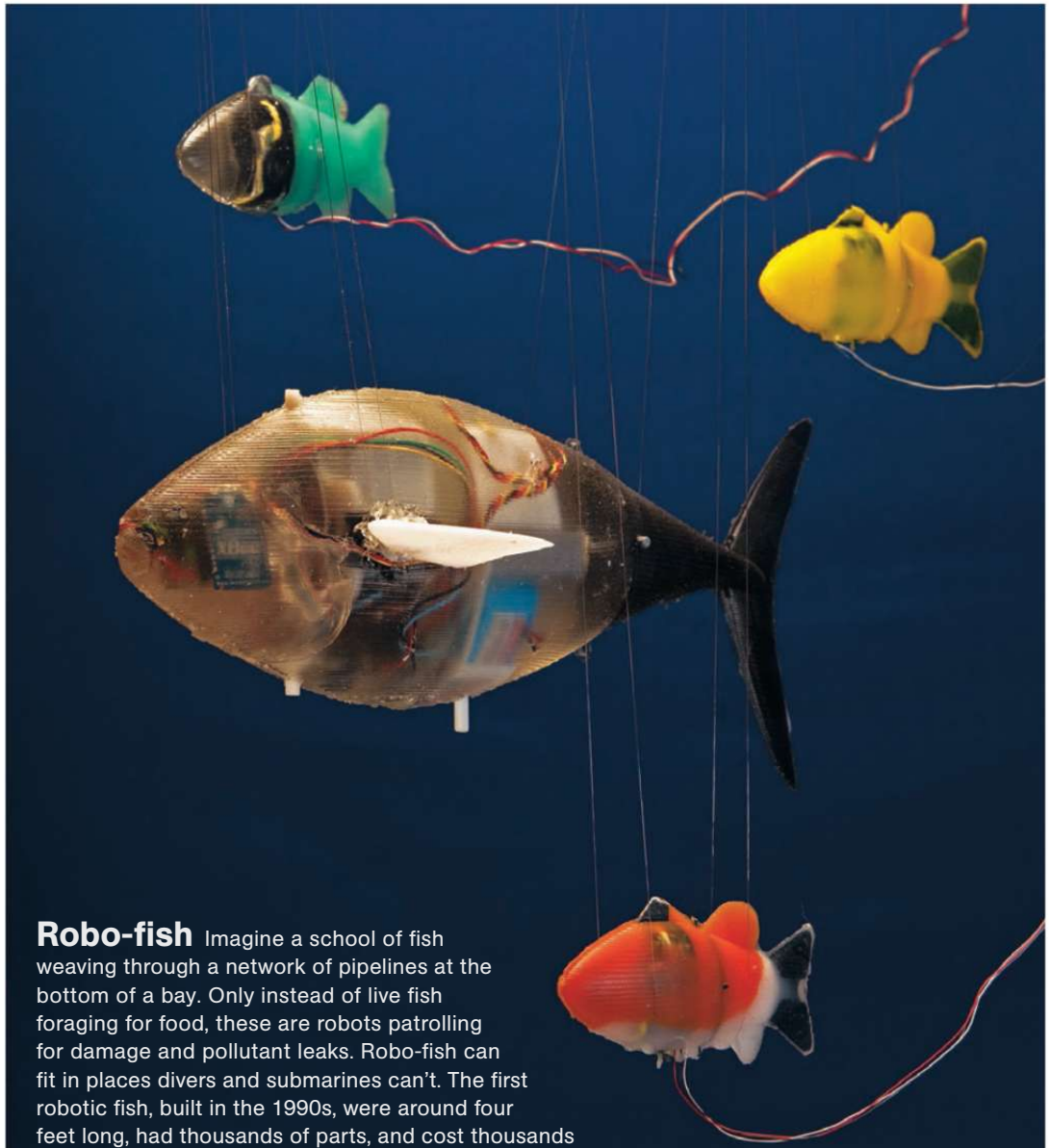


1991 · DESERT STORM
The 3-D flower is a result of hand engraving. Acid etching is faster but lacks dimensionality.



2004 · WEST NILE VIRUS
When devising a new design, "rollers" ask themselves: What's in the news now—and will it sell?

PHOTOS: MARK THIESSEN, NG STAFF. PENNIES COURTESY RAY DILLARD AND PETE AND CHRISTINE MORELEWICZ



Robo-fish Imagine a school of fish weaving through a network of pipelines at the bottom of a bay. Only instead of live fish foraging for food, these are robots patrolling for damage and pollutant leaks. Robo-fish can fit in places divers and submarines can't. The first robotic fish, built in the 1990s, were around four feet long, had thousands of parts, and cost thousands of dollars. The newest, designed by MIT researchers Kamal Youcef-Toumi and Pablo Valdivia y Alvarado, are five to eighteen inches long, have about ten parts, and cost just hundreds of dollars. These sleek robots are made of a seamless, synthetic compound engineered to be flexible in places where fish bend a lot—the tail—and rigid where they don't—the midsection. A single motor sends a wave down the interior, and the motion of the material mimics the swimming motion of a real fish. Although the latest robotic fish are pretty close to making a splash, they are not yet swimming in lakes and oceans. It'll be a few more years before you can tell the story about the robo-fish that got away. *—Juli Berwald*

Robotic fish, strung up in an MIT lab, have lasted for four years in tests conducted in tap water.

PHOTO: TIM LAMAN



Lightning Up Not only can lightning strike the same place twice, but on Lake Maracaibo, at the mouth of the Catatumbo River in northwestern Venezuela, it flashes almost continuously nearly 200 nights (and days) of the year. The ancient Yukpa people believed the bursts of blue, pink, and white light, known as Catatumbo lightning, were sparked when fireflies met ancestral spirits. For centuries mariners navigated by the brilliant discharges, visible up to a hundred miles out at sea. The phenomenon is "beautiful, like fireworks in the middle of the night," says Ángel G. Muñoz, a scientist at the University of Zulia in Maracaibo.

Methane, a nontoxic gas rising from marshes and nearby oil deposits, is thought to play a key role in the process (graphic, below). For reasons not yet clear, storms have grown more intense over the past decade. Bolts flare mainly within clouds, but ground strikes are now more common—and can do damage. *—Linda Kulman*

BIRTH OF A BOLT

1 Warm and humid Caribbean winds meet cold air from the Andes in a counterclockwise swirl that can create thunderstorms.

2 Methane rises from oil deposits in the lake and from decomposing marsh matter. The wind lifts it to the clouds.

3 Air currents inside the clouds distribute the methane fairly evenly, but the gas is concentrated in certain areas.

4 Normally, air in a cloud has insulating properties that decrease electrical activity. Methane weakens the insulation. Bolts ensue.

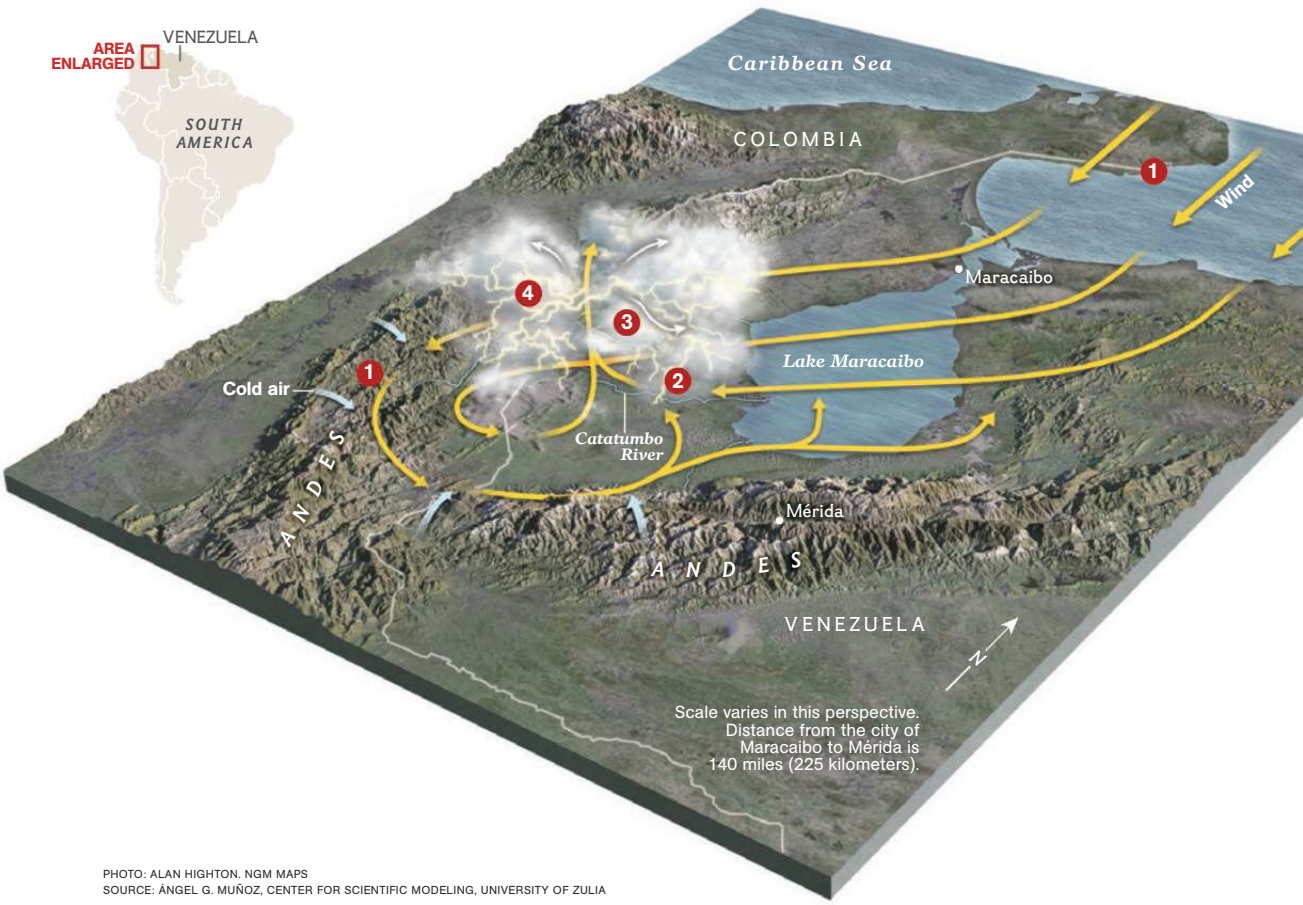


PHOTO: ALAN HIGHTON. NGM MAPS
SOURCE: ÁNGEL G. MUÑOZ, CENTER FOR SCIENTIFIC MODELING, UNIVERSITY OF ZULIA



Name That Element Last year the periodic table welcomed the 112th element, a product of nuclear fusion. A German-led team had identified 112, the heaviest element yet, in 1996. They want to dub it copernicium in honor of 16th-century astronomer Nicolaus Copernicus, whose sun-centric model of the planetary system mirrors the structure of an atom, with electrons orbiting a nucleus. The International Union of Pure and Applied Chemistry should sign off on the label this year.

Traditionally, scientists named elements more or less at will, favoring planets, mythological figures, or properties like color. In the 1800s nationalism kicked in, and researchers paid homage to native lands. U.S. and Soviet scientists later tangled over names of elements they'd vied to discover. In recent years IUPAC issued naming guidelines to avert scuffles. One rule: Until a name is finalized, a Latin-based placeholder is assigned. For element 112, it's the ungainly "ununbium"—or one one two. *—Hannah Bloch*

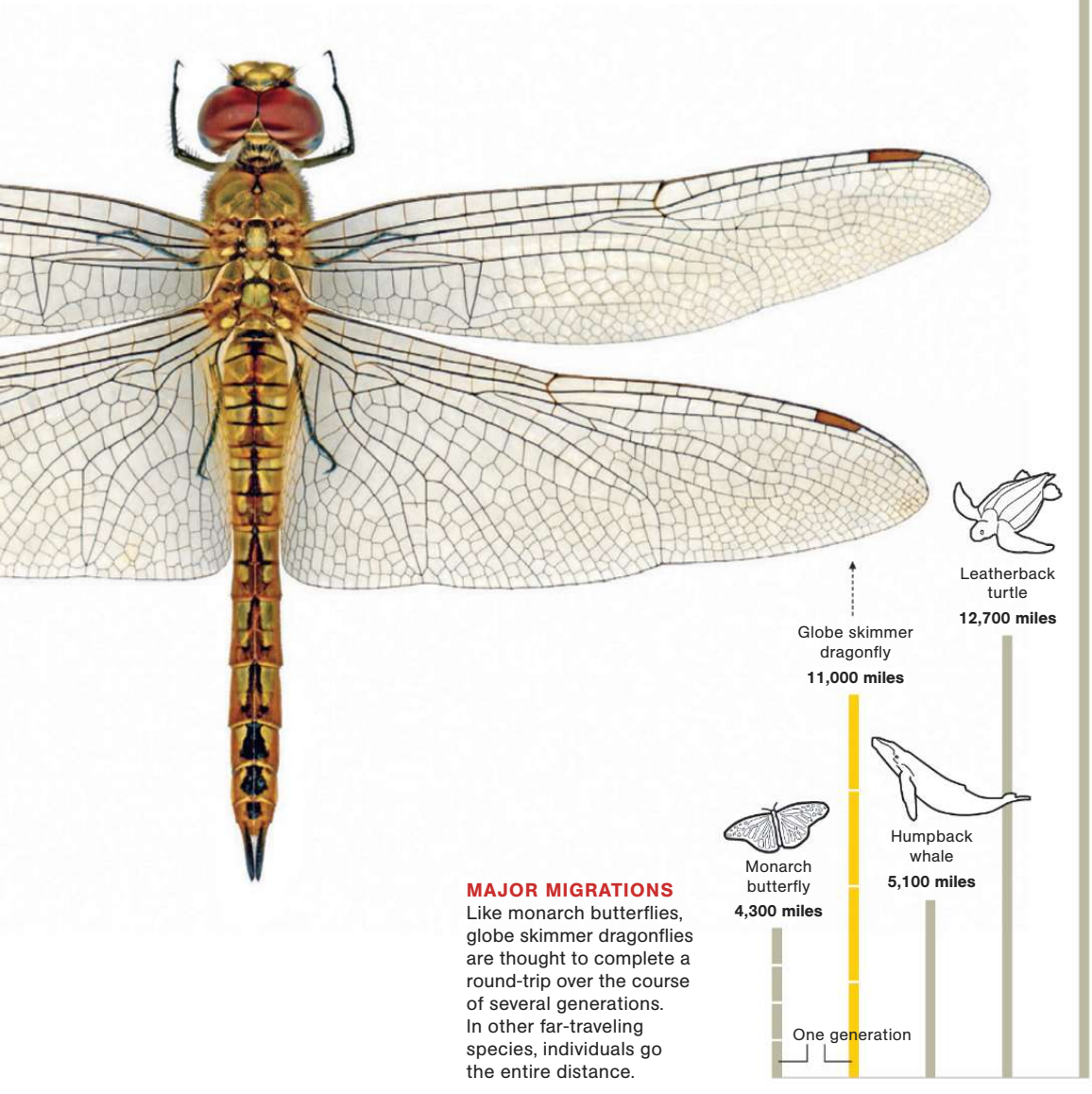
NAMED FOR...

Francium derives from its discoverer's native France.
Promethium, found via nuclear fission, refers to the figure from Greek myth who stole fire from the gods.
Rhodium turns pink in solution. It's named for *rhodon,* Greek for "rose."
Plutonium follows neptunium in the periodic table, just as Pluto comes after Neptune.
Helium, glimpsed in a solar eclipse, is from *helios,* Greek for "sun."

ART: BRIAN REA

An Epic Journey Every October millions of dragonflies—mostly the widespread species known as the globe skimmer—begin to arrive in the Maldives, more than 300 miles southwest of India. By year's end the insects have gone, only to reappear briefly in May. Where do they come from? And where are they headed?

Charles Anderson, a Maldives-based biologist, has 14 years of dragonfly data and an intriguing theory. The insects, which breed in pools of fresh water, appear to follow seasonal rains. Each fall this takes them from India to East Africa via the Maldives and brings them back on a similar route months later—a round-trip distance of some 11,000 miles. If Anderson is right, the globe skimmers' migration would be the longest of any insect, putting them in the company of other great travelers of the animal world. *—A. R. Williams*



MAJOR MIGRATIONS
Like monarch butterflies, globe skimmer dragonflies are thought to complete a round-trip over the course of several generations. In other far-traveling species, individuals go the entire distance.

PHOTO: FORREST MITCHELL AND JAMES LASSWELL
GRAPHIC: OLIVER UBERTI, NG STAFF

There are 2 sources of cholesterol.
Food & Family.





Only VYTORIN treats both.

It's important to eat healthy and stay active, but when that's not enough, talk to your doctor about treating the 2 sources of cholesterol with VYTORIN. VYTORIN contains two cholesterol medicines, *Zetia* (ezetimibe) and *Zocor* (simvastatin), in a single tablet.

VYTORIN is the only product that helps block cholesterol that comes from food and reduces the cholesterol your body makes naturally, based on family history. And VYTORIN can dramatically lower your bad cholesterol 45%–60%. (Average effect depending on dose; 52% at the usual starting dose.)

VYTORIN contains two cholesterol medicines, *Zetia* (ezetimibe) and *Zocor* (simvastatin), in a single tablet. **VYTORIN has not been shown to reduce heart attacks or strokes more than *Zocor* alone.**

Ask your doctor if VYTORIN is right for you. Or, to learn more, call **1-877-VYTORIN** or visit **vytorin.com.**

To find out if you qualify, call 1-800-347-7503.

Merck/Schering-Plough Patient Assistance Program

Important Risk Information About VYTORIN: VYTORIN is a prescription tablet and isn't right for everyone, including women who are nursing or pregnant or who may become pregnant, and anyone with liver problems.

Unexplained muscle pain or weakness could be a sign of a rare but serious side effect and should be reported to your doctor right away. VYTORIN may interact with other medicines or certain foods, increasing your risk of getting this serious side effect. So tell your doctor about any other medications you are taking.

Your doctor may do simple blood tests before and during treatment with VYTORIN to check for liver problems. Side effects included headache, muscle pain, and diarrhea. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

Please read the more detailed information about VYTORIN on the adjacent page.

VYTORIN®
(ezetimibe/simvastatin)

Treat the 2 sources of cholesterol.

MERCK / Schering-Plough Pharmaceuticals

Copyright © Merck/Schering-Plough Pharmaceuticals, 2010. All rights reserved. 20952542(3)(513)-VYT
VYTORIN and ZETIA are registered trademarks of MSP Singapore Company, LLC. Other brands listed are the trademarks of their respective owners and are not trademarks of MSP Singapore Company, LLC.

VYTORIN® (EZETIMIBE/SIMVASTATIN) TABLETS
PATIENT INFORMATION ABOUT *VYTORIN* (VI-tor-in)

Generic name: ezetimibe/simvastatin tablets

Read this information carefully before you start taking VYTORIN. Review this information each time you refill your prescription for VYTORIN as there may be new information. This information does not take the place of talking with your doctor about your medical condition or your treatment. If you have any questions about VYTORIN, ask your doctor. Only your doctor can determine if VYTORIN is right for you.

WHAT IS *VYTORIN*?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. VYTORIN is for patients who cannot control their cholesterol levels by diet and exercise alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight. VYTORIN has not been shown to reduce heart attacks or strokes more than simvastatin alone.

WHO SHOULD NOT TAKE *VYTORIN*?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For a list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.
- If you are a woman of childbearing age, you should use an effective method of birth control to prevent pregnancy while using VYTORIN.

VYTORIN has not been studied in children under 10 years of age.

WHAT SHOULD I TELL MY DOCTOR BEFORE AND WHILE TAKING *VYTORIN*?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle breakdown resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine
- danazol
- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin, clarithromycin, and telithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN® (ezetimibe/simvastatin) may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

HOW SHOULD I TAKE *VYTORIN*?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

WHAT SHOULD I DO IN CASE OF AN OVERDOSE?

Contact your doctor immediately.

WHAT ARE THE POSSIBLE SIDE EFFECTS OF *VYTORIN*?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache, muscle pain, and diarrhea (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with VYTORIN or with ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), rash, hives; raised red rash, sometimes with target-shaped lesions; joint pain; muscle pain; alterations in some laboratory blood tests; liver problems (sometimes serious); inflammation of the pancreas; nausea; dizziness; tingling sensation; depression; gallstones; inflammation of the gallbladder; trouble sleeping; poor memory.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is <u>not</u> a complete list of side effects. For a complete list, ask your doctor or pharmacist.

GENERAL INFORMATION ABOUT *VYTORIN*

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: vytorin.com.

Inactive ingredients:
Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hypromellose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

Issued May 2009

VYTORIN®
(ezetimibe/simvastatin) tablets

MERCK / Schering-Plough Pharmaceuticals

Manufactured for:
Merck/Schering-Plough Pharmaceuticals
North Wales, PA 19454, USA

20952542(3)(513)-VYT



We Can Only Find One

A rare chance to claim a unique piece of watchmaking history for under $100!

Eighty-six years ago, a watchmaker in Paris famous for building the magnificent clocks at Versailles created a legendary timepiece. He invented the first watch with an automatic mechanical drive. These innovative movements required no batteries and never needed to be manually wound. Only seven of these ultra-rare watches were ever made and we've studied the one surviving masterpiece in a watch history museum. Inspired by history, classic design and technology, our Stauer ***Meisterzeit II*** has been painstakingly handcrafted to meet the demanding standards of vintage watch collectors.

