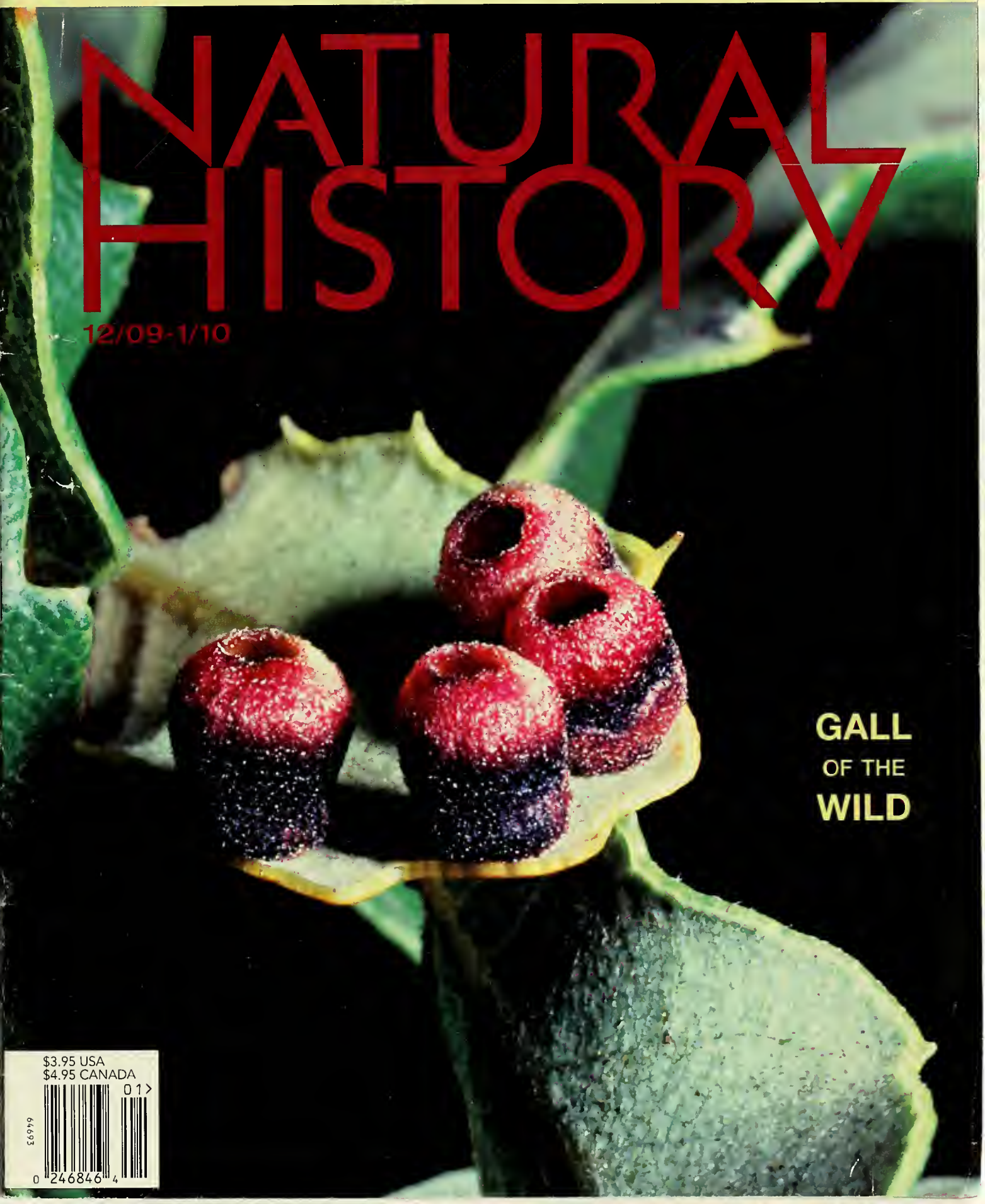
THE TELESCOPE MAN • ST. CUTHBERT'S CRINOIDS • A GOOD TERN

NATURAL HISTORY

12/09-1/10



GALL OF THE WILD

$3.95 USA
$4.95 CANADA
01>
0 246846 4
64693

ED VIESTURS

High-altitude mountaineer.
Eco-conscious philanthropist.
Summited the world's 14 tallest
peaks, without supplemental oxygen.
A man on a mission.
Obviously, he's not out of breath.

ROLEX. A CROWN FOR EVERY ACHIEVEMENT.

OYSTER PERPETUAL EXPLORER II

ROLEX
ROLEX.COM

FOR AN OFFICIAL ROLEX JEWELER CALL 1-800-367-6539. ROLEX ® OYSTER PERPETUAL AND EXPLORER II ARE TRADEMARKS.
NEW YORK

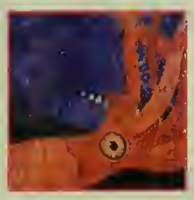
NATURAL HISTORY

www.naturalhistorymag.com

DECEMBER 2009 / JANUARY 2010 VOLUME 118 NUMBER 10

FEATURES

DEPARTMENTS



ON THE COVER: *Urn galls growing on the underside of a scrub oak leaf contain larvae of the wasp* Phylloteras cupella. *Image by Ron Russo*

THE NATURAL MOMENT

MEALS ON HEELS

Photograph by Scott Linstead

◄ *See preceding two pages*

THE NATURAL EXPLANATION BY ERIN ESPELIE

Epicenters of distinctive animal behavior—such as Kaikoura, New Zealand, for spouting sperm whales, and Churchill, Manitoba, for lounging polar bears—are destinations for specialized enthusiasts. In the world of birdwatchers, Blue Cypress Lake in central Florida attracts those eager to see nesting ospreys (*Pandion haliaetus*). Or, if you're after ospreys out for a kill, there's Damariscotta Mills, Maine, about fifty miles northeast of Portland. Every May, the birds dive for alewives—a kind of herring—as the fish swarm upriver to spawn. But that spot, says photographer Scott Linstead, is only second best in the world for osprey action. The acme, where these photographs were taken, is the Pohtiolampi Osprey Center in Kangasala, Finland—roughly a hundred miles north of Helsinki.