Why the new "antique" is better than the original. The original timepiece was truly innovative, but, as we studied it closely, we realized that we could engineer ours with a much higher level of precision. The 27-ruby-jewel movement utilizes an automatic self-winding mechanism inspired by a patent from 1923, but built on $31 million in state-of-the-art Swiss-made machinery. With an exhibition back, you can see into the heart of the engineering and view the rotor spin—it's powered by the movement of your body.

This limited edition Stauer ***Meisterzeit II*** allows you to wear a watch far more exclusive than most new "upscale" models. Here is your chance to claim a piece of watchmaking history in a rare design that is priced to wear everyday.

Elegant and accurate. This refined beauty has a fastidious side. Each movement and engine-turned rotor is tested for 15 days and then certified before it leaves the factory.

The best part is that with our special price, you can wear a superb classic historical reproduction watch and laugh all the way to the bank. Stauer specializes in classic timeless watches and jewelry that are made for the millionaires who want to keep their millions. This watch will quickly move to heirloom status in your household.



View the precision movement of the *Meisterzeit* through the rear exhibition port.

Try it for 30 days and if you are not thrilled with the beauty and construction of the ***Meisterzeit II***, simply return it for a refund of the purchase price.

Only 4,999 available. Since it takes about 6 months to build each watch, the release is a limited edition, so please be sure to order yours soon.

WATCH SPECS:
- 18K Gold-clad case and bezel
- Precision 27-jeweled movement
- Interior dials display day and month
- Croc-embossed leather strap
- Fits 6 3/4"–8 1/4" wrist

80% OFF

Exclusively Through Stauer

Stauer Meisterzeit II Watch—~~$395~~

Now* only $95** +S&P ***Save $300!

Call now to take advantage of this limited offer.

1-888-324-4351

Promotional Code MZW150-01
Please mention this code when you call.

Stauer
14101 Southcross Drive W.,
Dept. MZW150-01
Burnsville, Minnesota 55337
www.stauer.com

Smart Luxuries—Surprising Prices



1 **THE THOUSAND-YEAR PROJECT** might begin with a series of 18-month survey missions. Each crew making the six-month journey from Earth to Mars would add a small habitation module to the base.

2 **AN ATMOSPHERE** could be made by releasing carbon dioxide now frozen in dirt and polar ice caps. Factories spewing potent greenhouse gases, and maybe space mirrors focusing sunlight on ice, could start the thaw.

Making Mars the New Earth

What would it take to green the red planet? For starters, a massive amount of global warming.



3 **RAIN** would fall and water would flow once enough CO_2 had been released to raise the atmospheric pressure and warm the planet above freezing. Microbes, algae, and lichens could start taming the desert rock.

4 **FLOWERING PLANTS** could be introduced after the microbes had created organic soil and added some oxygen to the atmosphere. Boreal and perhaps even temperate forests might ultimately take root.

Could we "terraform" Mars—that is, transform its frozen, thin-aired surface into something more friendly and Earthlike? Should we? The first question has a clear answer: Yes, we probably could. Spacecraft, including the ones now exploring Mars, have found evidence that it was warm in its youth, with rivers draining into vast seas. And right here on Earth, we've learned how to warm a planet: just add greenhouse gases to its atmosphere. Much of the carbon dioxide that once warmed Mars is probably still there, in frozen dirt and polar ice caps, and so is the water. All the planet needs to recapture its salad days is a gardener with a big budget.

Most of the work in terraforming, says NASA planetary scientist Chris McKay, would be done by life itself. "You don't build Mars," McKay says. "You just warm it up and throw some seeds." Perfluorocarbons, potent greenhouse gases, could be synthesized from elements in Martian dirt and air and blown into the atmosphere; by warming the planet, they would release the frozen CO_2, which would amplify the warming and boost atmospheric pressure to *(Continued on next page)*

ART BY STEFAN MORRELL. SOURCES: CHRISTOPHER McKAY, NASA AMES RESEARCH CENTER; JAMES GRAHAM, UNIVERSITY OF WISCONSIN–MADISON; ROBERT ZUBRIN, MARS SOCIETY; MARGARITA MARINOVA, CALIFORNIA INSTITUTE OF TECHNOLOGY. EARTH AND MARS IMAGES: NASA



THE PANDA EVERYONE IS LOOKING FOR… BUT SOON NEARLY IMPOSSIBLE TO FIND!

Everyone loves pandas, but there's one panda that has enduring value. The Panda Silver Dollar struck by the China Mint since 1989—a massive coin of one full troy ounce of precious silver. Each year the panda design changes, which enhances their desirability. But what doesn't change is how hard it is to get your hands on one of these precious yet elusive coins!

Save Money—Buy Direct

As an official distributor, we buy directly from the China Mint and then bring these Silver Pandas directly to you. By ordering from us, you get our best price, plus the security of dealing with a company with 25 years of experience and a top reputation in the coin business. Better yet, your coin comes with a full 30 day money back guarantee of satisfaction.

2010 Pre-Sellout Event… Available TODAY… But not for long!

2009 Panda Silver Dollars are sold out and already selling for $100 each in the marketplace. This is a PRE-SELLOUT event for the 2010's. We are expecting the limited supplies of 2010 Silver Pandas to sell out quickly. We cannot guarantee future availability, so act immediately to avoid disappointment.

A Personal Asset of Lasting Value— A Legacy for Loved Ones

In times of economic uncertainty, few things bring peace of mind better than the rock-solid value of precious metals. So call NOW to secure these Silver Pandas for yourself, for your family, and as a legacy for your children.

The more you buy… the more you'll save!

- **One 2010 Panda Silver Dollar for only $39.95** +s/h
- **Five for only $38.75 each** +s/h **SAVE $6**
- **Half Roll (10) for only $37.25 each** +s/h **SAVE $27**
- **Bankers Roll (20) for only $34.95 each** +s/h **SAVE $100**

TOLL-FREE 24 HOURS A DAY

1-800-910-7267

Offer Code SPD127
Please mention this code when you call.

GovMint.com
YOUR ONE BEST SOURCE FOR COINS WORLDWIDE

14101 Southcross Drive W., Dept. SPD127
Burnsville, Minnesota 55337

www.GovMint.com

BBB ACCREDITED BUSINESS

Prices and availability subject to change without notice.

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 2009. ©GovMint.com, 2010



5 **ENERGY** for cities, if a purpose and a desire for them emerged, might come initially from nuclear power and wind turbines. Fusion reactors, if they could be built, might be the best bet in the long run.

6 **MARTIANS** would go out only with scuba gear—oxygen would remain low for millennia. Over geologic time, before Earth itself becomes uninhabitable, Mars would lose its new atmosphere and freeze again.

the point where liquid water could flow. Meanwhile, says botanist James Graham of the University of Wisconsin, human colonists could seed the red rock with a succession of ecosystems—first bacteria and lichens, which survive in Antarctica, later mosses, and after a millennium or so, redwoods. Coaxing breathable oxygen levels out of those forests, though, could take many millennia.

Enthusiasts such as Robert Zubrin, president of the Mars Society, still dream of Martian cities; Zubrin, an engineer, believes civilization cannot thrive without limitless expansion. Only research outposts seem plausible to McKay. “We’re going to live on Mars the way we live in Antarctica,” he says. “There are no elementary schools in Antarctica.” But he thinks the lessons learned in terraforming Mars—a horrifying prospect to some—would help us manage our limited Earth better.

There is time to debate the point; Mars is in no immediate danger. A White House–appointed panel recently recommended going to the moon or an asteroid first—and pointed out the space agency lacks the budget to go anywhere. It didn’t estimate the cost of gardening a dead planet. *—Robert Kunzig*


The
Polygamists
AN EXCLUSIVE LOOK INSIDE THE FLDS



At 88, Joe Jessop is an elder of the Fundamentalist Church of Jesus Christ of Latter-Day Saints (FLDS), the controversial sect that split from the Mormon Church after it banned plural marriage. In Hildale, Utah, he has tried to fulfill his duty to build up his "celestial family"—5 wives, 46 children, and 239 grandchildren. "I've had a blessed life," he says. "I wouldn't trade places with anyone."





An FLDS man leaves the funeral service for Foneta Jessop, linking arms with six of his wives, two of them Foneta's daughters. "They made these dresses especially for the occasion," he says, "and chose the same color to symbolize the love they share." Only men deemed "godly" are permitted to enter into plural marriage by the church leader; those later judged unworthy can have their wives and children reassigned to other men.


45



Opinionated and feisty, Melinda Jeffs (crouching) plays with the family's children outside their home in Colorado City, Arizona. Melinda says she enjoys sharing life with sister wife Susanna (on porch) and decries media reports that "make us sound like a brainwashed cult." Yet her father is a strong FLDS critic.



After helping bring in the hay harvest, Amber Barlow, 16, soars on a homemade swing with friends at the 4,000-acre FLDS ranch in Pony Springs, Nevada. FLDS members, even young children, are expected to help with chores—sowing, picking, canning—throughout the year.



Veda Keate, 20, and her daughter, Sereena, 4, were among more than 400 church members taken into protective custody after a 2008 raid on the FLDS ranch in West Texas.

BY SCOTT ANDERSON

PHOTOGRAPHS BY STEPHANIE SINCLAIR

THE FIRST CHURCH MEMBERS arrive at the Leroy S. Johnson Meeting House in Colorado City, Arizona, at about 6 p.m. Within a half hour the line extends out the front doors, down the side of the building, and out into the parking lot. By seven, it stretches hundreds of yards and has grown to several thousand people—the men and boys dressed in suits, the women and girls in Easter egg–hued prairie dresses.

The mourners have come for a viewing of 68-year-old Foneta Jessop, who died of a heart attack a few days ago. In the cavernous hall Foneta's sons form a receiving line at the foot of her open casket, while her husband, Merril, stands directly alongside. To the other side stand Merril's numerous other wives, all wearing matching white dresses.

Foneta was the first wife.

Colorado City is a town with special significance for those of Foneta's faith. Together with its sister community of Hildale, Utah, it is the birthplace of the Fundamentalist Church of Jesus Christ of Latter-Day Saints (FLDS), a polygamous offshoot of the Mormon Church, or LDS. Here in the 1920s and '30s, a handful of polygamous families settled astride the Utah-Arizona border after the leadership of the Mormon Church became increasingly determined to shed its polygamous past and be accepted by the American mainstream. In 1935 the church gave settlement residents an ultimatum: renounce plural marriage or be excommunicated. Practically everyone refused and was cast out of the LDS.

At the memorial service for Foneta, her husband and three sons give testimonials praising her commitment to the covenant of plural marriage, but there is an undertone of family disharmony, with vague references by Merril Jessop to his troubled relationship with Foneta. No one need mention that one of Merril's wives is missing. Carolyn Jessop, his fourth wife, left the household in 2003 with her eight children and went on to write a best-selling book on her life as an FLDS member. She describes a cloistered environment and tells of a deeply unhappy Foneta, an overweight recluse who fell out of favor with her husband and slept her days away, coming out of her room only at night to eat, do laundry, and watch old Shirley Temple movies on television.

At the conclusion of the service, most of the congregation walk over to the Isaac Carling cemetery for a graveside observance. I assume the enormous turnout—mourners have come in from FLDS communities in Texas, Colorado, and British Columbia—stems from the prominent position Foneta's husband holds: Merril Jessop is an FLDS leader and the bishop of the large chapter in West Texas. But Sam Steed, a soft-spoken, 37-year-old accountant acting as my guide, explains that elaborate funerals are a regular occurrence. "Probably between 15 and 20 times a year," he says. "This one is maybe a little bigger than most, but even when a young child dies, you can expect three or four thousand people to attend. It's part of what keeps us together. It reminds us we're members of this larger community. We draw strength from each other."

FEW AMERICANS HAD HEARD of the FLDS before April 2008, when law enforcement officials conducted a raid on a remote compound in West Texas known as the Yearning for Zion Ranch. For days after, television viewers witnessed the bizarre spectacle of hundreds of children and women—all dressed in old-fashioned prairie dresses, with elaborately coiffed hair—being herded onto school buses by social workers and police officers.

That raid had been spurred by phone calls to a domestic violence shelter, purportedly from a 16-year-old girl who claimed she was being sexually and physically abused on the ranch by her middle-aged husband. What lent credibility to the calls was that the residents of YFZ Ranch



An estimated 38,000 breakaway Mormon fundamentalists continue the practice of plural marriage in North America today. The FLDS, founded in Hildale and Colorado City, astride the Utah-Arizona border, is the largest organized group, with about 10,000 members across the western U.S. and Canada.

FLDS communities

Large
Medium
Small

0 mi 400
0 km 400
NGM MAPS

were disciples of the FLDS and its "prophet," Warren Jeffs, who had been convicted in a Utah court in 2007 for officiating at the marriage of a 14-year-old girl to a church member.

The raid made for gripping television, but it soon became clear that the phone calls were a hoax. And although authorities had evidently anticipated a violent confrontation like the 1993 shoot-out at the Branch Davidian compound in Waco—SWAT teams were brought in, along with an armored personnel carrier—the arsenal at the YFZ Ranch consisted of only 33 legal firearms. A Texas appeals court later found that authorities had not met the burden of proof for the removal of the more than 400 children, and most were returned to their families within two months.

Yet after interviewing teenagers who were pregnant or had children, Texas authorities began investigating how many underage girls might have been "sealed" to older men. (Plural marriages are performed within the church and are not legal.) The result: Twelve church members, including Warren Jeffs, were indicted on charges ranging from bigamy to having sex with a minor. The first defendant to stand trial, Raymond Jessop, was convicted of one charge last November. Trials of the other defendants are scheduled to take place over the coming year.

FROM THE BLUFF BEHIND his Hildale home, Joe Jessop has a commanding view of the Arizona Strip, an undulating expanse of sagebrush and piñon-juniper woodland that stretches south of the Utah border all the way to the northern rim of the Grand Canyon, some 50 miles away. Below are the farm fields and walled compounds of Hildale and Colorado City, which Joe refers to collectively by their old name, Short Creek. "When I first came to Short Creek as a boy, there were just seven homes down there," says Joe, 88. "It was like the frontier."

Today, Short Creek is home to an estimated 6,000 FLDS members—the largest FLDS community. Joe Jessop, a brother of Merril, has contributed to that explosive growth in two very different ways. With the weathered features and spindly gait of a man who has spent his life outdoors and worked his body hard, he is the community's undisputed "water guy," a self-taught engineer who helped with the piping of water out of Maxwell Canyon back in the 1940s. He's had a hand in building the intricate network of waterlines, canals, and reservoirs that has irrigated the arid plateau in the decades since.

A highly respected member of the FLDS, Joe is also the patriarch of a family of 46 children and—at last count—239 grandchildren. "My



Bishop Merril Jessop (at center) heads a receiving line beside the casket of his first—and only legal—wife, Foneta, as his other wives line up behind him. “My hand is a bit sore today,” Merril admitted, after greeting some 5,000 mourners in Colorado City.

family came to Short Creek for the same reason as everyone else," he says, "to obey the law of plural marriage, to build up the Kingdom of God. Despite everything that's been thrown our way, I'd say we've done a pretty good job."

Members of the faith describe the life that the Jessops and other founding families have built as idyllic, one in which old-fashioned devotion and neighborly cooperation are emphasized and children are raised in a wholesome environment free of television and junk food and social pressures. Critics, on the other hand, see the FLDS as an isolated cult whose members, worn down by rigid social control, display a disturbing fealty to one man, the prophet Warren Jeffs—who has claimed to be God's mouthpiece on Earth.

To spend time in Hildale and Colorado City is to come away with a more nuanced view. That view is revealed gradually, however, due to the insular nature of the community. Many of the oversize homes are tucked behind high walls, both to give children a safe place to play and to shield families from gawking Gentiles, as non-Mormons are known. Most residents avoid contact with strangers. *National Geographic* was given access to the community only on the approval of the church leadership, in consultation with the imprisoned Warren Jeffs.

In keeping with original Mormon teachings, much of the property in Hildale and Colorado City is held in trust for the church. Striving to be as self-sufficient as possible, the community grows a wide variety of fruits and vegetables, and everyone, including children, is expected to help bring in the yield. Church members also own and operate a number of large businesses, from hotels to tool and machine manufacturers. Each Saturday, men gather at the meetinghouse to go over a roster of building and maintenance projects around town in need of volunteers. In one display of solidarity, the men built a four-bedroom home, from foundation to roof shingles, in a single day.

This communal spirit continues inside the polygamous home. Although living arrangements vary—wives may occupy different wings of a house or have their own granny cottages—the





Merril Jessop's son Raymond, 38, is escorted to jail after a Texas jury sentenced him last November to ten years in prison for sexual assault of a 16-year-old girl, who had been "sealed" to him in a polygamous marriage. During sentencing the defense argued the prosecution offered no evidence the sex was not consensual, but state law holds that unmarried girls under age 17 cannot give consent.

A woman's primary role in the FLDS is to bear as many children as possible, to build up the "celestial family" that will remain together for eternity.

women tend to carve out spheres of influence according to preference or aptitude. Although each has primary responsibility for her own children, one wife might manage the kitchen, a second act as schoolteacher (virtually all FLDS children in Hildale and Colorado City are homeschooled), and a third see to the sewing. Along with instilling a sense of sorority, this division of labor appears to mitigate jealousy.

"I know it must seem strange to outsiders," says Joyce Broadbent, a friendly woman of 44, "but from my experience, sister wives usually get along very well. Oh sure, you might be closer to one than another, or someone might get on your nerves occasionally, but that's true in any family. I've never felt any rivalry or jealousy at all."

Joyce is a rather remarkable example of this harmony. She not only accepted another wife, Marcia, into the family, but was thrilled by the addition. Marcia, who left an unhappy marriage in the 1980s, is also Joyce's biological sister. "I knew my husband was a good man," Joyce explains with a smile as she sits with Marcia and their husband, Heber. "I wanted my sister to have a chance at the same kind of happiness I had."

Not all FLDS women are quite so sanguine about plural marriage. Dorothy Emma Jessop is a spry, effervescent octogenarian who operates a naturopathic dispensary in Hildale. Sitting in her tiny shop surrounded by jars of herbal tinctures she ground and mixed herself, Dorothy admits she struggled when her husband began taking on other wives. "To be honest," she says, "I think a lot of women have a hard time with it, because it's not an easy thing to share the man you love. But I came to realize this is another test that God places before you—the sin of jealousy, of pride—and that to be a godly woman, I needed to overcome it."

What seems to help overcome it is an awareness that a woman's primary role in the FLDS is to bear and raise as many children as possible, to build up the "celestial family" that will remain together for eternity. It is not uncommon to meet FLDS women who have given birth to 10, 12, 16 children. (Joyce Broadbent is the mother of 11, and Dorothy Emma Jessop of 13.) As a result, it's easy to see why this corner of the American West is experiencing a population explosion. The 400 or so babies delivered in the Hildale health clinic every year have resulted in a median age of just under 14, in contrast with 36.6 for the entire U.S. With so many in the community tracing their lineage to a handful of the pioneering families, the same few names crop up over and over in Hildale and Colorado City, suggesting a murkier side to this fecundity: Doctors in Arizona say a severe form of a debilitating disease called fumarase deficiency, caused by a recessive gene, has become more prevalent in the community due to intermarriage.

The collision of tradition and modernity in the community can be disorienting. Despite their old-fashioned dress, most FLDS adults have cell phones and favor late-model SUVs. Although televisions are now banished, church members tend to be highly computer literate and sell a range of products, from soaps to dresses, via the Internet. When I noticed how few congregants wore glasses, I wondered aloud if perhaps a genetic predisposition for good eyesight was at work. Sam Steed laughed lightly. "No. People here are just really into laser surgery."

THE PRINCIPLE OF PLURAL MARRIAGE was revealed to the Mormons amid much secrecy. Dark clouds hovered over the church in the early 1840s, after rumors spread that its founder, Joseph Smith, had taken up the practice of polygamy. While denying the charge in public, by 1843 Smith had shared a revelation with his closest disciples. In this "new and everlasting covenant" with God, plural wives were to be taken so that the faithful might "multiply and replenish the earth."

After Smith was assassinated by an anti-Mormon mob in Illinois, Brigham Young led believers on an epic 1,300-mile journey west to the Salt Lake Basin of present-day Utah. There the covenant was at last publicly revealed and with it, the notion that a man's righteousness before God would be measured by the size of his family; Brigham Young himself took 55 wives, who bore him 57 children.

But in 1890, faced with the seizure of church

property under a federal antipolygamy law, the LDS leadership issued a manifesto announcing an end to plural marriage. That certainly didn't end the practice, and the LDS's tortured handling of the issue—some church leaders remained in plural marriages or even took on new wives after the manifesto's release—contributed to the schism between the LDS and the fundamentalists.

"The LDS issued that manifesto for political purposes, then later claimed it was a revelation," says Willie Jessop, the FLDS spokesman. "We in the fundamentalist community believe covenants are made with God and are not to be manipulated for political reasons, so that presents an enormous obstacle between us and those in the LDS mainstream."

Upholding the covenant has come at a high price. The 2008 raid on the YFZ Ranch was only the latest in a long list of official actions against polygamists—persecutions for simply adhering to their religious principles, in the eyes of church members—that are integral to the FLDS story. At various times both Utah and Arizona authorities attempted to crack down on the Short Creek community: in 1935, in 1944, and most famously, in 1953. In that raid some 200 women and children were hauled to detention centers, while 26 men were brought up on polygamy charges. In 1956 Utah authorities seized seven children of Vera Black, a Hildale plural wife, on grounds that her polygamous beliefs made her an unfit mother. Black was reunited with her children only after agreeing to renounce polygamy.

MELINDA FISCHER JEFFS is an articulate, outgoing woman of 37, and she gives an incredulous laugh when describing what she's read about the FLDS. "Honestly, I can't even recognize it!" the mother of three exclaims. "Most all of what appears in the media, it makes us sound like we're somehow being kept against our will."

Melinda is in a unique position to understand the conflicting views of this community. She is a plural wife to Jim Jeffs, one of the prophet's nephews and an elder in the FLDS. But she is also the daughter of Dan Fischer, a former FLDS member who has emerged as one of the church leadership's most vociferous critics. In 2008 Fischer testified before a U.S. Senate committee about alleged improprieties within the FLDS, and he now heads an organization that works with people who have been kicked out of the church or who have "escaped." When Fischer broke with the church in the 1990s, his family split apart too; today 13 of his children have left the FLDS, while Melinda and two of her half siblings have renounced their father.

"And that is not an easy thing," Melinda says softly, "obviously, because I still love my father. I pray all the time that he will see his errors—or at least, stop his attacks on us."

If there is one point on which FLDS defenders and detractors might agree, it is that most of the current troubles can be traced to when its leadership passed to the Jeffs family, in 1986. Until then, the FLDS had been a fairly loosely run group led by an avuncular man named Leroy Johnson, who relied on a group of high priests to guide the church. That ended when Rulon Jeffs took over following Johnson's death. After being declared the prophet by the community, Rulon solidified the policy of one-man rule.

Charges that a theocratic dictatorship was taking root in the Arizona Strip grew louder when, after Rulon's death in 2002, the FLDS was taken over by his 46-year-old son, Warren. Assuming the role of the prophet, Warren first married several of his father's wives—and then proceeded to wed many more women, including, according to Carolyn Jessop, eight of Merril Jessop's daughters. Although many FLDS men have multiple wives, the number of wives of those closest to the prophet can reach into the double digits. A church document called the Bishop's Record, seized during the Texas raid, shows that one of Jeffs's lieutenants, Wendell Nielsen, claims 21 wives. And although the FLDS would not disclose how many plural wives Warren Jeffs has taken (some estimate

---

Scott Anderson is a war correspondent and novelist. Photographer Stephanie Sinclair spent more than a year documenting the FLDS community.



Female FLDS members wear modest attire—ankle-length prairie dresses—even while swimming. “It can get kind of cold,” says Verda Shapley, 19, reaching for a cable trolley with her sisters at a pond near Hildale. “We do everything together,” says their father, William (at left). “The foundation of this life is your belief in a life after this. Where are we going after this life? That’s the big question.”







"Singing is a nice way to wind down the day, but it's hard to manage during harvesttime," says Aaron Jessop, Jr. (beneath the large picture of Warren Jeffs). The portraits in the Pony Springs meeting hall depict Mormon leaders the FLDS regards as Joseph Smith's true inheritors, from Brigham Young to Jeffs.

"If you have men marrying 20, 30, up to 80 or more women," Fischer says, it's "simple math that there will be a lot of men who aren't going to get wives."

more than 80), at least one was an underage girl, according to a Texas indictment.

Although the issue of underage marriage within the church has garnered the greatest negative media attention, Dan Fischer has championed another cause, the so-called Lost Boys, who have left or been forced from the community and wound up fending for themselves on the streets of Las Vegas, Salt Lake City, and St. George, Utah. Fischer's foundation has worked with 300 such young men, a few as young as 13, over the past seven years. Fischer concedes that most of these boys were simply "discouraged out," but he cites cases where they were officially expelled, a practice he says increased under Jeffs.

Fischer attributes the exodus partly to a cold-blooded calculation by church leaders to limit male competition for the pool of marriageable young women. "If you have men marrying 20, 30, up to 80 or more women," he says, "then it comes down to biology and simple math that there will be a lot of other men who aren't going to get wives. The church says it's kicking these boys out for being disruptive influences, but if you'll notice, they rarely kick out girls."

Equally contentious has been the FLDS restoration of an early Mormon policy of transferring the wives and children of a church member to another man. Traditionally, this was done upon the death of a patriarch so that his widows might be cared for, or to rescue a woman from an abusive relationship. But critics argue that under Jeffs this "reassignment" became one more weapon to hold over the heads of those who dared step out of line.

Determining who is unworthy has been the exclusive province of the prophet. When in January 2004 Jeffs publicly ordered the expulsion of 21 men and the reassignment of their families, the community acquiesced. Jeffs's diary, also seized during the Texas raid, reveals a man who micromanaged the community's every decision, from chore assignments and housing arrangements to who married whom and which men were ousted—all directed by revelations Jeffs received as he slept. He claimed that God guided his every action, no matter how small. One diary entry reads: "The Lord directed that I go to the sun tanning salon and get sun tanned more evenly on their suntanning beds."

In 2005 a Utah court transferred control of the trust that oversees much of the land in Hildale and Colorado City from the FLDS leadership to a state-appointed fiduciary; the church is currently waging a campaign to recover control of the trust. As for Jeffs, after spending over a year on the lam avoiding legal issues in Utah—and earning a spot on the FBI's Ten Most Wanted list—he was caught and is currently serving a ten-year-to-life sentence as an accomplice to rape. He awaits trial on multiple indictments in Arizona and Texas. The 11 other church members awaiting trial in Texas include Merril Jessop, who was indicted for performing the marriage of Jeffs to an underage girl.

Yet Jeffs's smiling portrait continues to adorn the living room of almost every FLDS home. In his absence, his lieutenants have launched a fierce defense of his leadership. While conceding that underage marriages did occur in the past, Donald Richter, contributor to one of the official FLDS websites, says the practice has now been stopped. As for the Lost Boys, he argues that both the numbers involved and the reasons for the expulsions have been greatly exaggerated by the church's enemies. "This is only done in the most extreme cases," Richter says, "and never for the trivial causes they're claiming. And anyway, all religious groups have the right to expel people who won't accept their rules."

Certainly Melinda Fischer Jeffs hasn't been swayed by the ongoing controversy. "Warren is just the kindest, most loving man," she says. "The image that has been built up about him by the media and his enemies is just unrecognizable to who he really is." Like other church members, Melinda has ready answers for most of the accusations leveled against Jeffs and is especially spirited in defending the policy of reassignment. According to her, it is almost always initiated at the request of a wife who has been abandoned or abused. This is debatable. In his diary Jeffs recounts reassigning the wives of three men, including his brother David, because God had

shown him that they "couldn't exalt their ladies, had lost the confidence of God." One of his brother's wives had difficulty accepting the news and could barely bring herself to kiss her new husband. "She showed a great spirit of resistance, yet she went through with it," Jeffs records. "She needs to learn to submit to Priesthood."

Yet Melinda's defense of Jeffs underscores one of the most curious aspects of the polygamous faith: the central role of women in defending it. This is not new. In Brigham Young's day a charity rushed to Utah to establish a safe house for polygamous women seeking to escape this "white slavery"; that house sat virtually empty. Today FLDS women in the Hildale–Colorado City area have ample opportunity to "escape"—they have cell phones, they drive cars, there are no armed guards keeping them in—yet they don't.

Undoubtedly one reason is that, having been raised in this culture, they know little else. Walking away means leaving behind everything: the community, one's sense of security, even one's own family. Carolyn Jessop, the plural wife of Merril Jessop who did leave the FLDS, likens entering the outside world to "stepping out onto another planet. I was completely unprepared, because I had absolutely no life skills. Most women in the FLDS don't even know how to balance a checkbook, let alone apply for a job, so contemplating how you're going to navigate in the outside world is extremely daunting."

It would seem there's another lure for women to stay: power. The FLDS women I spoke with tended to be far more articulate and confident than the men, most of whom seemed paralyzed by bashfulness. It makes sense when one begins to grasp that women are coveted to "multiply and replenish the earth," while men are in extraordinary competition to be deemed worthy of marriage by the prophet. One way to be deemed worthy, of course, is to not rock the boat, to keep a low profile. As a result, what has all the trappings of a patriarchal culture, actually has many elements of a matriarchal one.

There are limits to that power, of course, for it is subject to the dictates of the prophet. After hearing Melinda's stout defense of Jeffs, I ask what she would do if she were reassigned.

"I'm confident that wouldn't happen," she replies uneasily.

"But what if it did?" I ask. "Would you obey?"

For the only time during our interview, Melinda grows wary. Sitting back in her chair, she gives her head a quarter turn to stare at me out of the corner of one eye.

ON A SUNNY AFTERNOON in March 2009, Bob Barlow, a friendly, middle-aged member of the FLDS, gives me a tour of the YFZ Ranch in West Texas. The compound consists of about 25 two-story log-cabin-style homes, and a number of workshops and factories are scattered over 1,700 acres. At the center sits a gleaming white stone temple. It is remarkable what the residents have created from the hardscrabble plain. With heavy machinery, they literally made earth out of the rocky terrain, crushing stone and mixing it with the thin topsoil. They planted orchards and gardens and lawns and were on their way to creating a self-sufficient community amid the barren landscape. All that ground to a halt after the 2008 raid.

"The families are slowly coming back now," Barlow says. "We'll come out the other side of this better and stronger than before."

I suspect he's right. So many times in the history of Mormon polygamy the outside world thought it had the movement on the ropes only to see it flourish anew. I'm reminded of this one afternoon in Colorado City when I speak with Vera Black. Now 92 and in failing health, Vera is the woman whose children were taken from her by Utah authorities in 1956 and returned only after she agreed to renounce polygamy. Within days of making that promise, she was back in Short Creek with her children and had renewed her commitment to the everlasting covenant.

Now living with her daughter Lillian, Vera lies in a daybed as her children gather around. Those children are now in their 50s and 60s, and as they recount the story of their long-ago separation—both from their mother and their faith—several weep, as if the pain were fresh.

"I had to make that promise," Vera says, with a smile, "but I crossed my fingers while I did it." □



Young FLDS women tarp the hay harvest on the church's ranch in Pony Springs. "It's hard work, but I enjoy it," says Annette Jessop, 19 (at far right). "I'm with friends and away from the rest of the world." Despite their conservative lifestyle, most FLDS women drive, have cell phones, and are computer literate.





Jim Jessop (at center) leads morning prayers for his children and three wives at his log-cabin home on the Yearning for Zion Ranch in Eldorado, Texas. Work schedule permitting, the family worships together twice a day. “We have been tested throughout our history,” he says of the church’s recent legal woes, “but this only brings us closer together, both as a family and as a faith.”











within

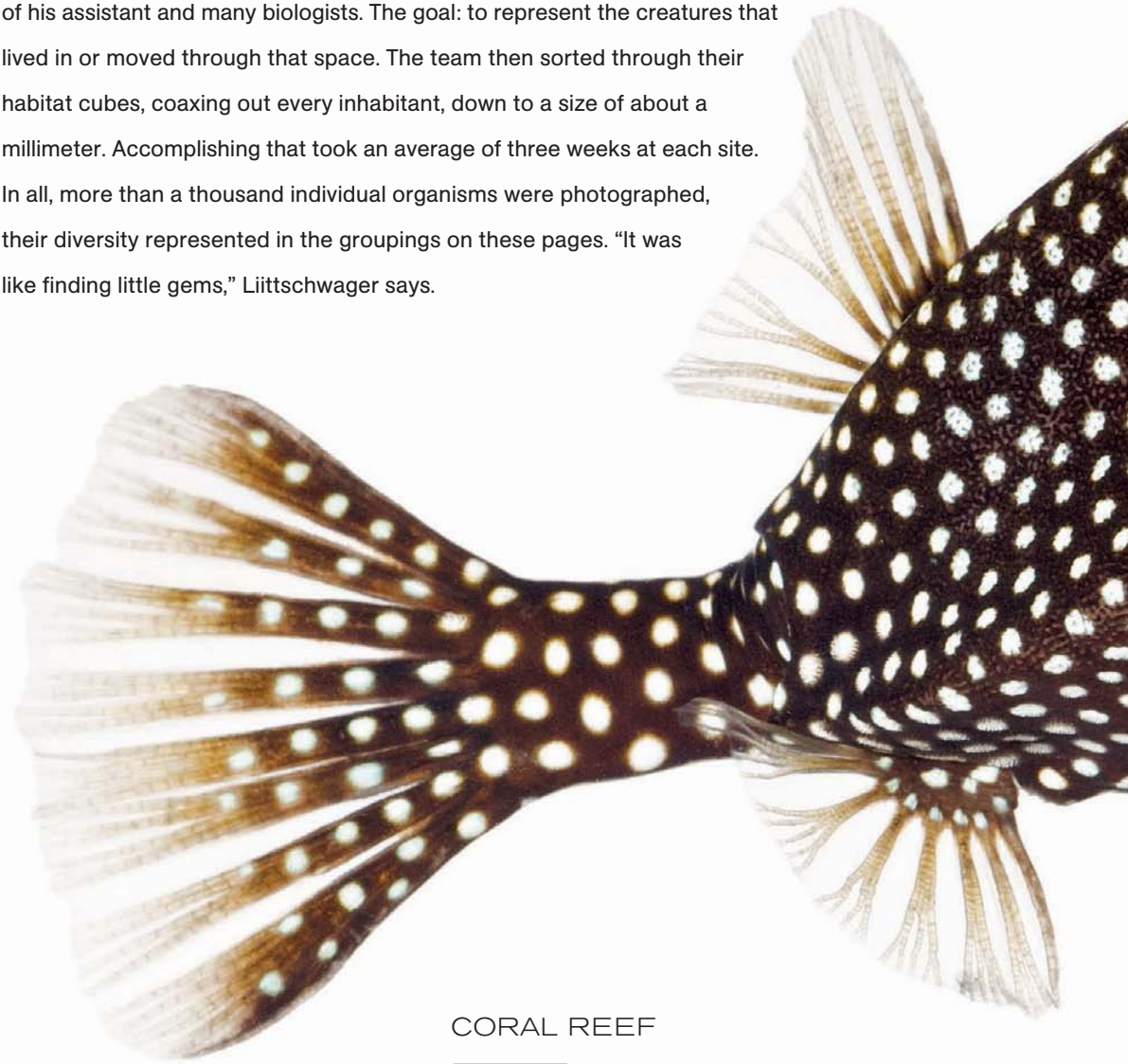
ONE CUBIC FOOT

Miniature Surveys of Biodiversity

Photographs by David Liittschwager

How much life could you find in one cubic foot?

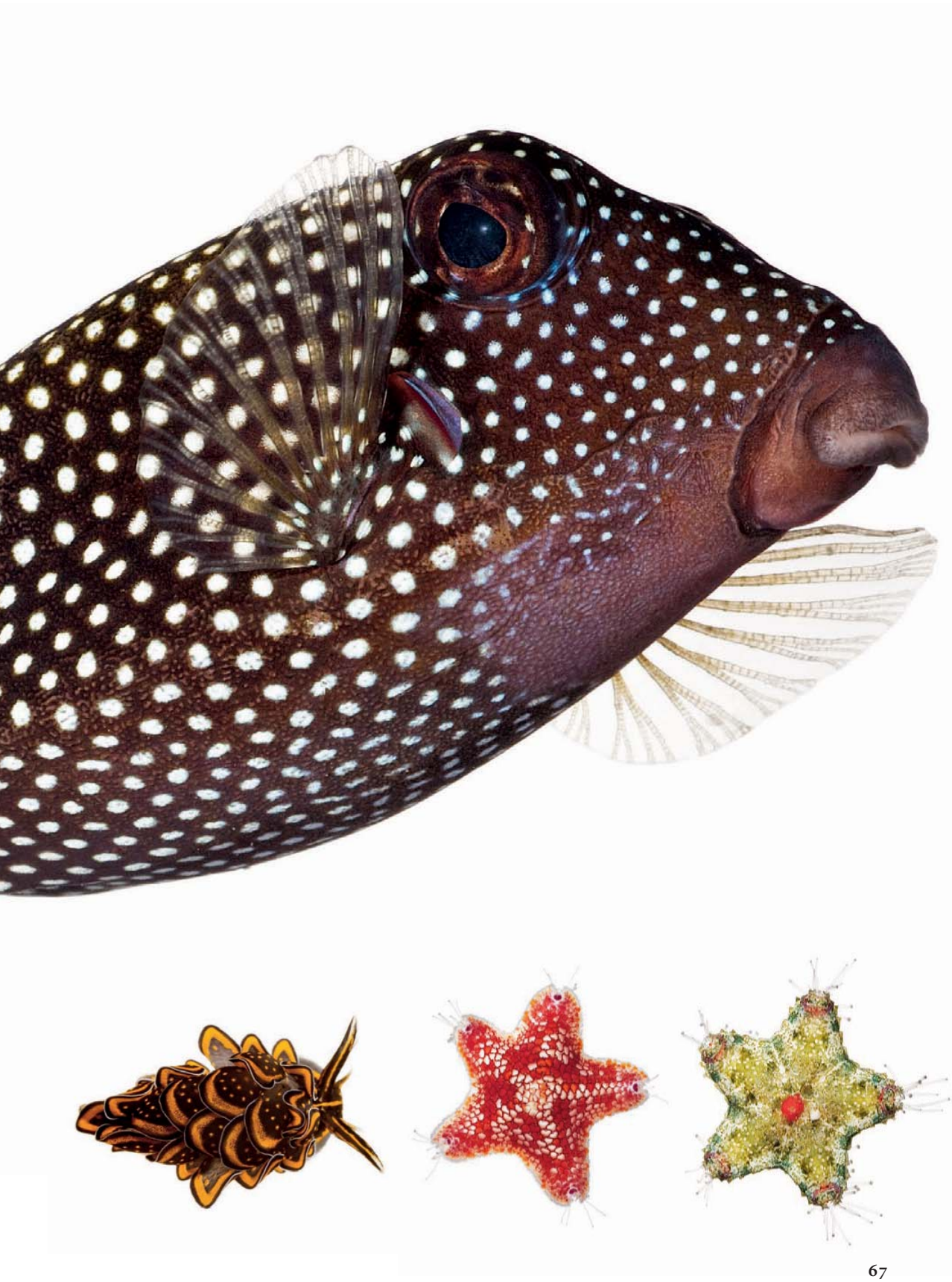
That's a hunk of ecosystem small enough to fit in your lap. To answer the question, photographer David Liittschwager took a green metal frame, a 12-inch cube, to disparate environments—land and water, tropical and temperate. At each locale he set down the cube and started watching, counting, and photographing with the help of his assistant and many biologists. The goal: to represent the creatures that lived in or moved through that space. The team then sorted through their habitat cubes, coaxing out every inhabitant, down to a size of about a millimeter. Accomplishing that took an average of three weeks at each site. In all, more than a thousand individual organisms were photographed, their diversity represented in the groupings on these pages. "It was like finding little gems," Liittschwager says.



CORAL REEF

Moorea Island in French Polynesia yielded a diverse catch (these and preceding pages).

OPPOSITE: FILE CLAM • *LIMARIA* SP., 0.8 INCH FROM TOP TO BOTTOM
ABOVE: WHITESPOTTED BOXFISH • *OSTRACION MELEAGRIS*, 6 IN LONG
RIGHT, FROM LEFT: SACOGLOSSAN SEA SLUG • *CYERCE NIGRICANS*, 0.6 IN LONG; SEA STAR • *MERIDIASTRA RAPA*, 0.55 IN ACROSS; PINCUSHION STAR • *CULCITA NOVAEGUINEAE*, 0.4 IN ACROSS





ABOVE: POST-LARVAL OCTOPUS • *OCTOPUS* SP., 0.45 IN ACROSS
OPPOSITE, TOP: BLACKSPOT SERGEANT • *ABUDEFDUF SORDIDUS*, 6 IN LONG
RIGHT, FROM LEFT: SQUAT LOBSTER • *GALATHEA PILOSA*, 0.5 IN ACROSS (BODY AND LEGS); POLYCHAETE WORM • *PHYLLODOCE MADEIRENSIS*, 6 IN LONG



Moorea, French Polynesia

Reef creatures seem a cartoonist's doodlings come to life, from a translucent post-larval octopus (opposite) to a brown-eyed polychaete worm (below, right). Like its residents, the reef grows best in clean, sun-drenched water with no sediment. At Temae Reef off the Pacific island of Moorea, Liittschwager worked with scientists from the Moorea Biocode Project—a venture to inventory every species on Moorea large enough to be gripped in the finest tweezers. He photographed more than 600 individuals, not counting the tens of thousands of shrimplike hatchlings and other plankton drifting through the cube one moonless night. Biocode researchers are conducting DNA sequencing on Liittschwager's collection, part of a larger effort to assign a unique identifier to each species. "Such detail will give us a new way to look at the ecosystem," says Smithsonian research zoologist Chris Meyer. This small survey can only hint at the reef's full diversity: Many animals flee during sampling and, Meyer says, "if you moved the cube over just a few feet, a third of your finds might be different."





By Edward O. Wilson

When you thrust a shovel into the soil or tear off a piece of coral, you are, godlike, cutting through an entire world. You have crossed a hidden frontier known to very few. Immediately close at hand, around and beneath our feet, lies the least explored part of the planet's surface. It is also the most vital place on Earth for human existence.

In any habitat, on the ground, in the forest canopy, or in the water, your eye is first caught by the big animals—birds, mammals, fish, butterflies. But gradually the smaller inhabitants, far more numerous, begin to eclipse them. There are the insect myriads creeping and buzzing among the weeds, the worms and unnameable creatures that squirm or scuttle for cover when you turn garden soil for planting. There are those annoying ants that swarm out when their nest is accidentally cut open and the pesky beetle grubs exposed at yellowed grass roots. When you flip a rock over, there are even more: You see spiderlings and sundry pale unknowns of diverse form slinking through mats of fungus strands. Tiny beetles hide from the sudden light, and pill bugs curl their bodies into defensive balls. Centipedes and millipedes, the armored snakes of their size class, squeeze into the nearest crevices and wormholes.

It may seem that the whole icky lot of them, and the miniature realms they inhabit, are unrelated to human concerns. But scientists have found the exact opposite to be true. Together with the bacteria and other invisible microorganisms swimming and settled around the mineral grains of the soil, the ground dwellers are the heart of life on Earth.

The terrain they inhabit is not just a matrix of dirt and rubble. The *entire* ground habitat is alive. Living forms create virtually all of the substances that flow around the inert grains.

If all the organisms were to disappear from any one of the cubic spaces depicted in these photographs, the environment in it would soon shift to a radical new state. The molecules of the soil or streambed would become smaller and simpler. The ratios of oxygen, carbon dioxide, and other gases in the air would change. Altogether, a new physical equilibrium would be approached, at which the cubic foot would resemble that on some distant, sterile planet.

Earth is the only planet we know that has a biosphere. This thin, membranous layer of life is our only home. It alone is able to maintain the exact environment we ourselves need to stay alive.

Most of the organisms of the biosphere, and the vast number of its species, can be found at the surface or just below it. Through their bodies pass the cycles of chemical reactions upon which all of life depends. With precision exceeding anything our technology can match, some of the species break down the dead plant and animal material falling from above. Specialized predators and parasites feed on these scavengers, and higher level specialists feed on them in turn. The whole, working together in a constant turnover of birth and death, returns to the plants the nutrients needed to continue photosynthesis. Without the smooth working of all this linkage, the biosphere would cease to exist.

Thus, we need all of this biomass and biodiversity, including all of the creepy-crawlies. Yet in spite of its vital role, life at the ground level

---

Pulitzer Prize winner Edward O. Wilson is honorary curator of entomology at Harvard's Museum of Comparative Zoology. David Liittschwager has photographed natural history subjects on six continents.

remains relatively unknown, even to scientists. About 60,000 species of fungi have been discovered and studied, for example, including mushrooms, rusts, and molds, but specialists estimate that more than 1.5 million species actually exist on Earth. Along with them in the soil thrive some of the most abundant animals in the world, the nematodes, also known as roundworms. These include, among other forms, the barely visible white wigglers that can be found everywhere just underground. Tens of thousands of roundworm species are known, and the true number could be in the millions. Both fungi and roundworms are outdone dramatically in turn by still smaller organisms. In a pinch of garden soil, about a gram in weight, live millions of bacteria, representing several thousand species. Most of them are unknown to science.

Ants, with more than 12,000 described species in the world (and the group on which I specialize as a naturalist), are among the better studied insects. Yet it's a good guess that the actual number is double or even triple that. In 2003 I completed a study of the "big-headed ants" of the Western Hemisphere, a genus *(Pheidole)* that has the largest number of known species and is among the most abundant of all the ants. At the end of my study, after 18 years of off-and-on effort, I had distinguished 624 species. A majority, 337, were new to science.

Only a dozen or so of the species have been closely studied. One of the smallest, I discovered, feeds on oribatid mites, which are usually much smaller than the letter *o* on this page and resemble a cross between a spider and a turtle. Oribatids are among the most abundant creatures of their size in the soil. A cubic foot might contain thousands of individuals. Yet I found that their diversity and habits remain largely unknown, much more than in the case of ants.

Life at the ground level is not just a random mix of species, not an interspersion of fungi, bacteria, worms, ants, and all the rest. The species of each group are strictly stratified by depth. In passing from just above the surface on down, the conditions of the microenvironment change gradually but dramatically. Inch by inch there are shifts in light and temperature, the size of the cavities, the chemistry of the air, soil, or water, the kind of food available, and the species of organisms. The combination of these properties, down to a microscopic level, defines the surface ecosystem. Each species is specialized to survive and reproduce best in its particular niche.



Soil studies, and especially the biology of the ground level, is growing rapidly into a major branch of science. Now bacteria and other microscopic forms of life can be identified quickly by the decoding of their DNA. The life cycles of increasing numbers of insects and other invertebrate animals, many entirely unknown to science, are being explored in the field and laboratory. Their physical and nutritional needs are coming clear, species by species. The Encyclopedia of Life, available in a single address *(eol.org),* is gathering all known information on each species and making it available free throughout the world.

A small world awaits exploration. As the floras and faunas of the surface are examined more closely, the interlocking mechanisms of life are emerging in ever greater and more surprising detail. In time we will come fully to appreciate the magnificent little ecosystems that have fallen under our stewardship. □

What life lies below Central Park? See what crawled out of the leaves at **ngm.com/cubicfoot.**

SHARPSHOOTER LEAFHOPPER · *PAROMENIA ISABELLINA,* 0.5 IN LONG



ABOVE: ALICE SUNDEW • *DROSERA ALICIAE,* 0.6 IN ACROSS
RIGHT, FROM LEFT: WOOD SORREL • *OXALIS POLYPHYLLA,*
1.5 IN ACROSS; PILL MILLIPEDE • *SPHAEROTHERIUM* SP., 0.25 IN
LEAFHOPPER • *CEPHALELUS* SP., 0.1 IN LONG





Table Mountain, South Africa

Fynbos, derived from Dutch, refers to the fine-leaved vegetation that grows in the mountainous areas of the Cape Floristic Region (CFR, as botanists call the unique area of floral diversity at the southern tip of Africa). The soils here are rocky and nutrient-poor, the scrub prone to going up in flames. Yet adversity has fostered one of the richest concentrations of plant diversity in the world: Some 9,000 native species live in the CFR—many of them evolved here and live nowhere else. Liittschwager's shovelful of fynbos came out of Table Mountain National Park, the monumental mesa that towers over Cape Town. Sifting through samples (following pages), the photographer counted 90 separate species, including 25 types of plants just on the soil surface, along with some 200 seeds representing at least five of those species. Root masses held a host of crawlies, and the sticky leaves of a carnivorous sundew plant (opposite)—looking too pretty to be predatory—offered another fistful of insects to the tally.

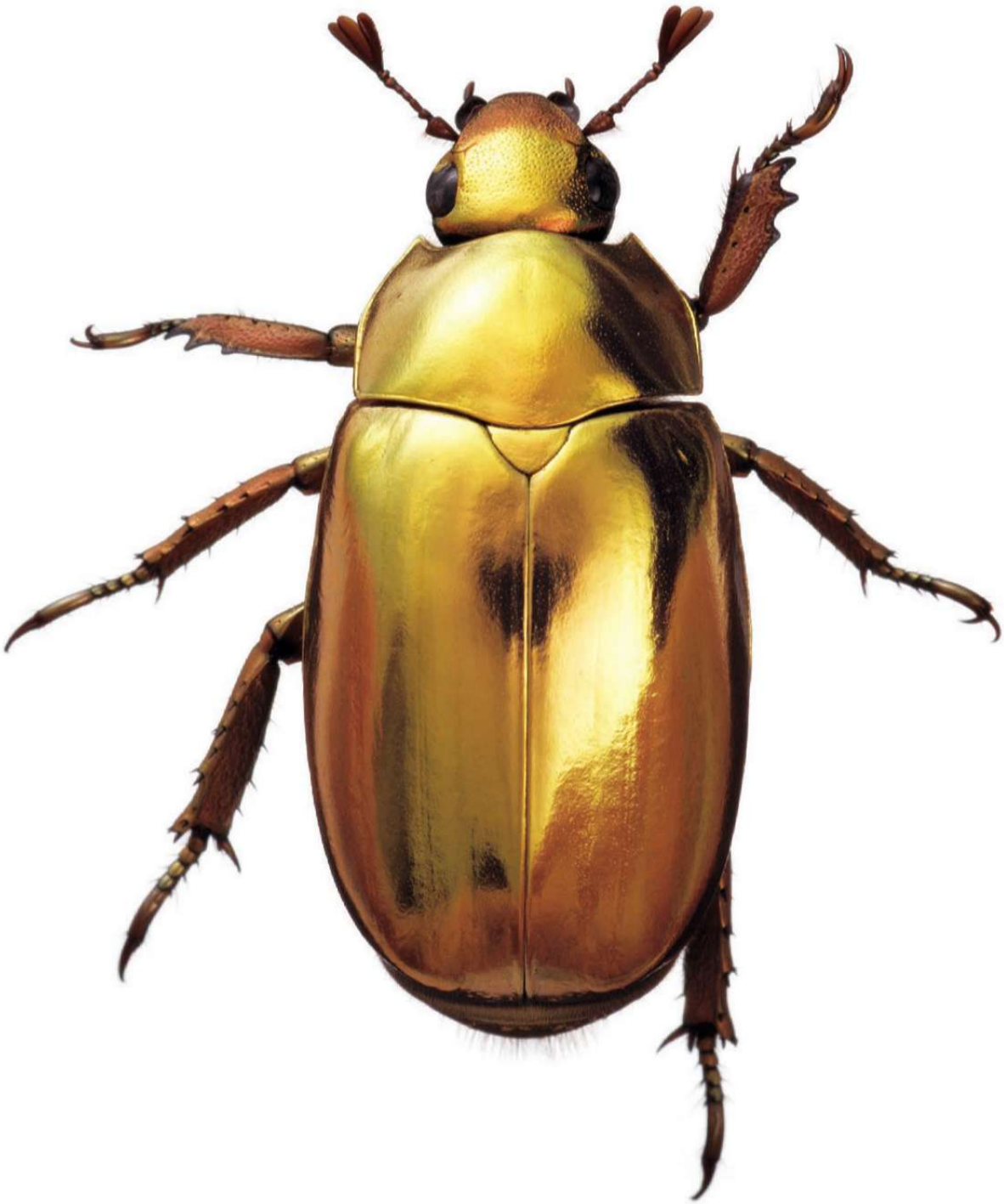




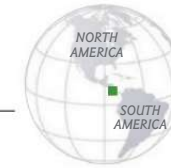








JEWEL SCARAB • *CHRYSINA RESPLENDENS*, 1 IN LONG





Monteverde, Costa Rica

Along the stout limb of a strangler fig a hundred feet up in the canopy of the Monteverde cloud forest, a luxuriant garden grows. Orchids, ferns, and bromeliads form living layers on the mossy bough, sprouting one atop another and creating canopy soil. They gather moisture from the rain and mist and vie for space in the sun. Most of the animals that thrive in this treetop ecosystem are fingertip small—beetles, ants, moths, and spiders—and prey for larger tree dwellers like rodents and monkeys. Insects and birds, including hummingbirds, do much of the pollinating; birds—along with nimble-footed mammals—also serve as vital dispersers of seeds. To survey this tropical richness, Liittschwager climbed ropes, scooted along creaking branches, and sampled day and night. None of the canopy's mammalian denizens was spied investigating the chosen spot. But five birds flitted by, and the team recorded 24 plant species and more than 500 insects representing 100 species within the cube's green borders.



TROPICAL CLOUD FOREST

HAWK MOTH • *XYLOPHANES PORCUS CONTINENTALIS*, 2 IN LONG
BURÍO TREE SEED • *HELIOCARPUS AMERICANUS*, 0.35 IN ACROSS







ABOVE: BIGCLAW CRAYFISH • *ORCONECTES PLACIDUS*, 4 IN LONG
OPPOSITE, TOP: SPOTTED BASS • *MICROPTERUS PUNCTULATUS*, 7.5 IN LONG



Duck River, Tennessee

It's one of the most biodiverse waterways in the U.S., and it harbors several endemic species—animals found nowhere else on Earth. Why such wealth in central Tennessee's Duck River? Time, says Don Hubbs of the Tennessee Wildlife Resources Agency. Part of an ancient, sprawling watershed, the 290-mile Duck River has streamed over its limestone base for millions of years. The mineral-rich geology favors creatures that are, in turn, vital to the river—including the 54 mussel species that filter the Duck's waters. The survey spot was at Lillard Mill, about 15 miles east of Columbia, Tennessee. After days of working in swirling waters turbid from rich crops of algae, the team lifted a sample into a tank (left, with spotted bass) for clearer access. The surveyors noted a bigclaw crayfish (opposite) and several turtles, including one sporting a flamboyant coat of algae (following pages). Evidence of 32 fish species, more than a hundred non-native Asian clams, and seven species of mussels, three of them endangered, further hints at the prosperity of this old man river. *—Photo text by Jennifer S. Holland*



FRESH WATER

BELOW: RIVER COOTER • *PSEUDEMYS CONCINNA*, 4 IN ACROSS
BOTTOM, FROM LEFT: NORTHERN STONE FLY NYMPH • *AGNETINA CAPITATA*, 0.6 IN LONG; SNAIL • *CAMPELOMA DECISUM*, 1 IN ACROSS; LONGNOSE GAR • *LEPISOSTEUS OSSEUS*, 12 IN LONG







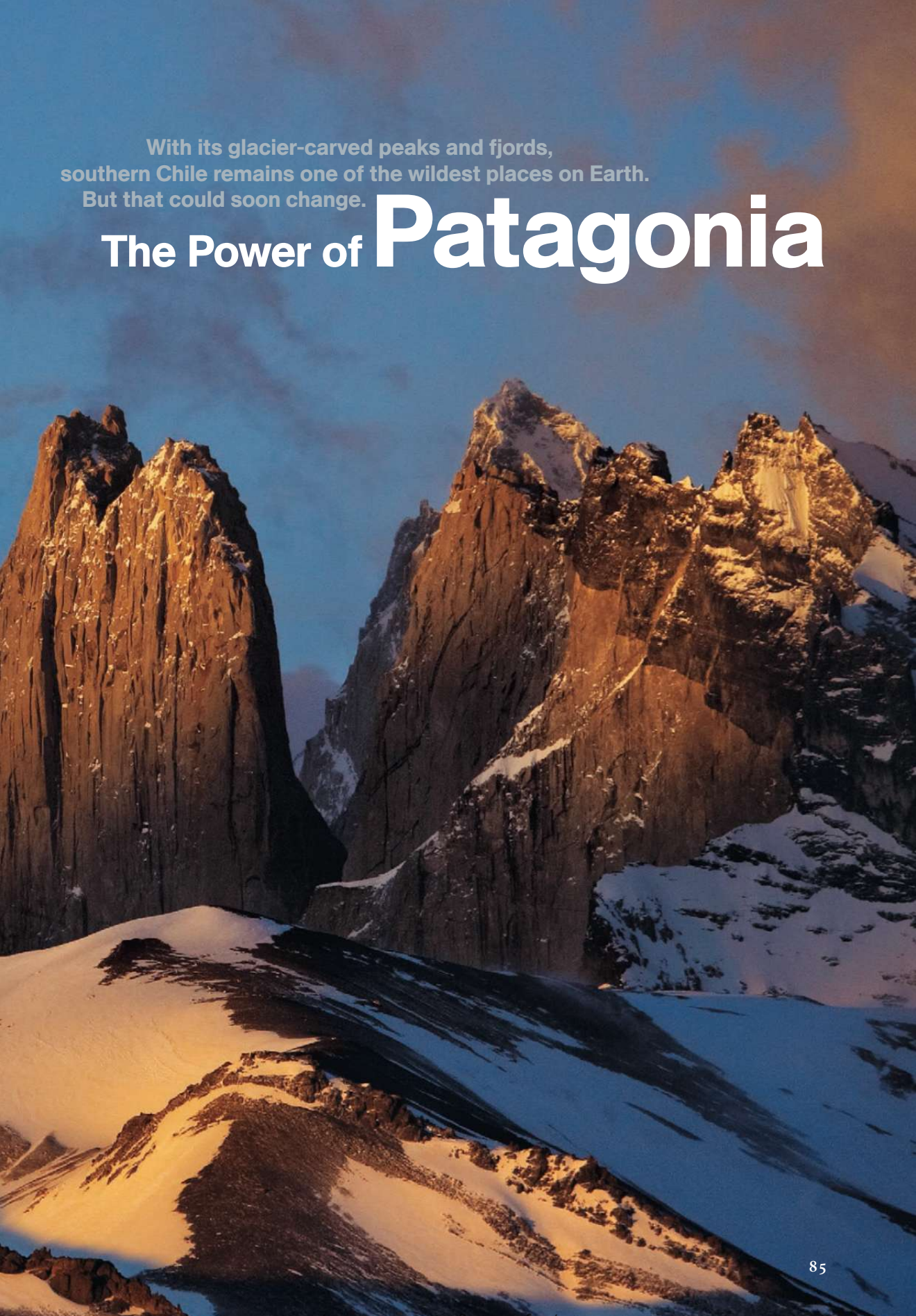




Once the haunt of a few stalwart climbers, Chile's Torres del Paine National Park now draws more than 100,000 visitors a year.

With its glacier-carved peaks and fjords, southern Chile remains one of the wildest places on Earth. But that could soon change.

The Power of Patagonia







BERNARDO O'HIGGINS NATIONAL PARK **Lautaro, an active volcano (background), broods over the tortured surface of Pío XI Glacier. Chile's sprawling ice fields are among the world's largest outside the polar regions.**

At the head of a remote fjord in southern Chile, a determined Norwegian named Samsing settled down in 1925 to a life of pasturing sheep in what was then a grass-filled valley. A year later he was literally chased out of his homestead by an advancing glacier.

Where his estancia lay there is now a glacial lake with icebergs floating in it. The glacier, today called Pío XI, relented for a time, then went on the march again. Nowadays it is lifting a forest by its roots, flinging it ever so slowly aside. Along the capsizing tree line, Guaitecas cypresses, some hundreds of years old, seem to have paused even as they were toppling. Roots have been upturned, crowns snapped off, trunks set akimbo. Elephantine boulders of ice have been driven under moss and carnivorous bog plants.

The woodland Pío XI is shoving aside is Magellanic rain forest—not the dark, canopy-rich rain forest of the tropics, but the kind of matted, windblown bonsai you see at tree line in the mountains. And no wonder. The fjords and islands of Chilean Patagonia take the brunt of the prevailing westerlies that wail across the southern seas. Here in the heart of the roaring forties, the wind can blow with almost constant ferocity. Rain and snow can fall all year round.

No place on the planet is fully at rest. Only time—unimaginable stretches of time that conceal from human eyes the dynamic natural forces shaping the Earth—creates the illusion of stasis. But sometimes, if you're lucky, you come upon a place where time seems compressed, where you can feel in your bones how kinetic even geology really is.

The glacier-carved coast of Chile is such a place. Here the Earth's energy seems almost palpable. Tectonic plates are spreading and then diving under this fringe of the continent, lifting the Andes and creating a geologically volatile zone. From the interior ice fields, glaciers such as Pío XI—short, brutal rivers of ice—descend swiftly to the sea. Offshore, the upwelling of the Peru Current is a fountain of aquatic life. The shoreline, divided by a labyrinth of waters, stretches more than 50,000 miles. This Patagonia differs utterly from the one that name usually conjures—a land of broad pampas. This Patagonia belongs to sea and ice.

At the heart of this wild region lies Bernardo O'Higgins National Park. More than 200 miles from end to end, the park encompasses Patagonia's Southern Ice Field, which with its northern counterpart forms one of the largest expanses of glacial ice outside the polar regions.

There is no coming overland to Bernardo O'Higgins, and no flying in either. The only way in is by water, intricately, through a maze of deepwater fjords that ultimately leads to the snout of Pío XI. There glacial thunder fills the air—cracking, resonant reports from deep in the ice field as well as duller but more profound detonations caused by the calving of bergs from Pío's snout. Those explosions end with the hiss of new waterfalls and spilling ice shards.

At the ragged seam where glacier meets rain forest, Pío fills the sky, a mountain of ice towering toward the midday sun. Nearby, the glacier is almost cormorant black, then petrel gray. Farther off, higher up, the ice turns white and then a hundred impossible species of blue.

In this distant and extreme terrain, the fundamental story of our time is being told afresh. Here it is possible to see, with a clarifying starkness, how tightly woven our new world really is. As isolated as Chilean Patagonia is, it is also on the brink of abrupt transformation. On land the few homesteads look as though they were carved out of the 19th century. But there are plans to dam the wild rivers north of Bernardo O'Higgins. And clinging to the water's edge, there is the steady southward movement of

By Verlyn Klinkenborg
Photographs by Maria Stenzel



KATALALIXAR NATIONAL RESERVE **Inland ice fields give way along Chile's coast to a maze of islands and fjords. The weather here is rarely calm. On Byron Island, the skull of a sei whale rests in a tidal creek—until the next storm.**

salmon farms, a source of economic opportunity and an environmental plague.

At the urging of conservationists, Chile has considered designating its ice fields and most of the protected areas along its southern coast as an enormous new UNESCO World Heritage site—millions of acres in all. But as of late 2009, the government was backing away from the ambitious plan in favor of a more modest proposal. Yet in its wild south, Chile still has the chance to preserve great tracts of a natural world that has barely begun to be explored, even as it is threatened by potentially devastating change.

On a map the seemingly endless archipelagoes in the Chilean fjords look like rubble that has spilled from the Andes. The main channels were charted early on—part of the search for a tolerable route around Cape Horn. Pedro Sarmiento de Gamboa worked his way into these waters as early as 1579. British navigator John Byron came to grief in 1741 on an island now named for his ship, the *Wager*—an epic tale of treacherous sailing and debilitating conditions. Darwin came here on the *Beagle* and noted that the sound of calving bergs "reverberates like the broadside of a man-of-war through the lonely channels."

Still, it's surprising just how recently even the most fundamental kinds of exploration were done. The English names that lie scattered across the map here were bestowed by a British surveying expedition in 1830. But Pío XI was named in honor of Pope Pius XI by Father Alberto de



PROMISE AND PERIL

With more than 30 million acres in national parks and reserves, Chilean Patagonia remains one of the world's great wildernesses. But the region faces an uncertain future. Fish farms are proliferating, and plans call for a series of dams to help power the country.

Agostini, an Italian missionary and explorer who in 1931 was the first person to cross the Southern Ice Field. The town of Cochrane—just on the edge of the proposed United Nations reserve and now a center of controversial hydropower development—was founded in 1954 but was reached by road (a rough gravel track) only in 1988. When the first charts based on aerial surveys of Chilean Patagonia were published in 1954, one scientist called them "the biggest map revision in the Earth's geography to be made in modern times."

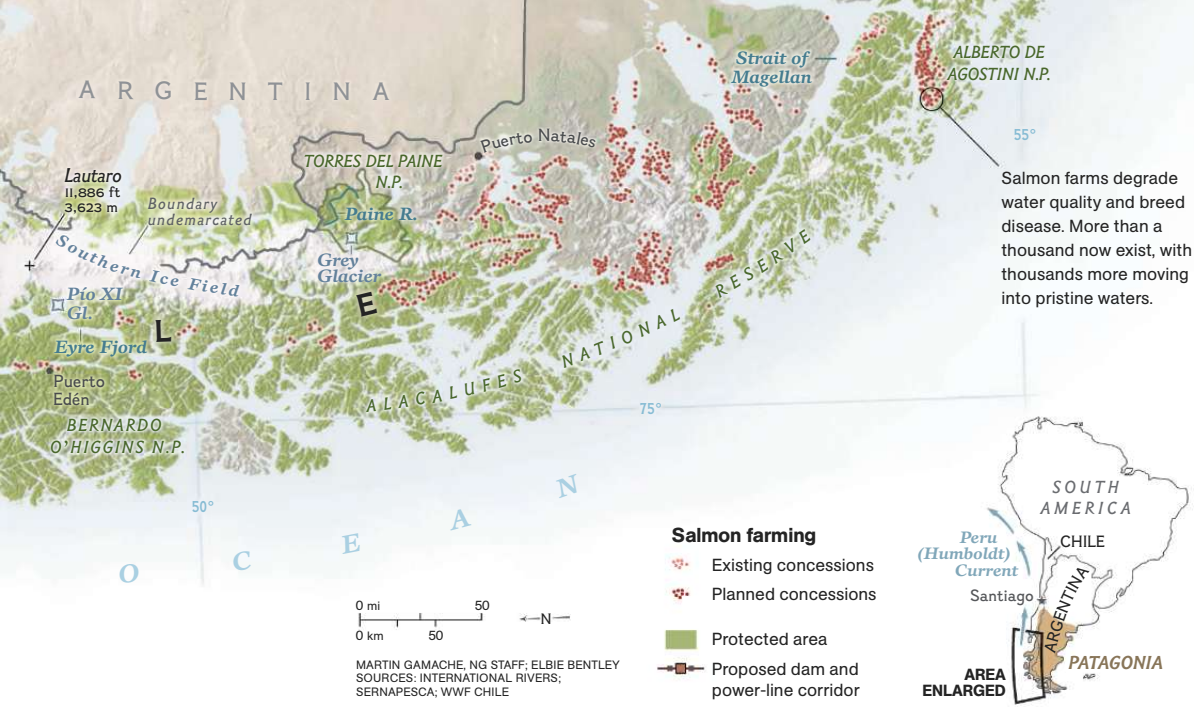
Yet even in 2007 the authors of a survey of glaciological studies felt compelled to point out a "serious gap in the observation of South American glaciers." It's safe to say that the interior regions of most of the protected areas along the fjords of Chilean Patagonia—Bernardo O'Higgins National Park, Katalalixar National Reserve, Las Guaitecas National Reserve, Laguna San Rafael National Park—are still utterly unknown. The forests are impassable, the footing knee-deep in moss and other low plants growing on a dense weave of branches and roots. They conform all too well to the experience of one observer who said in 1904, "The general wetness of these half-submerged islands quite surpasses all ordinary experience."

Verlyn Klinkenborg last wrote about Finland's Oulanka National Park. This is photographer Maria Stenzel's 25th assignment for National Geographic.

Change is invading by water. A few small cruise ships from Puerto Natales now make a run to the faces of several glaciers, where they gather ice for cocktails from small bergs drifting in the shadow of ice cliffs. The Navimag ferry churns its way from Puerto Natales to Puerto Montt—a four-day, one-way trip—stopping to exchange propane, produce, and a few passengers in Puerto Edén. The Chilean Navy patrols these waters. CONAF—the Chilean version of the U.S. Forest Service—has assumed responsibility for protecting as well as exploiting the region.

Over the past century the indigenous inhabitants have dwindled. The rookery of seals that early explorers found at the entrance to Eyre Fjord, where Pío XI terminates, is long gone. The whales of many species that frequented these fjords now barely make up a biological quorum. A red tide plagues the mussels that once sustained the fishing economy. The Alacaluf Indians, who once hunted and fished here, have dwindled to a handful of disconsolate souls in Puerto Edén, a place whose only Edenic quality is its distance from the rest of the world.

Distance is no protection these days. After Norway, Chile is the world's largest producer of farmed salmon, which are grown in podlike cages anchored offshore in Las Guaitecas National Reserve near the Northern Ice Field. (What is legally preserved in Guaitecas and other parks is the land, not the water.) The Norwegian companies that began salmon farming in Chile came



MARTIN GAMACHE, NG STAFF; ELBIE BENTLEY
SOURCES: INTERNATIONAL RIVERS; SERNAPESCA; WWF CHILE

here because the fjords were unspoiled. That is no longer the case. Like nearly every form of concentrated animal agriculture, salmon aquaculture creates an excess of waste. Here salmon farms deaden the water, creating anoxic conditions, and have led to the spread of a lethal salmon virus called infectious salmon anemia. The solution of the salmon-farming companies has simply been to move south into clean waters. Already the companies have taken out new leases on stretches of water throughout the southern fjords.

Meanwhile, on land, the threat comes from hydropower. Thanks to the Pinochet regime, most of the water rights on the major rivers that spill into the fjords are privately owned—and by foreign corporations, no less. For the past several years there has been increasing pressure to build a series of hydroelectric power dams along the Pascua and Baker Rivers. But critics argue that dams are antiquated and unnecessary in a country with such abundant renewable energy potential. They destroy the ecosystems of the watersheds in which they are built, and running transmission lines from these dams to Santiago will require a clear-cut more than a thousand miles long.

The gravest danger to the Chilean fjords is, of course, climate change, which threatens to alter the rivers that depend on these glaciers and upset the balance of salt and fresh water in the inner fjords. Of the 48 glaciers in the Southern Ice Field, 46 are retreating and one is stable. Only one, Pío XI, is advancing. It is almost certainly the only glacier in the world at its neoglacial maximum—its farthest reach since the beginning of the Little Ice Age in Patagonia some 400 years ago. Pío is now uprooting trees that are several centuries old. No one knows for certain why it has advanced so far and so fast over the past 80 years. It may be recovering ground that was lost to eruptions of Lautaro, the active volcano from which the Southern Ice Field radiates. Or its advance may be due to the tectonic upheaval that is lifting the Andes, or to the volatility of a temperate glacier—its ice nearly always at the melting point—in a region of very high precipitation, 30 feet a year and more. But one thing is clear. Pío XI is an anomaly in a melting icescape.

A hundred and thirty miles south of Pío XI, in Torres del Paine National Park, tourists are bused in by the thousands. They camp in tent cities and queue to cross the mountain passes. They share a sense that this national park is unique and worth protecting. In the Chilean fjords, however, there will never be crowds. Their very remoteness puts them at risk, and not just from salmon farming and hydro dams. The risk is a lack of awareness, a forgetting that places as wild as Chilean Patagonia cannot survive without protection. Creating parks and reserves—even a UNESCO World Heritage site—may make a difference. But it may also be only a change in name. □



TORRES DEL PAINE NATIONAL PARK **A 40-knot wind bends a *ñirre* tree on the banks of the Río Paine. Fed by runoff from glaciers and copious snow and rain, Patagonia's rivers flow fast and furious—a tempting source of hydropower.**



TORRES DEL PAINE NATIONAL PARK **Seen from space, Grey Glacier resembles a great white bear come to drink. In reality it is shedding water and fast retreating. All but two of the 48 glaciers in the Southern Ice Field are shrinking at record rates.**

NASA



LAS GUAITECAS NATIONAL RESERVE **Floating pens (right) hold salmon being raised for export to foreign markets. Fish are fed pellets (below) containing fish proteins and antibiotics. Intensive production methods have led to pollution and the spread of infectious salmon anemia. The industry's solution—even as output falters—is to move south into pristine fjords, leaving behind waste, disease, and oxygen-depleted water.**





Salmon companies came to Chile because the fjords were unspoiled. That is no longer the case.





LAGUNA SAN RAFAEL NATIONAL PARK **Andean peaks crest the clouds above the Northern Ice Field. At once severe and sublime, this icy wilderness is ruled by elemental forces that cause it to remain, for the most part, a blank spot on scientific maps.**

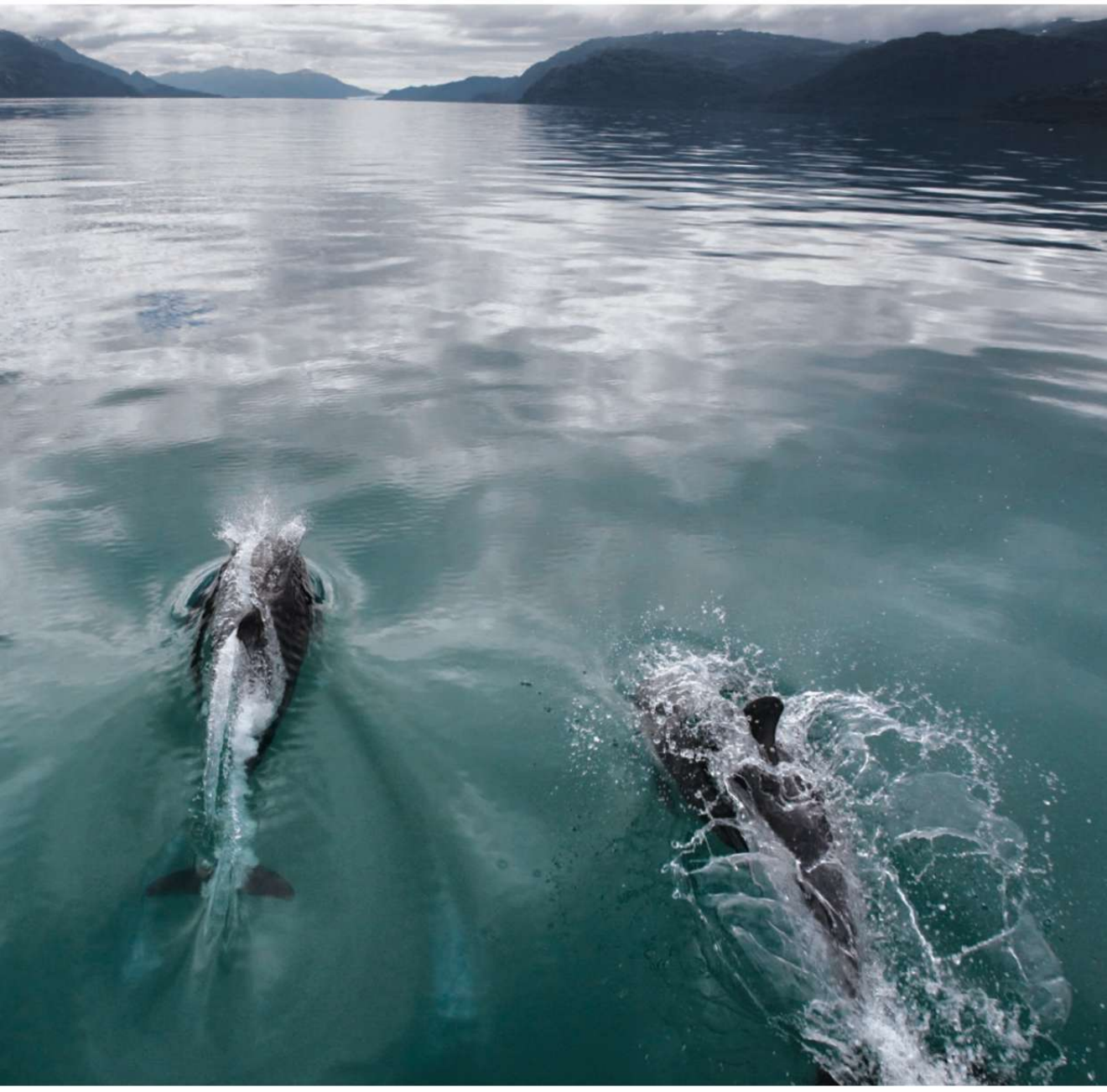


BERNARDO O'HIGGINS NATIONAL PARK **"Very confiding," wrote an early observer of the *huemul* deer (below), which showed little fear of humans. Now endangered, the deer have become wary in areas visited by tourists. In Eyre Fjord (right), a small pod of Peale's dolphins lead the way to the face of Pío XI, one of many places where dynamic forces are shaping the future of Chilean Patagonia.**



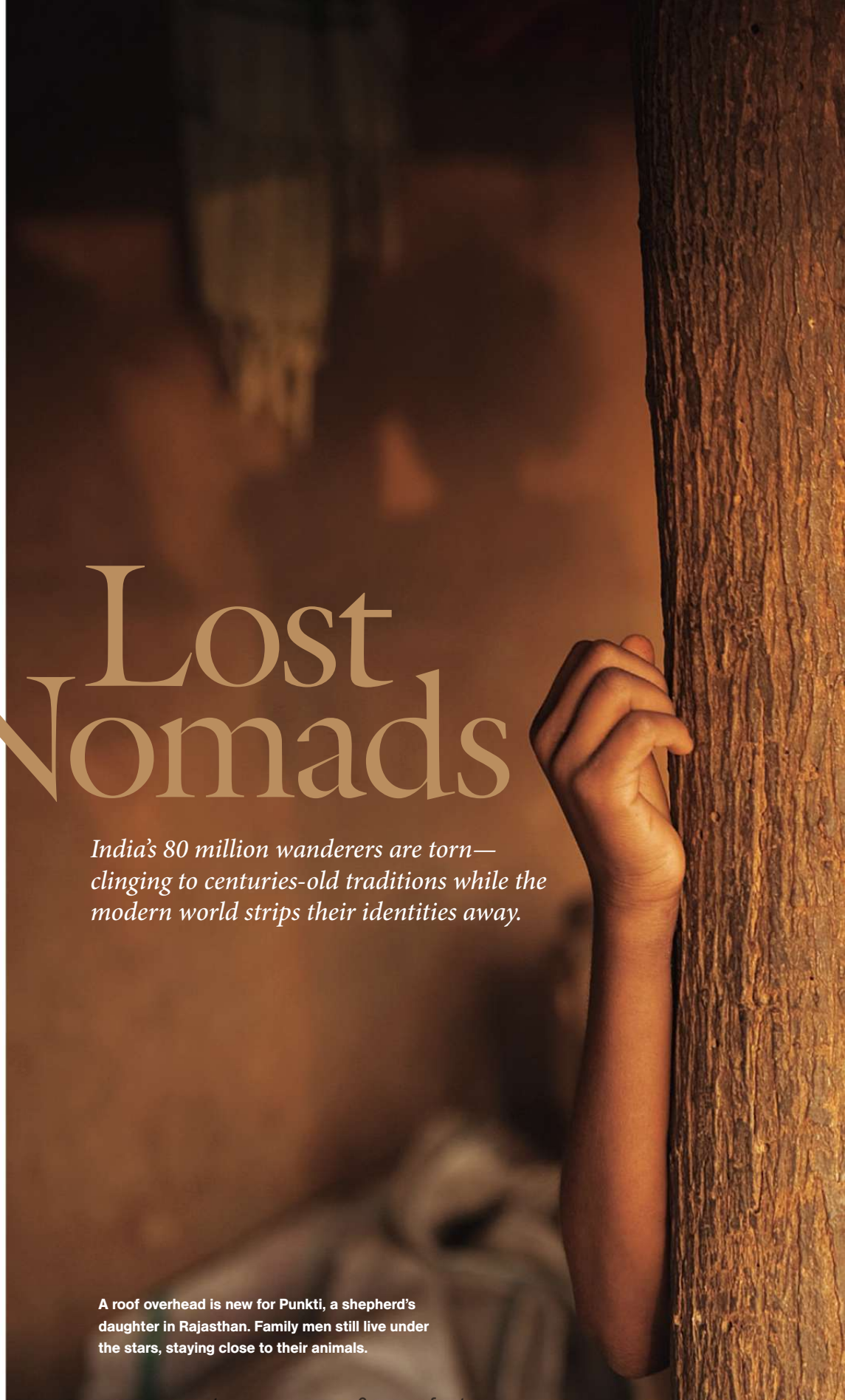


In this distant and extreme terrain, it is possible to see how tightly woven our world really is.



Lost Nomads

India's 80 million wanderers are torn—clinging to centuries-old traditions while the modern world strips their identities away.



A roof overhead is new for Punkti, a shepherd's daughter in Rajasthan. Family men still live under the stars, staying close to their animals.







Drumbeats draw a crowd as acrobats from the Nat nomadic group perform outside Jodhpur in Rajasthan. Uncounted in the census and lacking permanent housing, the traveling entertainers find it difficult to qualify for government benefits.

BY JOHN LANCASTER
PHOTOGRAPHS BY STEVE McCURRY

In their illustrious past the Gadulia Lohar forged armor for Hindu kings. Today these blacksmiths pitch camp on the outskirts of tiny Indian villages and make simple goods from metal scrap. • On a warm February day I arrived at such a camp in India's northwestern Rajasthan state, carrying bars of soap to aid my introduction. But as I approached, men, women, and children surrounded me, grabbing the bag and shredding it, spilling the soap onto the dirt. A maelstrom of curses and tangled limbs ensued. It ended with at least one older child in tears.

Such desperate behavior hints at a larger story about the nomads who have roamed the subcontinent for hundreds, sometimes thousands, of years. The Gadulia Lohar (their name comes from the Hindi words for "cart," *gaadi,* and "blacksmith," *lohar*) are among the best known; others are herders, such as the Rabari, famous throughout western India for their bulky turbans and familiarity with all things camel. Some are hunters and plant gatherers. Some are service providers—salt traders, fortune-tellers, conjurers, ayurvedic healers. And some are jugglers, acrobats, grindstone makers, storytellers, snake charmers, animal doctors, tattooists, basketmakers. All told, anthropologists have identified about 500 nomadic groups in India, numbering perhaps 80 million people—around 7 percent of the country's billion-plus population.

These wanderers were once part of India's mainstream. They meshed comfortably with the villagers who lived along their annual migration routes. In the 19th century, though, attitudes began to change. British administrators disparaged them as vagrants and criminals, sowing prejudice that survived colonial rule. The rapidly modernizing India of call centers and brand-obsessed youth has scant use for tinkers or bear trainers, and pastoralists are in a losing battle with industry and urban sprawl. Fragmented by caste, language, and region, the nomads are ignored by politicians and, in contrast to other downtrodden groups, have reaped few benefits from social welfare schemes.

Just defining the term "nomad" is problematic in India. Many groups that once unambiguously fit the category have clustered in slums in a process anthropologists call sedentarization. Yet India remains a rigidly stratified society in which birth is often synonymous with destiny. So, mobile or not, India's nomads are united by a history of poverty and exclusion that continues to this day: arguably the biggest human rights crisis you've never heard of.

To the lonely few who have taken up the nomads' cause, a big part of the solution is to provide them with roofs over their heads, or at least an address, which would make it easier for them to get welfare benefits and enroll their kids in school. But such efforts have met fierce resistance from villagers and local politicians, who see the roamers as grubby outsiders. Practical obstacles aside, a larger question looms: Do the nomads have to stop being who they are in order to survive?

AFTER THE RUCKUS over the soap, my morning arrivals were easier. The next day the camp was quiet except for an occasional racking cough. Smoke rose from a crude earthen forge,women took turns at a goatskin bellows while men and boys pounded scrap metal on small anvils, shaping it into cooking spoons, axheads, and other simple wares.

Achala, a herder, marks himself as Rabari with his turban and white garments. The Rabari are "those who live outside," and traditionally they eschew the confines of villages or farms.







Open space keeps shrinking for itinerant herders. In the Kutch region of Gujarat, construction of a coal-fired power plant forces Sangbhai and his buffalo to detour down paved roads and past boundary walls to find what grazing land remains.





IN 1871, COLONIAL AUTHORITIES PASSED THE CRIMINAL TRIBES ACT, WHICH IDENTIFIED DOZENS OF NOMADIC GROUPS AS, IN EFFECT, CRIMINAL BY NATURE.

My interpreter and I counted 23 people among four Lohar families, all related. They carried their belongings in five open carts built from acacia and teak and decorated with lotus-blossom carvings, brass studs, and painted Hindu swastikas. All were baffled by my presence, and some were unabashedly hostile. "Whatever we say, whatever we do, you write it down!" one woman complained. But a few were more welcoming. Lallu and Kailashi were a couple in their 40s—the Lohar could only guess at their ages—with four children. Dressed in a grimy cotton dhoti, Lallu was small and wiry, with gold earrings shaped like seedpods and an amulet dangling from a cord around his neck. Kailashi was thin and hollow-eyed, her breastbone tattooed with om symbols and her matted hair covered by a purple shawl. Both had bad teeth and frequently interrupted their labors to light cheap, hand-rolled cigarettes known as bidis from the embers of their forge.

Kailashi was embarrassed about the soap melee. "I am poor, but I have my morals," she said. "These people have lost that."

Her oldest child, Kanya, fetched a rope cot and invited me to sit. About 20 years old, Kanya was vivacious and strikingly pretty, with broad cheekbones and carefully plucked eyebrows. She also had a forceful personality. "Stop acting like a thug!" she scolded one of her cousins when the young man persisted in pestering me for handouts. Kanya had recently returned to her family after fleeing an abusive husband.

I asked Lallu where he was from, expecting him to name his birthplace, or perhaps the town where the family camped for the summer, when the weather is too hot for traveling. Instead he named a place he had never even seen.

During the dry season herding activity slackens, and the Rabari alter their routines. In Rajasthan, women turn to grueling wage labor (top left), earning two dollars a day for digging a reservoir. Men hunker down to shear sheep. Once the rains return, they'll set out with their flocks, depending on landowners for access to water and pasture.

"Chittaurgarh," he said. And then he raised his fist above his head in a kind of salute.

Chittaurgarh is a massive sandstone fort on a plateau in southern Rajasthan. Built in the seventh century, it was the capital of Mewar, a powerful kingdom of the high-caste Hindu warriors known as Rajputs. The Lohar are Rajputs too, according to their oral tradition. They served the kingdom as weapon-makers. But in 1568, Chittaurgarh was captured by Akbar, the great Mogul emperor, and the Lohar fled.

Shamed, they committed to a life of wandering and self-denial, vowing never to spend the night in a village, light a lamp after dark, or even use rope to draw water from a well—pledges known collectively as the Oath. (They also vowed to do without comfortable beds and even now travel with their cots turned upside down, in symbolic observance of the ancient promise.)

Still, they had to earn a living, so they put their metalworking skills to more prosaic use. Their kitchenware and farm tools were prized for their durability and, in the age before manufacturing and low-cost Chinese imports, found no shortage of buyers.

India once teemed with such traveling niche workers. Many were first described in detail by a British civil servant, Denzil Ibbetson, in an 1883 report based on census data from the Punjab region. Among them were the Qalandari ("their ostensible occupation is that of leading about bears, monkeys and other performing animals"); the Nats ("acrobatic feats and conjuring of a low class"); the Gagra ("catching, keeping and applying leeches"); and the Kanjar ("curing boils"). "They are not pleasant people to deal with," Ibbetson concluded, "and we are thrown but little into contact with them."



Ibbetson's observations reflected the prejudices of the day and the widely held belief in Britain that nomads—and especially the dark-skinned Romany-speaking people known as Gypsies—were incorrigible agents of vice. Such attitudes transferred easily to the subcontinent. In 1871, colonial authorities passed a notorious piece of legislation called the Criminal Tribes Act, which identified dozens of nomadic groups as, in effect, criminal by nature. Itinerant families were required to register with police, and thousands of men, women, and children were forcibly corralled in work camps, some of them run by the Salvation Army, according to the book *Dishonoured by History,* by Indian sociologist Meena Radhakrishna.

After independence in 1947, the law was replaced by a comparable if less draconian measure, the Habitual Offenders Act, and the stigma of criminality lingers. "I would never have imagined that the descendants of these communities would be viewed with exactly the same prejudices," Radhakrishna says. "It's not that they don't want to be a part of society—they are not allowed to be."

THE WOMEN were fixing dinner. With a mortar and pestle, Kailashi crushed chili peppers for a vegetable stew, while Kanya cooked chapatis, the ubiquitous Indian flatbread, over an open fire. Night was coming, so they had to work fast, because of the prohibition against lamps. The Lohar had arrived in the village a few days earlier and weren't sure how long they would stay. It depended on the availability of work. As one of them said, nodding in the direction of a nearby buffalo, "There is not much of a difference between my life and that buffalo's life. He's roaming for food, and we also roam for food."

It was hard to argue with the comparison. The Lohar had never been to school. They relieved themselves in fields and slept under the stars, except during monsoon season, when they rigged their carts with awnings and encircled them with low mud walls to prevent flooding. They had never heard of the United States. When I first turned up, Kanya assumed—despite my white skin—that I was from Jaipur, the state capital, which was 40 miles distant and marked the geographic limit of her experience. "Ahhh," she said when I explained the airplane. "You came in a *cheel gaadi*." An eagle cart.

LIKE OTHER NOMADIC GROUPS, the Gadulia Lohar occasionally have been targeted for attempts at rehabilitation. In 1955, Jawaharlal Nehru, India's first prime minister, argued in a famous speech at Chittaurgarh that the blacksmiths' honor had been restored with the establishment of Indian sovereignty and appealed to them to cease their wandering. Thousands who had traveled to the fort by bullock cart and train watched as Nehru ceremonially righted an overturned cot, then invited them to enter by traversing a bridge strewn with rose petals. A boarding school for Lohar boys was established nearby, and housing and employment schemes were launched.

The initiatives never came to much. A settlement where the blacksmiths were supposed to learn farming was abandoned after two girls died of illness—interpreted as a warning to those who would violate Lohar tradition. Others

Twelve-year-old Vijay Nath exhibits his harmless sand boa at a squatter's camp in Gujarat. His family stays on the lookout for police: Snake handling has been outlawed since 1972.







WHAT WOULD THESE TIME TRAVELERS FORFEIT IF THEY GAVE UP THEIR WANDERING AND ENTERED SOCIETY'S MAINSTREAM? PROBABLY EVERYTHING.

fizzled because of corruption and poor planning.

But the nomads' cause was kept alive by human rights groups, and in 2005 the Indian Parliament formed a temporary commission to address their plight. Its chairman, Balkrishna Renke, was uniquely qualified for the job: Born into a group of mendicants, he spent his early childhood roaming among villages in western India, literally singing for his supper, before a charity took him in and gave him an education.

For Renke the goal is clear. "If they want to have a right of citizenship, education, and participate in modern progress, they have to settle," he says. Renke is under no illusions about the scale of the challenge. India's creaky but expansive social welfare system has long been geared toward redressing the inequities of caste. Because the nomads are dispersed among many castes, they have garnered few of the affirmative action benefits—and none of the political clout—that have accrued to other persecuted groups, such as the Untouchables. "There is no organization. There is no awakening," Renke says. "They are unheard people."

AFTER A WEEK in the Lohar's company, I was beginning to understand one reason: They were not easy to be around. Although I had made clear at the outset that I would not give them money, I tried to remain in their good graces by dispensing small gifts—usually bags of lentils and flour—and regularly treating them to chai from a nearby vendor. But for some it was never enough. Kartar, Lallu's older brother, badgered me constantly for *kalakand,* a kind of milk pudding, and sulked when I failed to oblige. His wife, Pooni, was no less insistent. "Give me money for chai!" she said by way of a greeting one morning, and whenever I caught her eye, she plucked at her ragged tunic or signaled her desire for bidis by raising two fingers to her lips. I learned not to catch her eye.

Even Lallu, whom Kailashi had pronounced "too shy to beg," was not above hitting me up now and then.

"I didn't eat yesterday because my hen died," he told me one afternoon. "I was very sad."

A dog had killed it. I murmured condolences.

"A new hen costs 300 rupees."

Sympathetic nod.

"You pay 100 rupees."

Sigh.

Still, I couldn't help but admire the Lohar. They were skilled artisans and hard workers and took obvious pride in what they do. One afternoon a gray-haired woman from the village came to buy a spoon. "I may charge you a few rupees more, but I make good-quality stuff," Kartar promised. Squatting in the shade of a neem tree, he heated a piece of iron until it glowed, then positioned it on an anvil with tongs while Pooni, her feet planted wide, flattened it with a sledgehammer. When the metal was thin and malleable, Kartar grabbed a smaller hammer and deftly teased out the shape of the long-handled spoon, pounding its surface to a lustrous, dimpled finish.

He filed its edges smooth, then handed it to the woman with a flourish and an expression of respect. "Take it, mother," he said, receiving 30 rupees—about 65 cents—in return.

The Lohar cared about their craft because they cared about their identity. All but the youngest knew the story of Chittaurgarh, and weeping children were silenced with the

A small boy practices with a slithery partner as his parents, members of the Vadi snake-handling community, watch and teach. The Vadi, like many nomadic entertainers, increasingly depend on begging to survive. The show goes on for Mangabhai (bottom), a 63-year-old Nat acrobat who jumps through knife-studded hoops.

command, "Don't cry—you're a Lohar." Kartar's son Arjun was the living expression of Lohar pride. About ten years old, he had wide, expressive features and the build of a junior wrestling champion. Arjun took unconcealed pleasure in his prowess with a sledgehammer, hoisting it tirelessly as his father urged him on with shouts of "Harder! Faster!"

FOR SEVERAL DAYS I had been asking the Lohar when they planned to move on, and each time the answer was the same: tomorrow. Then tomorrow finally came. I showed up at the campsite one morning to find them loading their carts. Tools were stowed in compartments, bullocks muscled into harnesses, bedding folded and piled on board along with cots, fire-blackened cooking vessels, and family members too young or infirm to walk alongside. Finally, on some unspoken signal, the ragged caravan lurched forward, ironbound wheels clattering on the pavement. Oncoming traffic, mostly motorcycles and homemade diesel-powered jalopies called *jugards,* gave way as the Lohar moved down the narrow road past mustard fields and rippling winter wheat.

It was hard not to be captivated by the romance of the scene. Here, after all, was a lost tribe in motion. Blot out the sputtering, Indian-made Hondas and the orange-and-white microwave towers, and the Lohar were virtually indistinguishable from the proud Rajput artisans who fled Chittaurgarh nearly half a millennium ago. What would these medieval time travelers forfeit if they gave up their wandering and entered society's mainstream? In terms of their culture and traditions, probably everything.

It seemed like a high price to pay. Lohar people I met everywhere cling to their nomadic identity. Yet most made it clear that they live out of their carts for the simple reason that they have no other choice.

"I will be the most happy person in the world if I get some land and a house," Lallu told me one night. Kanya, too, ached for the comforts of a home she'd never known. Their yearning was easy enough to grasp. Even in this rural pocket of Rajasthan, there was evidence of India's rapid economic transformation in the cell phones carried by many of the Lohar's customers (though not the Lohar themselves) and the satellite dishes sprouting from the larger farmhouses. It seemed natural that they would want a share of this new prosperity. Moreover, their consciousness has been raised. Like other nomadic groups in northern Rajasthan, the Lohar have been encouraged by local land-rights activists to apply to the local governing council for land and housing. Besides providing them with shelter, this also would satisfy the Indian bureaucracy's need for a fixed address, without which access to welfare benefits, such as subsidized cooking oil and free medical care, is quite difficult.

But so far their efforts have been for naught. Officials in one town where the Lohar had made an appeal said they had no land to give—and that even if they did, they doubted the Lohar would take it. "They don't want to settle," one official said dismissively. "They want to live on the road."

The same response came in Thana Ghazi, about 60 miles northeast of Jaipur, where local officials had reluctantly provided plots for a dozen Lohar families on a spur of the town's busiest thoroughfare. The blacksmiths lived in one-room brick houses with their carts and forges out front. But after five years, the town had provided no electricity and had turned down their application for a communal latrine.

The *pradhan,* the senior elected official for the district, confirmed that he had resisted providing the settlement with services because he didn't think the Lohar should have been permitted to settle there in the first place. It was too close to a girls' hostel and a high school, he explained, and they would be better off on another tract outside of town.

Paras the magician relies on a jester's hat of buttons, coins, and shells to attract an audience in Rajasthan. The appeal of his card tricks is steadily dwindling, outdone by the wizardry of television, available now throughout rural India.





The scavenged tarp on their cart—and home—may advertise modernity, but the skills and lowly status of the Gadulia Lohar haven't changed for generations. Once weapon-makers for royalty, the blacksmiths now make and repair tools at roadside camps.


obalVillage



Karma Tashi attends a boarding school in the Himalayan region of Ladakh, a change from living in a tent and tending goats. Many nomad children, looking toward the future, want a fixed address.

A few days after my inquiry, workers showed up at the settlement to begin wiring the homes for electricity. Some townspeople made no effort to hide their hostility. As I left the settlement with a charity worker one afternoon, three teenage boys in slacks and sweaters jeered at us from the roof of the adjacent high school. "What are you going to do for them?" one shouted. "They are nomads, and they will always be nomads."

It was early March, and the spring harvest was almost upon Lallu and Kailashi and their clan. Wheat fields turned golden under a sun that grew hotter by the day. At their campsite in the new village, the Lohar found refuge in the shadows cast by their carts and splashed themselves cool at a nearby well.

Spring is normally a hopeful time in the Rajasthan countryside, but for Kanya this season



was filled with dread. Her parents had decided that after the Hindu festival of Akha Teej, in April, she would return to live with her husband and his family. "The boy is very bad," she had told me. She said that he and his mother had forced her to work all day on the bellows, and he'd beaten her when she resisted. But Kanya knew that divorce was unthinkable for a woman in her position. "I can't do anything," she said. "If I stay here I'll suffer. If I go there I'll suffer. It's all a matter of destiny."

Kanya's powerlessness is compounded by her gender, but it is shared to some degree by all the Lohar, whose low social standing leaves them vulnerable to the pressures and prejudices of rural India. One afternoon I turned up at the campsite to learn that the Lohar had been visited the day before by followers of the Rashtriya Swayamsevak Sangh, or RSS, India's main Hindu nationalist group. Extremists from the group had gotten wind of my presence, assumed that I was a Christian missionary, and threatened to beat me. The Lohar were plainly terrified and pleaded with me to leave.

Eventually I was able to make clear that my purpose was journalistic, not evangelical. Local RSS workers apologized and even accompanied me to meet with the Lohar, who by now had moved a second time, to a trampled pasture on the outskirts of another village. The RSS urged the Lohar to cooperate, but my relations with the blacksmiths never really recovered.

Wary from the start, they saw little reason after the trouble with the RSS to tolerate me any longer. "You give us a handful of flour, and yet you're writing so much," Kartar said, glaring. "Go now. We've had enough of you."

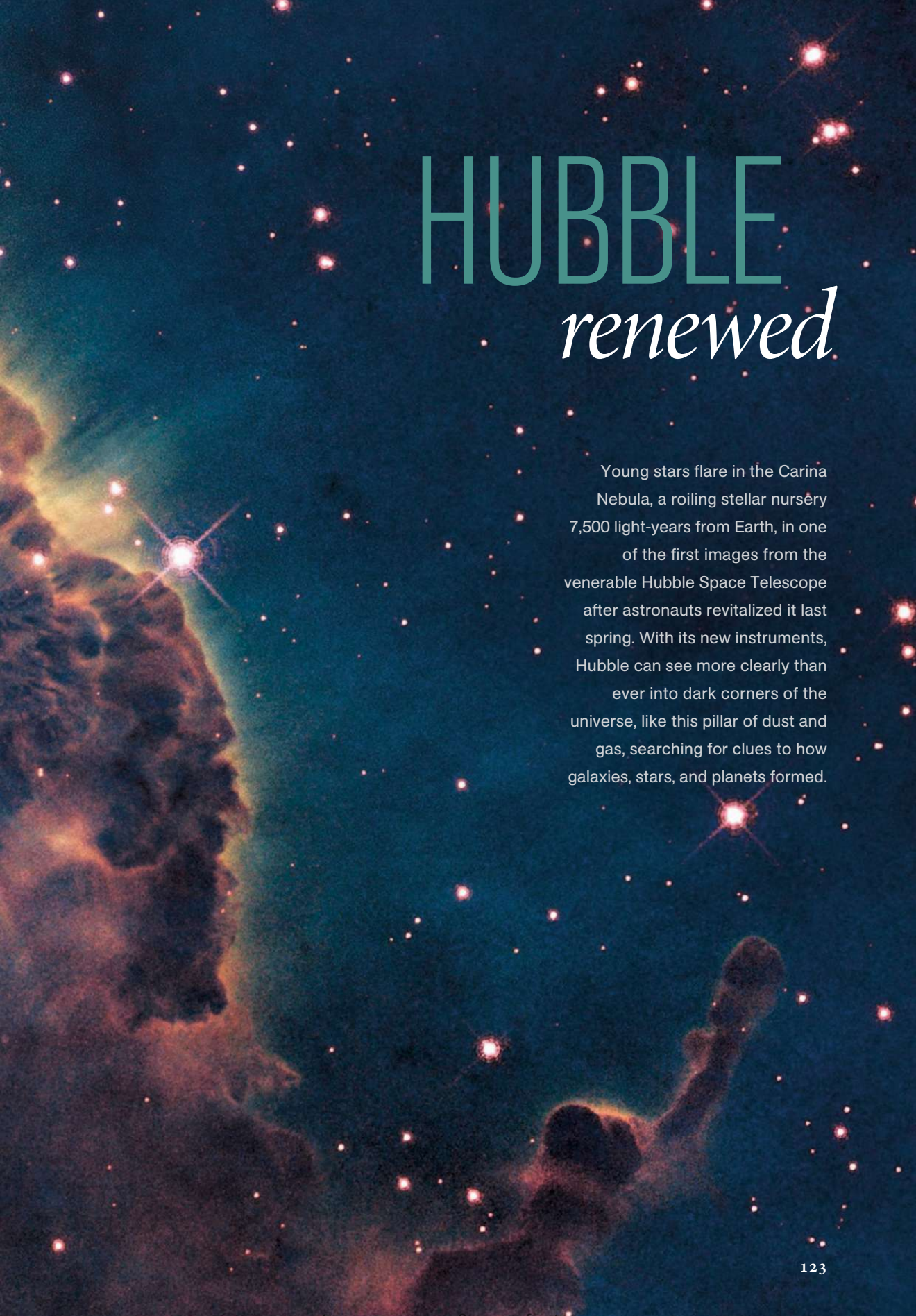
One afternoon I drove out from Jaipur in a final attempt at reconciliation. Unfortunately, Lallu and Kailashi were not around to lend support. They had taken a bus to the Rajasthan capital, where Kailashi hoped to find treatment for her chronic cough and fever. The others would hardly speak to me, and some turned their backs at my approach. I took the hint and walked back to my car. "Don't come back," Kartar shouted.

Before I drove away, I turned and looked at the Lohar for the last time. Business had dried up and their forges had all gone cold. Tomorrow, or perhaps the next day, they would pack up their carts and move on, as they had done so many times before. But for now they just looked listless and weary. They looked like travelers who had reached the end of the road. □

John Lancaster was East Asia bureau chief for the Washington Post. *Steve McCurry covered the Hazara people of Afghanistan for the February 2008 issue.*



NASA/ESA/HUBBLE SM4 ERO TEAM



HUBBLE *renewed*

Young stars flare in the Carina Nebula, a roiling stellar nursery 7,500 light-years from Earth, in one of the first images from the venerable Hubble Space Telescope after astronauts revitalized it last spring. With its new instruments, Hubble can see more clearly than ever into dark corners of the universe, like this pillar of dust and gas, searching for clues to how galaxies, stars, and planets formed.







BUTTERFLY NEBULA, 2004



2009

The long view

Last May astronauts gave the Hubble Space Telescope what will likely be its final overhaul. The team, including spacewalker John Grunsfeld (above left), on his third visit to the orbiting observatory, repaired power and control systems to give Hubble several more years of life riding high above Earth's atmospheric haze. They also installed a new camera and spectrograph and repaired two other instruments to make the telescope more productive than ever. "The best times for this telescope are ahead of it," says Hubble Project Scientist Ken Sembach of the Space Telescope Science Institute. "The public is going to be amazed."

The signature images from Hubble, which turns 20 in April, show careering galaxies, exploding stars, eerie nebulae. With the telescope's greater imaging sensitivity and resolution, its new images will be even more spectacular.

And even more profound. Soon after the upgrades, Hubble took aim at a dark patch of sky, gathering infrared light for a total of four days to detect the very faintest objects. The images reveal blurry dots, "just a handful of pixels," says Garth Illingworth, a University of California, Santa Cruz, astrophysicist. The dots, analyzed by computer to rule out camera artifacts, are images of objects that are among the most distant, and thus most ancient, ever seen—small, bloblike early galaxies shining 13.1 billion years ago. The universe itself is but 13.7 billion years old. "The new camera has pushed the frontier a few hundred million years closer to the beginning," Illingworth says. In its final years Hubble is seeing back almost to the beginning of time. —*Chris Carroll*

Massed stars in the Omega Centauri globular cluster (left) showcase the abilities of the new Wide Field Camera 3. Sensitive to a wider spectrum of light than its predecessors, it reveals blue and red giants beside yellow, sunlike stars. In the Butterfly Nebula (top center and right) the new camera shows subtler detail in gas clouds being eroded by stellar wind.

LEFT: NASA/ESA/HUBBLE SM4 ERO TEAM. ABOVE, LEFT TO RIGHT: NASA; NASA/ESA/ALBERT ZIJLSTRA, UNIVERSITY OF MANCHESTER; NASA/ESA/HUBBLE SM4 ERO TEAM



A four-way galactic pileup appears imminent, but the bluish spiral, 40 million light-years away, is seven times as close as the rest of Stephan's Quintet. (Two of the galaxies are entangled, bottom, and a fifth is out of the frame.) The distant galaxies' warm hues mean their stars are older.

NASA/ESA/HUBBLE SM4 ERO TEAM





NASA/ESA/HUBBLE SM4 ERO TEAM



In a final gust of wind, the dying star at the center of the Butterfly Nebula sweeps hot gas into lacy wings trillions of miles across. Two decades into its mission, Hubble is beaming back its deepest, most detailed views yet, drawing closer to the absolute limits of vision.



The Truth About Chimps

Virtually innocent of human contact, the chimps of Congo's Goualougo Triangle display a sharp curiosity about us—and a sophisticated culture of toolmaking observed nowhere else.

As rain falls in Nouabalé-Ndoki National Park, a chimp adds to the chorus of excited calls ringing through the forest.





In pursuit of honey, a chimpanzee works to smash open a beehive in the crevice of a tree. It takes her nearly 40 minutes, using a half dozen sticks of varying sizes, to crack the hive. Such “honey pounding” is a learned behavior and hasn’t been observed outside central Africa.

By Joshua Foer
Photographs by Ian Nichols



A FEW YEARS AGO, while setting up camp deep in the Congolese rain forest, Dave Morgan and Crickette Sanz heard a party of male chimpanzees vocalizing raucously in the distance. The hoots grew louder, and they could tell the group was moving rapidly through the canopy.

The chimps, they realized, were headed straight for their camp and would soon be nearly on top of them. Then, just as the group seemed to be closing its distance to a few dozen yards, the forest went silent. A few seconds passed before Sanz and Morgan heard a gentle *hoo* from a tree almost directly above them. They looked up and saw a perplexed adult chimp peering down.

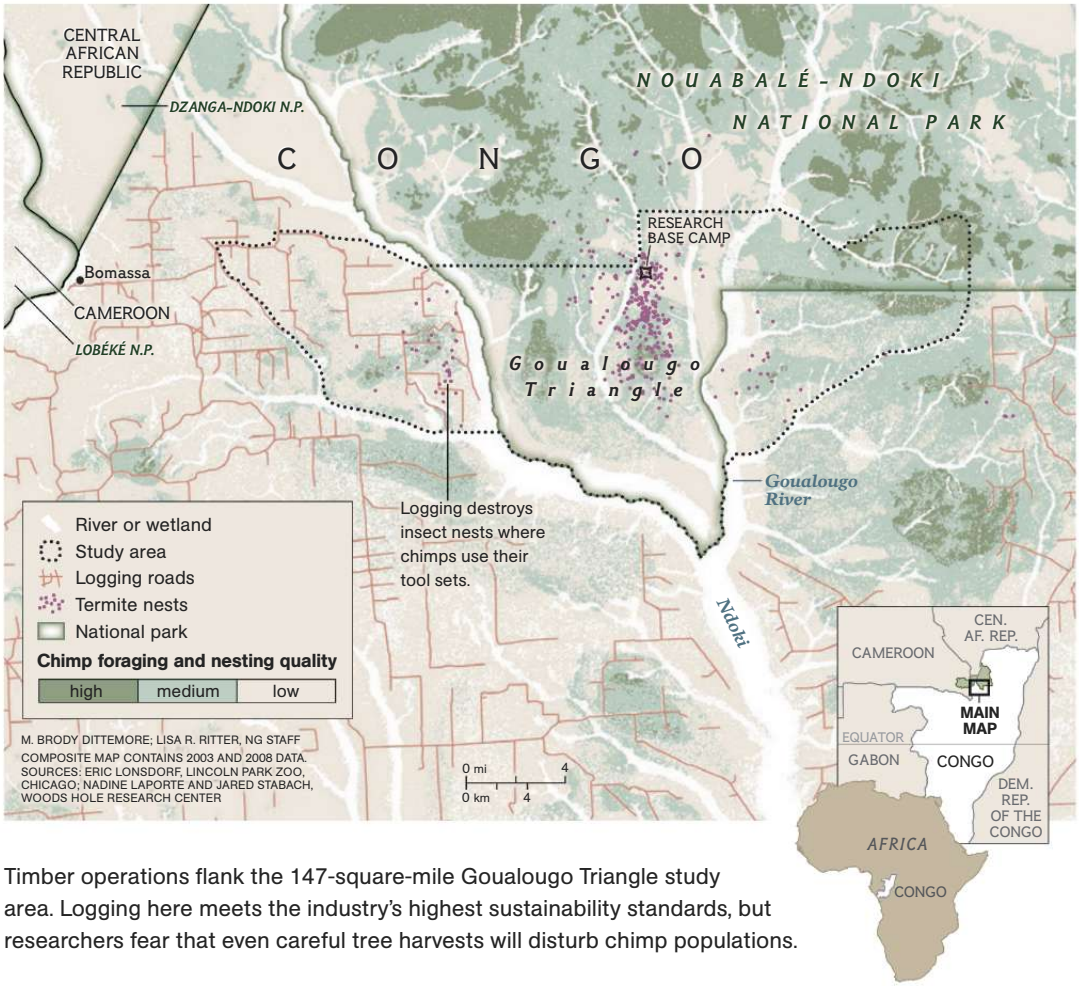
When wild chimps encounter humans, they typically flee in panic—understandable given that the relationship between our two species has often been one of prey and predator. This reticence around humans is part of what makes wild chimp research so difficult. Before the animals can ever be studied, they must learn not to bolt at the sight of a person, a process of habituation that requires many years of diligently trailing the animals around the forest.

One thing unhabituated chimps aren't ever expected to do when they run into humans is call over all their buddies. But that's exactly what happened. Another chimp showed up a moment later. Then a third. Then a fourth. Manic yelping enveloped the canopy. Morgan and Sanz may have been the scientists, but it was the chimps who were behaving as if they'd made some great discovery. The party sat on limbs above the camp all evening, watching excitedly as a fire was started, tents were pitched, and dinner was prepared.

"I thought, This is what loggers must have seen all through central Africa, and poachers shot them all," says Morgan, 40, a conservation fellow with Lincoln Park Zoo and the Wildlife



After morning feeding, sated chimps from the Moto community socialize in the canopy. Foraging groups change in size and composition hourly. Fruiting trees can bring together individuals who haven't seen each other for weeks.



Timber operations flank the 147-square-mile Goualougo Triangle study area. Logging here meets the industry's highest sustainability standards, but researchers fear that even careful tree harvests will disturb chimp populations.

Conservation Society (WCS). Morgan has spent the better part of the past ten years living with Sanz in the Goualougo Triangle study area, a pristine 147-square-mile nub of lowland forest overlapping the Ndoki and Goualougo Rivers in northern Republic of the Congo. He and Sanz were awed by the close encounter, but they began to wonder when it might end. It was getting dark. Where were the chimps going to nest?

"Sure enough, they built their nests directly over our tents," says Morgan. "I was like, This is great! But our trackers were like, No way, man, this is very bad news." All night long, the chimps hollered from the trees, shook branches, urinated and defecated on the tents, and hurled sticks at the team. Nobody slept. At daybreak the chimps came down from their perches and watched from the forest floor as the group built up the fire and made breakfast. Then, quietly, one by one, the chimps slunk away and vanished into the thick underbrush.

When tales of the "curious" chimps of northern Congo—uncorrupted by misdealings with humans and apparently fully ignorant of our existence—were first reported in this magazine in

Morgan and Sanz may have been the scientists, but it was the chimps who were behaving as if they'd made a discovery.

1995, more than a few primatologists scoffed. "People were like, Curiosity: Hmmm, how do you define that?" says Sanz, 34, now a professor at Washington University in St. Louis. "Poor Dave, when he first told me about these chimps, even I didn't believe him." Though there had long been scattered anecdotes of fearless central African apes who trailed explorers around the jungle and behaved as if they'd never seen a human before, it beggared belief that there could be an entire forest full of them.

Yet the Goualougo Triangle and the vast, uninhabited Nouabalé-Ndoki National Park, of which the Goualougo is a part, are so remote and inaccessible that they have remained virtually untouched by humanity. The nearest settlement, a 400-person Bantu-Bangombé Pygmy village called Bomassa, is a 30-mile trek away. There are no poachers here, no loggers, nobody even wandering through. The only people a chimp in the Goualougo might ever have a chance of crossing paths with are Morgan, Sanz, and members of their small team.

Originally WCS, which co-manages two of Congo's national parks with the Congolese government, had hoped to leave the Goualougo Triangle completely untouched as a kind of preserve within the preserve, off-limits even to the corrupting influence of science. But that calculation changed during Congo's 1997 civil war, when Congolaise Industrielle des Bois (CIB), the forestry company with logging rights in the neighboring Kabo concession, built a levee for transporting lumber across the Ndoki River a few miles south of its confluence with the Goualougo. Since CIB would soon be brushing up against the triangle's natural borders, WCS felt that it was critical to put some boots on the ground. "We had to beat the logging companies in here," says Morgan. In 1999 he hiked out to the Goualougo with a single Congolese assistant and set up one of the most remote great ape research sites in the world.

That Morgan was able to persevere out in the middle of nowhere, with spartan accommodations and minimal logistical support, had a lot to do with Sanz, who came out to the Goualougo in 2001 and has been his partner in both science and life ever since.

When I visited the triangle in 2008, I wanted to see what had become of this Eden and its supposedly guileless inhabitants. The Goualougo remains a primate wonderland, with an astounding density of both gorillas and chimps. Things that haven't been observed anywhere else in Africa happen here—and often. Morgan and Sanz have watched chimps and gorillas nibble on fruit in the very same tree. (Not quite the lion lying down with the lamb, but for primatologists, just as bizarre.) They've seen chimps cup their hands and beat their chests, as if mimicking their gorilla neighbors. But the most spectacular finding to come out of the Goualougo over the past several years is an expanded view of what can only be called chimp culture, a tradition of using complex "tool kits." After a decade of determined study by Morgan and Sanz, the story of the Goualougo is no longer how little the chimps know of us, but rather how much we now know of them.

On a sticky September morning at the front end of the Congo's rainy season, Morgan, Sanz, and I leave the Goualougo base camp at dawn with our tracker Bosco Mangoussou and begin marching down one of the well-worn elephant trails carved into the forest. The sun has barely broken through the canopy, but already swarms of stingless Meliponini sweat bees are clinging to any piece of exposed flesh not coated with menthol balm. Our route regularly slaloms around patties of elephant dung and heaps of rotting fruit, whose pungent aromas permeate the humid air. It is the immense variety of those fruits—more than two dozen edible species ranging from

Joshua Foer is co-founder of Atlas Obscura, an online compendium of curiosities and esoterica. Ian Nichols is a wildlife photographer based in Virginia.





Tool Craft

To fish for a high-protein snack, a male chimp has arrived at a termite mound carrying a fishing probe and puncturing stick. Though termite fishing has been observed in chimp populations throughout Africa, the chimps of the Goualougo have their own set of tricks passed from generation to generation. The chimp has ripped a hard, straight stick from a tree (for the puncturing stick, left). In his mouth he holds a softer stem he has prepared by pulling its end through his teeth to split the last six inches into a fringe. He uses the bigger stick to puncture the termite mound (right, top and middle). Finally, he threads the second tool into the hole and, if he has executed the strategy properly, bugs will be clinging to the bristles when he pulls the probe out of the mound (bottom right).









Primatologists Dave Morgan and Crickette Sanz examine tools their subjects use to secure food. Chimps agitate underground safari ant nests with long saplings like these, then use stems to collect insects forced to the surface.

pumpkin-size *Treculia africana* to rubbery, softball-size *Chrysophyllum lacourtiana*—that makes the Goualougo such an attractive habitat for chimps. Our destination this morning is the primary range of the Moto community, one of 14 distinct chimp groups that call the Goualougo Triangle home.

Periodically the sound of a distant pant-hoot pierces the forest. When that happens, Morgan sets the bearings on his compass and we tear off on a sprint through prickly brambles and knobby lianas. Mangoussou, a Babenzélé Pygmy who stands barely five feet tall and has a mouthful of teeth chiseled to sharp points, leads the way, sometimes slowing to clip a path through the understory with a pair of gardening shears. After one five-minute dash, we spot a half dozen chimps lounging in an *Entandrophragma* tree about 130 feet off the ground.

We watch through binoculars as a puckish subadult female, a new immigrant to the Moto community, horses around with Owen, a juvenile orphan whose mother was recently killed by a leopard. With a small twig clenched between her teeth, the female (Morgan and Sanz later generously named her Dinah, after my wife) chases after Owen and wrestles him onto a

Part of what makes Dinah's behavior so intriguing is that she used two different kinds of tools in sequence.

nearby limb. Then something remarkable happens that has almost never been observed outside of the Goualougo.

Dinah spies a cloud of sweat bees emerging from a hole near the main trunk of the tree. She leaps to her feet, leaves Owen behind, and breaks off a branch about as thick and long as a human arm. With the blunt end she begins whaling away at the bark. She knows that somewhere inside a hard-to-access crevice is a hive with a small cache of honey.

Dinah's rhythmic thumping echoes loudly off the surrounding trees. She transfers the club to her foot and swings around to the other side of the trunk to get a better angle. Then she rips a small twig off a nearby branch, dips it into the hive, and swirls it around like a knife at the bottom of a peanut butter jar. She pulls it out, sniffs it, realizes there's no honey on it, throws it away, and starts pounding some more. She repeats the process, running through seven different dipping sticks. Finally, after nearly 12 minutes of hammering at the disobliging hive, she plunges her finger into a crack and seems to yank out the slightest bit of honey, which goes straight into her mouth. But just as she is beginning to enjoy the fruits of her labor, Finn, the Moto community's alpha male and resident bully, descends from a nearby branch with his hair standing on end, seemingly outraged that a young upstart is enjoying a sugary delicacy in his presence. He lunges at Dinah, who drops her club and flees to another limb. Morgan and Sanz exchange high fives. "That's one of the best honey-pounding observations anyone has ever had!" Sanz exclaims gleefully.

The fact that honey pounding hasn't been observed at other chimp research sites outside of central Africa suggests that it is not part of the species' innate behavioral repertoire, but rather is a learned skill that has been culturally transmitted. Part of what makes Dinah's behavior so intriguing is that she used two different kinds of tools—a big club and a thin twig—in sequence to accomplish her goal.

This isn't the only form of serial tool use common in the Goualougo. At the exact moment that we are watching Dinah attack the beehive, a camera trap set up near a termite mound half a mile away records another female chimp named Maya, a matron of the Moto community, engaging in what may be the most sophisticated form of serial tool use by any nonhuman animal.

Maya arrives at the termite mound, a rock-hard, bulbous structure three times her height, carrying in her mouth several plant stems that she will use to fish out its high-calorie occupants. First she rams a thick twig into a termite hole and widens it by jiggling the stick vigorously. Then she grabs a thin, flexible stem that she plucked off a nearby *Sarcophrynium* plant. Chimps in other parts of Africa are known to fish for termites with implements like this, but Maya goes one step further and modifies the tool. She drags the last six inches of the stem through her teeth to create a wet, frayed end, like a paintbrush, and pulls it through her closed fist to straighten out the bristles. With the dexterity of a professional lock picker, she then threads the brush-tipped stem into the same hole, pulls it out, and nibbles off a couple bugs that cling to the wand's frayed edges.

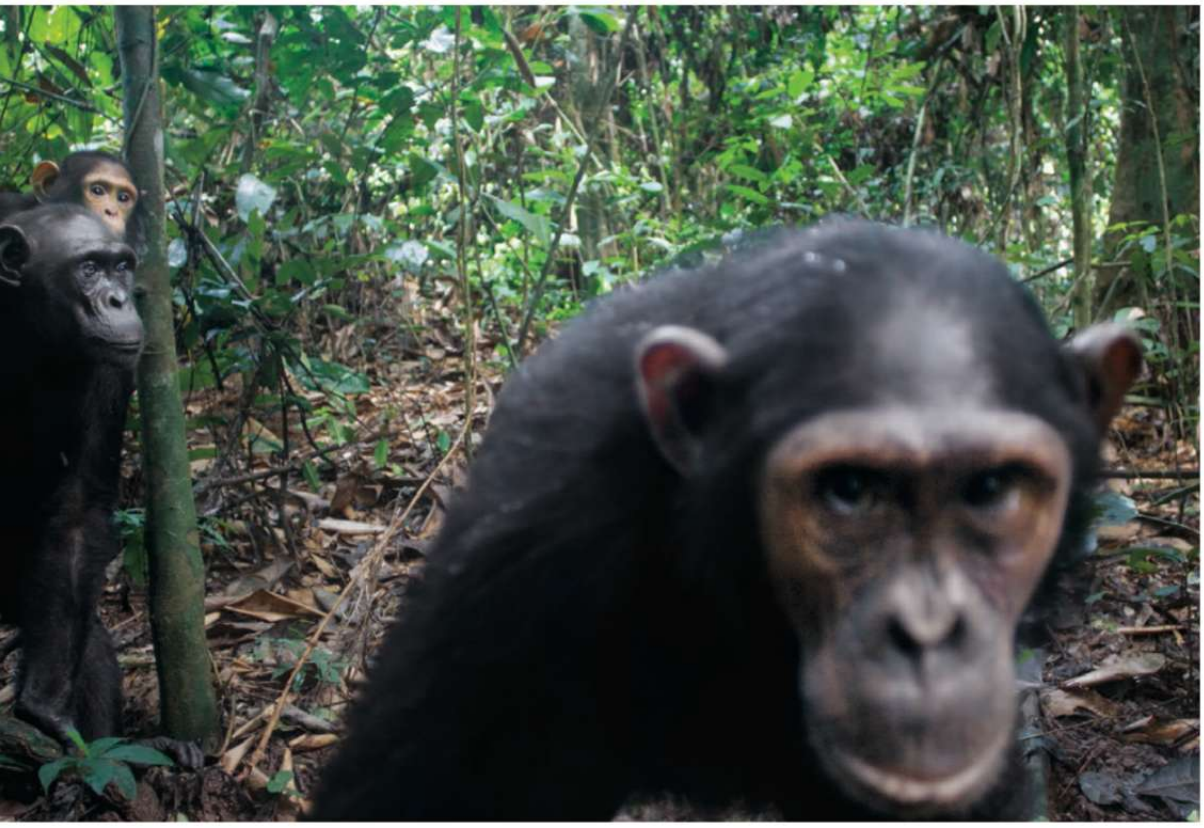
What's so remarkable about that fishing probe is that it represents a refinement. It's not just that some clever chimp figured out that it could break off a plant stem and use it to fish for termites—an impressive enough discovery in its own right—it's that some other chimp figured out a way to do it even better. And the brush tip is not merely a trivial upgrade. Morgan and Sanz have tried termite fishing themselves with both brush-tipped and unmodified sticks and found that they picked up ten times more termites with the frayed tool. Without a time machine, we'll never know how human culture began, but it must have looked something like this: one simple discovery building on another.

"The Goualougo is probably the only place on Earth where humans will ever have the





With her infant clinging to her belly, a female saunters up a fig-tree limb 130 feet above the ground. This forest, with its dense canopy, is home for hundreds of chimps—here they find food, shelter, and community as well as elevated routes for moving freely throughout their range.



A small party of chimps triggers a remote video camera that researchers use to observe subjects without influencing behavior. A decade of study in this pristine habitat has yielded new insights into the complexity of chimpanzee culture.

chance to see what chimpanzee culture is really about," says J. Michael Fay, the WCS conservationist who helped set up the Nouabalé-Ndoki Park. "Ninety-five percent of chimps on Earth don't live like this because of humans." In the Kibale National Park and Budongo Forest Reserve, two of the most important chimp study sites in Uganda, about a quarter of the population has snare wounds. At Gombe, the site in Tanzania pioneered by Jane Goodall, there are only about a hundred chimps left, and they are surrounded by humans.

This is a powerful and troubling notion: What if everywhere scientists have thought they were observing chimps in their natural state, they've actually been studying behavior distorted by the presence of humans?

Chimps are highly adaptive creatures. They can get along just as well in the forests of Congo as on the dry savanna fringes of Senegal. But according to the fragile-cultures hypothesis, first proposed by the Dutch primatologist Carel van Schaik, we may be radically underestimating just how fragile chimp culture is. Humans don't necessarily have to be clear-cutting forests for our presence to distort primate behavior. Even selective logging and casual hunting can throw chimp society into disarray if it

What if other scientists observing chimps have actually been studying behavior distorted by the presence of humans?

pushes groups into conflict or decreases the number of termite mounds where they can fish.

Morgan and Sanz have put forth a powerful hypothesis: With fewer mounds and, therefore, fewer opportunities for young chimps to learn tool techniques from their elders, chimp culture may slowly attenuate, and complex learned behaviors may disappear. The pair will soon have an opportunity to test their hypothesis. In the next few years, CIB will probably begin logging operations in a sector of forest just east of the Goualougo River dubbed Zone C. In anticipation, the research team has been conducting rigorous line-transect studies in Zone C since 2002 in order to get a clear before-and-after picture of how logging affects chimp behavior.

Zone D, an area west of the triangle that CIB began logging five years ago, offers a preview of what might happen in Zone C. "This was beautiful forest in 2004," says Morgan dolefully, as we step from our pirogues onto the dry land of Zone D. It is clear that we've entered an entirely different environment. We cross muddy logging road after muddy logging road, some as wide as a two-lane boulevard, lined with upturned roots and rotting offcuts.

CIB's logging operation meets the logging industry's most demanding standards for sustainability and environmental responsibility. "They're the best logging company in central Africa," says Paul Telfer, head of the WCS Congo program. "I'd prefer no logging at all, but if you're going to have a logging company next to a park, you'd want it to be CIB."

Still, the landscape has been selectively ravaged, and the chimps are nowhere to be found. Just six years ago, the apes that Morgan and Sanz found in Zone D were mostly naive. Now when they catch wind of humans, they hide or flee. They've learned to fear us.

Most of the 400-odd chimps that Morgan and Sanz have encountered in the Goualougo no longer display the same sense of curiosity they once did. The more time the researchers spend there, and the more they demystify the wonders of this primal forest, the rarer their naive encounters have become. To study and conserve these chimps inevitably means changing them.

Yet the triangle is just one small corner of a vast, virtually unexplored forest. Before leaving the Goualougo, I trek out to its very southern tip with Morgan and Sanz to spend two nights camping in the home range of the Mayele community, near the juncture of the Goualougo and Ndoki Rivers. Here, in a part of the forest that Morgan and Sanz only occasionally visit, we encounter a naive chimp.

As soon as he sees us, he begins screaming hysterically, ducking between branches to get a better look. Morgan puts down his backpack and quietly pulls out a spotting scope, the kind that a hunter might use to pick off a deer from 300 yards, and uses it to get a closer look. "That chimpanzee has never seen a human before," he tells me.

The young male whips a liana around violently in a display of youthful bluster, then hurls a few sticks in our direction to see how we'll respond. Before long, his calls attract others, and a total of seven chimps join him on the limbs above us, all raptly watching the hairless, upright apes on the forest floor. We might as well be from outer space.

Cautiously, and without averting their gazes, the chimps inch ever nearer to us until finally the youngest one is sitting on a branch not ten yards away. Sanz hands us each a surgical mask—to protect the chimp, not us.

"Talk about maladaptive behavior," Morgan whispers, with a chuckle. We back off a bit and spend the next several hours with our eyes locked on theirs: Us watching them watch us watch them. Eventually we have to move on. There's more forest to explore, more chimps to find. Our curiosity gives out before theirs does. ▯

Society Grant This project was funded in part by your National Geographic Society membership.

INSIDE GEOGRAPHIC



ON ASSIGNMENT **Small Worlds** It was buried in the pages of E. O. Wilson's book *Biophilia* that photographer David Liittschwager found a fascinating phrase: "It is possible to spend a lifetime in a magellanic voyage around the trunk of a single tree." This idea—of intensely studying a tightly focused ecosystem—propelled Liittschwager to explore one cubic foot of life in different habitats across the globe. Each sample had its wonders. South Africa's beguiling, bug-eating sundew plant (above, with Liittschwager) was especially captivating. "It's a beautiful magenta flower," he explains, "with the carcasses of 40 insects on one rosette."

IN MEMORIAM **Des Bartlett** In 1992 *National Geographic* published "Africa's Skeleton Coast," by Des Bartlett (below, on assignment) and his wife, Jen—one of many contributions the Australian couple made to this magazine and to the film industry during their 53 years of marriage. A pioneer in documenting Namibia's natural history, Des died in September. Says friend and colleague Frans Lanting, "Des had great modesty, yet he was a hero and mentor to a generation of filmmakers and photographers."



Society Updates

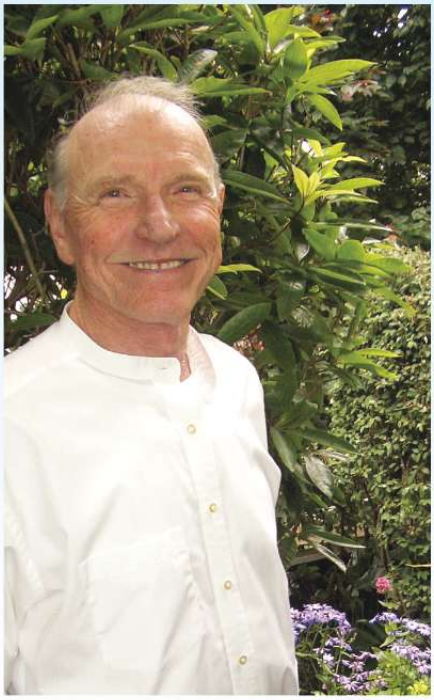
NG CHANNEL
Watch as a Navy SEAL and law enforcement officers test their limits in *Fight Science,* a series debuting this month on the National Geographic Channel.

NG BOOKS
The *Complete National Parks of the United States,* by frequent *Geographic* contributor Mel White, serves as both a travel planner and a resource guide, featuring 400-plus parks, monuments, battlefields, scenic trails, and more ($40).

GeoPuzzle Answers



PHOTOS: ANAND VARMA (TOP); DES AND JEN BARTLETT, NATIONAL GEOGRAPHIC STOCK



John-Joseph van Haelewyn

John McCallister included National Geographic in his estate plans.

Inspire Future Generations

An avid traveler and horticulturist, John McCallister was introduced to National Geographic when his aunt sent him a gift subscription to the magazine in the 1940s. "I like everything about National Geographic, what it stands for, and what it accomplishes," John says.

Now retired, John spends his time taking continuing education classes, landscaping his garden, and frequenting art museums, theatre performances, and concerts. John made a bequest gift as a way to support the things he holds dear. "I included National Geographic in my will because I want the Society to be around for future generations," he says.

For more information about how to include us in your estate plans, or to let us know that you have already done so, please contact the Office of Estate Planning.

NATIONAL GEOGRAPHIC

Office of Estate Planning
1145 17th Street NW
Washington, DC 20036

(800) 226 - 4438
plannedgiftinfo@ngs.org
www.nationalgeographic.org/donate

THE GARDINER GREENE HUBBARD SOCIETY
Est 1904
NATIONAL GEOGRAPHIC

The National Geographic Society is a 501(c)(3), tax-exempt organization.

Charitable Gift Annuities may not be available in every state. Please call for availability.

Card to cut off and mail in

- ◯ Yes! Please send me information on how to include National Geographic in my will
- ◯ I have already included National Geographic in my will
- ◯ Please send me information on a National Geographic charitable gift annuity

Birthdate(s) _____

Minimum age 45. *Payments begin at age 65*

Name _____

Address _____

_____

Phone _____

Email _____

Mail to: National Geographic Office of Estate Planning
1145 17th Street NW, Washington, DC 20036

FLASHBACK

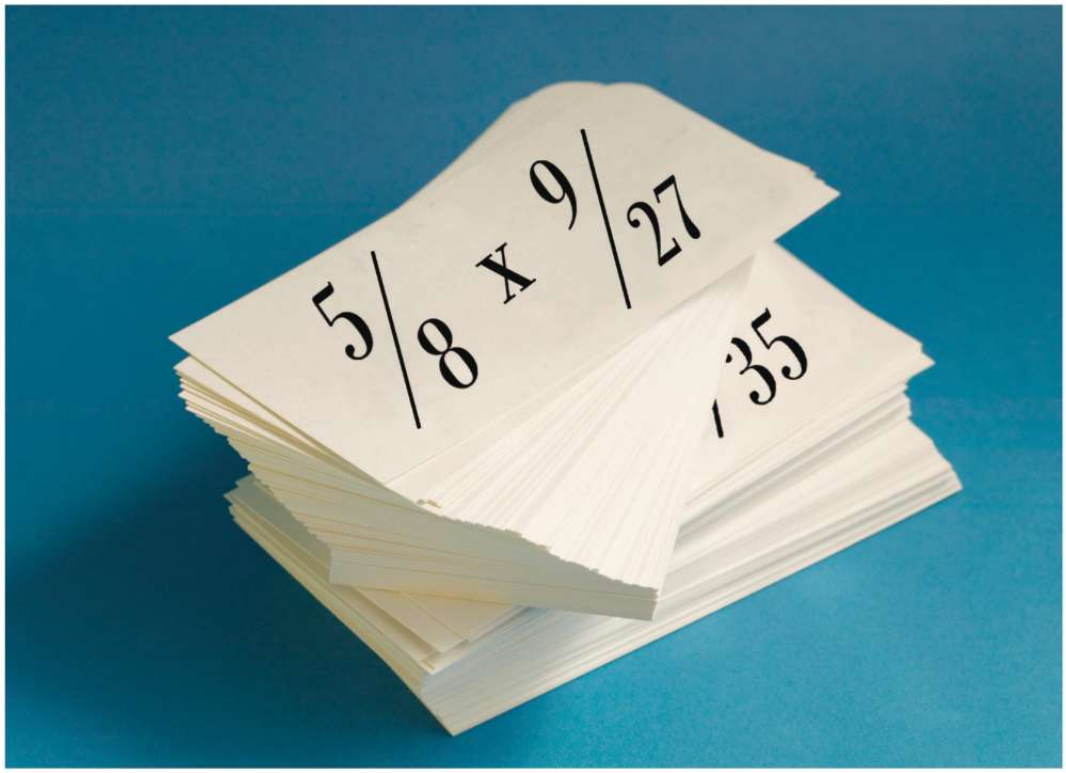


Family Portrait "Apachie women and their white husban Arizonia 1879," notes the handwritten caption for this hand-colored portrait. That same year the U.S. Supreme Court upheld a ruling against polygamy. "Everything there has changed," wrote T. S. Hitchcock, a retired dentist, who submitted this photo (and others likely acquired during his travels) to the *Geographic* in 1917. An editor responded that the unsolicited images "of course are not suitable for publication." —*Margaret G. Zackowitz*

Flashback Archive Find all the photos at **ngm.com.**

PHOTO: T. S. HITCHCOCK, NATIONAL GEOGRAPHIC STOCK

NATIONAL GEOGRAPHIC (ISSN 0027-9358) PUBLISHED MONTHLY BY THE NATIONAL GEOGRAPHIC SOCIETY, 1145 17TH ST. NW, WASHINGTON, DC 20036. ONE YEAR MEMBERSHIP: $34.00 U.S. DELIVERY, $38.00 TO CANADA, $49.50 TO INTERNATIONAL ADDRESSES. SINGLE ISSUE: $7.00 U.S. DELIVERY, $10.00 CANADA, $15.00 INTERNATIONAL. (ALL PRICES IN U.S. FUNDS; INCLUDES SHIPPING AND HANDLING.) PERIODICALS POSTAGE PAID AT WASHINGTON, DC, AND ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NATIONAL GEOGRAPHIC, PO BOX 63002, TAMPA, FL 33663. IN CANADA, AGREEMENT NUMBER 40063649, RETURN UNDELIVERABLE ADDRESSES TO NATIONAL GEOGRAPHIC, PO BOX 4412 STN. A, TORONTO, ONTARIO M5W 3W2. UNITED KINGDOM NEWSSTAND PRICE £4.99. REPR. EN FRANCE: EMD FRANCE SA, BP 1029, 59011 LILLE CEDEX; TEL. 320.300.302; CPPAP 0710U89037; DIRECTEUR PUBLICATION: D. TASSINARI DIR. RESP. ITALY; RAPP IMD SRL, VIA G. DA VELATE 11, 20162 MILANO; AUT. TRIB. MI 258 26/5/84 POSTE ITALIANE SPA; SPED. ABB. POST. DL 353/2003 (CONV L.27/02/2004 N.46) ART 1 C. 1 DCB MILANO STAMPA QUAD/GRAPHICS, MARTINSBURG, WV 25401. MEMBERS: IF THE POSTAL SERVICE ALERTS US THAT YOUR MAGAZINE IS UNDELIVERABLE, WE HAVE NO FURTHER OBLIGATION UNLESS WE RECEIVE A CORRECTED ADDRESS WITHIN TWO YEARS.



© Corbis 6 Productions/Brand X Corbis

The Basics of Math—Made Clear

Basic Math introduces students to the fundamental concepts of mathematics, as well as those of more complicated areas. These 30 engaging lectures provide students with an understanding of arithmetic and prepare them for the challenges of Algebra I and beyond. Professor Murray H. Siegel—honored by Kentucky Educational Television as "the best math teacher in America"—has a gift for explaining mathematical concepts in ways that make them seem clear and obvious rather than arbitrary and murky.

These lectures are arranged sequentially to allow for a logical development of the material and cover topics such as: whole numbers, fractions, decimals, integers, percents, exponents, the order of operations, and square roots. In addition to learning how to perform various mathematical operations, students discover *why* these operations work and *how* they can be used practically. By the conclusion of **Basic Math**, students will have improved their understanding of basic math, will have cleared away the mystery behind mathematics, will be able to face their studies with more confidence than they ever imagined, and will have strengthened their ability to accept new and exciting mathematical challenges.

This course is one of The Great Courses®, a noncredit, recorded college lecture series from The Teaching Company®. Award-winning professors of a wide array of subjects in the sciences and the liberal arts have made more than 300 college-level courses that are available now on our website.

Basic Math

Taught by Professor Murray H. Siegel, Central Arizona College

Lecture Titles

1. Introduction and a Review of Addition and Subtraction
2. Multiplication and Division
3. Long Division
4. Introduction to Fractions
5. Adding Fractions
6. Subtracting Fractions
7. Multiplying Fractions
8. Dividing Fractions, Plus a Review of Fractions
9. Adding and Subtracting Decimals
10. Multiplying and Dividing Decimals
11. Using the Calculator
12. Fractions, Decimals, and Percents
13. Percent Problems
14. Ratios and Proportions
15. Exponents and the Order of Operations
16. Adding and Subtracting Integers
17. Multiplication and Division of Integers, and an Introduction to Square Roots
18. Negative and Fractional Powers
19. Geometry I
20. Geometry II
21. Graphing in the Coordinate Plane
22. Number Theory
23. Number Patterns I
24. Number Patterns II
25. Statistics
26. Probability
27. Measurement
28. Problem-Solving Techniques
29. Solving Simple Equations
30. Introduction to Algebra I

Order Today!
Offer expires Saturday, March 27, 2010

ACT NOW!

1-800-TEACH-12
www.TEACH12.com/3ng

Basic Math
Course No. 104
30 lectures (30 minutes/lectures)

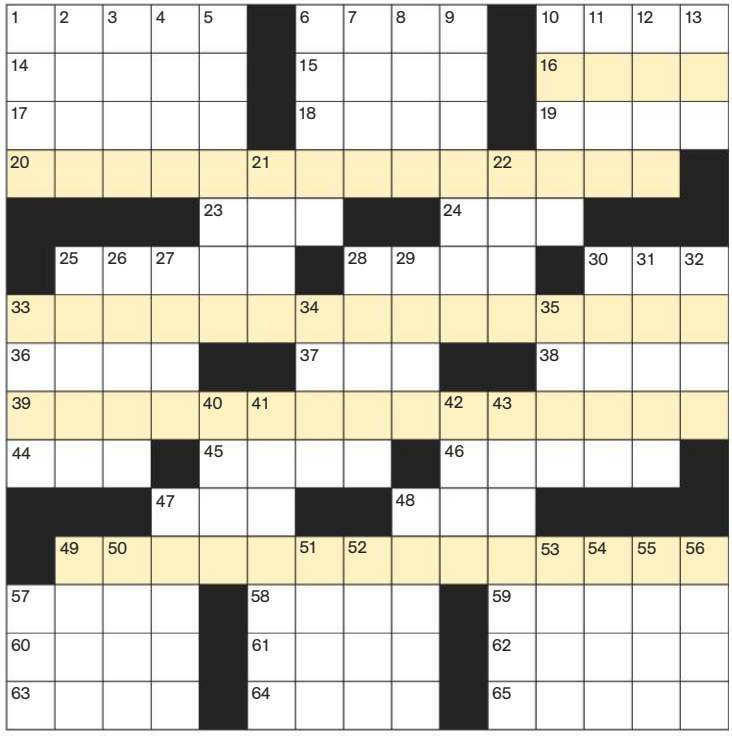
DVDs ~~$254.95~~ NOW $79.95

+ $15 Shipping, Processing, and Lifetime Satisfaction Guarantee

Priority Code: 38827

The Teaching Company®
The Joy of Lifelong Learning Every Day®
Great Professors, Great Courses, Great Value Guaranteed.®

GEOPUZZLE





Clever Chimps

Puzzle by Cathy Allis

Chimpanzees usually flee from humans. Not in the Republic of the Congo. Chimps in the remote Goualougo Triangle hang with humans—a boon for researchers (story, page 130). Tinted clues touch on the ingenuity of those chimps.

ACROSS

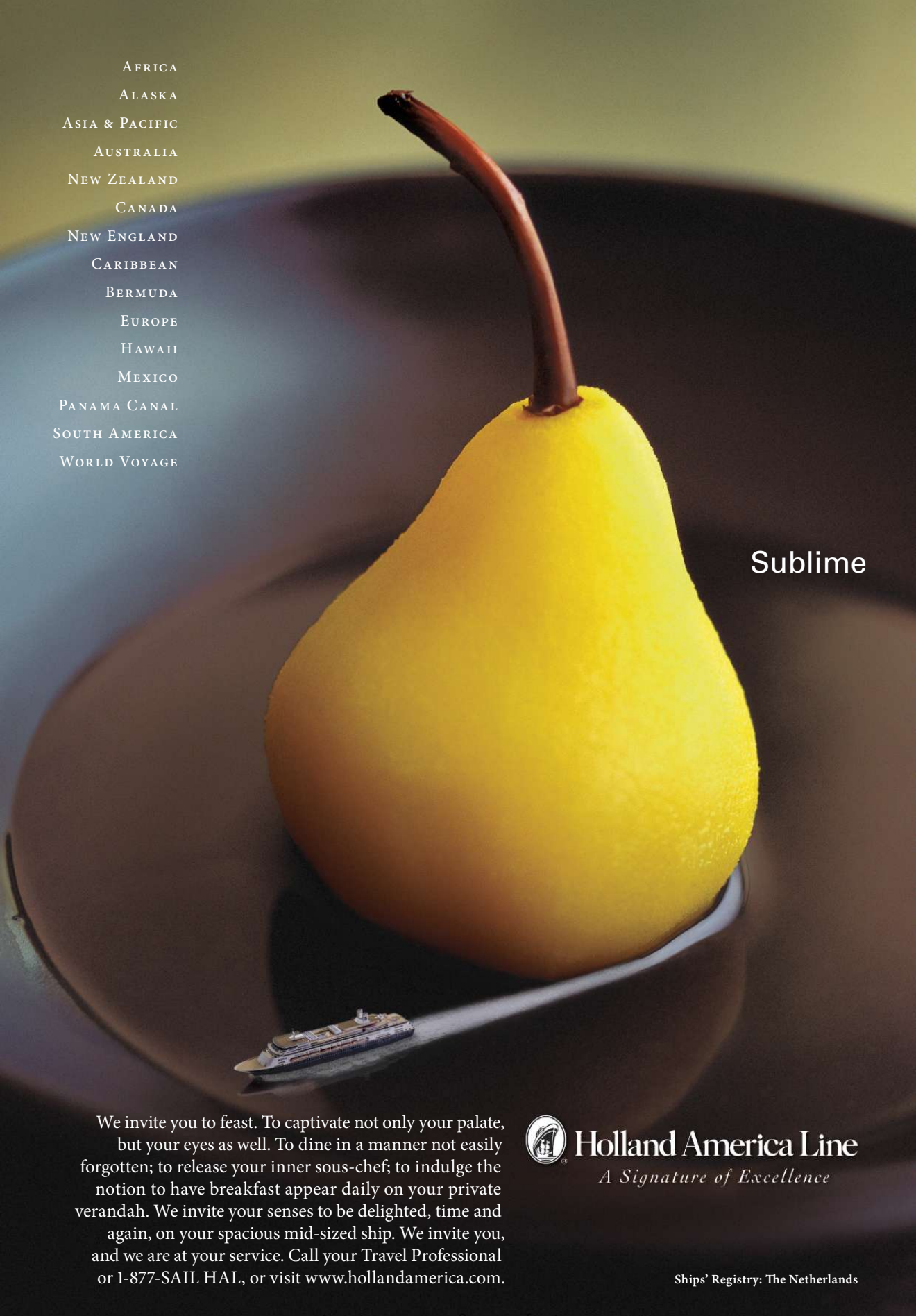
1 Plug on a book jacket
6 Attempt
10 "Yo!" quietly
14 Edmonton skater
15 Etna ejecta
16 Goualougo researchers observed that chimps did this vis-à-vis gorillas
17 Frenzy
18 Age after Bronze
19 Cornfield clamor
20 Goualougo chimps, while pounding tree trunks to dislodge honey?
23 *Eloise* creator Thompson
24 Beatty of film and TV
25 Archetype
28 Swimming trumpeter
30 __ Canals (Great Lakes passageways)
33 What the chimps do to refine the honey-extracting process of 20 across?
36 Abu Dhabi denizen
37 Alley-__ (type of basketball pass)
38 *Julie & Julia* writer-director Ephron
39 Is captured, as a termite by a Goualougo chimp's specially modified plant stem?
44 Percent suffix
45 Chimps do this in trees
46 Winds down in the pit?
47 202.5 deg. compass pt.
48 Letters on mil. addresses
49 Help preserve the Goualougo chimp habitat?
57 Touched down
58 Pizzazz
59 Emcee's opening
60 Machu Picchu land
61 River of Leeds
62 Persist in bothering
63 "Your food's finished being zapped!"
64 Pocket-watch chains
65 Priest's scarf

DOWN

1 Lead balloon
2 Perjurer
3 Bone under one's watch
4 It's a bit controlling?
5 Shelf support
6 Slug-ish?
7 Margaret Mitchell's version didn't have columns
8 The Bard's river
9 Way a wild chimp might go?
10 Walked worriedly
11 Trade jabs or gibes
12 Bastes waists, e.g.
13 QB's goals
21 It's sure no circle of hell?
22 Well-mannered fella
25 Gourmet wild mushroom
26 Egg-shaped
27 Eugene in union history
28 Filming session
29 Was lachrymose
30 Work by Richard Rodgers
31 Stew-thickening pods
32 Start of "The Star-Spangled Banner"
33 Visiting Nativity trio
34 Playgroup group
35 Stats, e.g.
40 Watson : Dr. :: Lestrade : __
41 It's good to turn over
42 Pueblo person
43 Trees whence some keys
47 Framing job
48 *Bewitched* actress Moorehead
49 Kandinsky colleague at the Bauhaus school
50 Ireland, Gaelic-style
51 Medley
52 You don it
53 Flying pest
54 Due, cubed
55 Eurasia's __ Mountains
56 Grocery bag, perhaps
57 Police dept. dispatch

Answers in Inside Geographic

PHOTO: IAN NICHOLS



We invite you to feast. To captivate not only your palate, but your eyes as well. To dine in a manner not easily forgotten; to release your inner sous-chef; to indulge the notion to have breakfast appear daily on your private verandah. We invite your senses to be delighted, time and again, on your spacious mid-sized ship. We invite you, and we are at your service. Call your Travel Professional or 1-877-SAIL HAL, or visit www.hollandamerica.com.

Holland America Line

A Signature of Excellence

Ships' Registry: The Netherlands