The Center's well-stocked pool, originally built with osprey research and protection in mind, now provides an engaging show for visitors, and photographers can reserve one of the exclusive viewing hides. The wait for a front seat at peak season, which is late August and early September, can be a year or more. Linstead finally found himself inside a blind for four days this past September, less than ten feet from the edge of the water. He set up his camera—with a mere 300-millimeter lens because of the proximity—every morning before dawn, scuttled out for a brief lunch break when the light was at its harshest, and left after dusk. He witnessed some fifty dives a day from thirty feet away, with the birds plucking out a rainbow trout about two-thirds of the time.

The ospreys, with wingspans of five feet or more, typically weighed between two and five pounds, while the rainbow trout in the pool were six to ten inches long and weighed less than a pound. But the birds' size advantage did not guarantee success. Linstead describes many failed attempts, with fish slipping from the birds' talons back into the water or onto the grassy banks. One frustrated juvenile perched and screamed at other birds making successful dives. Linstead says he started to know when a bird would keep its catch: the osprey would float and maneuver on the water after a dive—spinning in a circle at the surface—until it had the fish pinned in a good position for takeoff.

Within a week of Linstead's stay in Finland, another remote watering hole gained notoriety among enthusiasts. Lake Diefenbaker in Saskatchewan yielded up a record forty-eight-pound rainbow trout to a young fisherman (whose twin brother held the previous world record for a forty-three-pounder, also from that lake). Those fish are gargantuan because they sport an extra set of chromosomes, their ancestors having escaped nearly a decade ago from a fish farm doing genetic modification. If ospreys went diving there, they might not come back up.

Scott Linstead became a freelance wildlife photographer after working as a high school teacher and an aerospace engineer. His column on the techniques of bird photography appears in every issue of *Outdoor Photography Canada*. Linstead lives with his wife Stephanie in Maple Grove, Quebec, where they run an independent bookstore. See www.scottyphotography.com for more examples of his work.

The World is Our Stage

BBC EARTH

Now on DVD and Blu-ray!*

*Blue Planet available in standard DVD only.

Available at BBC AMERICA SHOP.COM

nature.net by robert anderson

IRON MEN

I HAVE ALWAYS HAD a strong preference for twentieth-century American history, but I admit to a soft spot for the Iron Age Celtic culture. I attribute that to reading the occasional *Asterix* comic book when I was a child struggling to learn French in Paris. In October 1959, the writer René Goscinny and illustrator Albert Uderzo unveiled the Gaul Asterix, the popular cartoon-strip hero whose mission is to lead Celtic resistance against the Roman invaders, battling them with a good deal of humor (see www.asterix.com). To celebrate the character's fiftieth anniversary, I decided to take a grown-up look at the Celts and their archaeological record. I discovered a culture that extended far beyond its modern, remnant outposts in Ireland, Scotland, and Wales. For my guide to Web sites exploring the Celtic tribes across Europe, please visit the magazine online (www.naturalhistorymag.com).

ROBERT ANDERSON is a freelance science writer who lives in Los Angeles.

WORD EXCHANGE

Fondly Remembered

With sadness we record the death of Florence Brauner, just shy of her ninety-fourth birthday. Florence worked as a copy editor for *Natural History* more than half a century ago, before taking charge of the American Museum of Natural History's scientific publications. After her retirement she returned to the magazine as a volunteer, helping to screen the latest books and serving as a last line of defense against errant hyphens and other anomalies. Her good humor, physical energy, and engagement with current times have inspired hope in all of us as we face growing old.

Vittorio Maestro
Editor in Chief

NATURAL HISTORY *welcomes correspondence from readers. Letters should be sent via e-mail to* nhmag@naturalhistorymag.com *or by fax to 646-356-6511. All letters should include a daytime telephone number, and all letters may be edited for length and clarity.*

NATURAL HISTORY

VITTORIO MAESTRO *Editor in Chief*

Steven R. Black *Art Director*

Erin Espèlie *Executive Editor*

Senior Editors
Rebecca Kessler, Dolly Setton

Melisa Beveridge *Associate Art Director*
Joe Sharkey *Assistant Art Director*
Annie Gottlieb *Copy Chief*
Graciela Flores *Editor-at-Large*
Florence Brauner *Volunteer*

Contributing Editors
Robert Anderson, Druin Burch, Robert R. Dunn, Avis Lang, Charles Liu, Laurence A. Marschall, Richard Milner, Robert H. Mohlenbrock, Joe Rao, Stéphan Reebs, Adam Summers, Neil deGrasse Tyson

CHARLES E. HARRIS *Publisher*
Edgar L. Harrison *Advertising Director*
Maria Volpe *Promotion Director*
Sonia W. Paratore *National Advertising Manager*
Adam Cohen *Advertising Manager*
Meredith Miller *Production Manager*

For advertising information
call 646-356-6508

Advertising Sales Representatives
Detroit—Barron Media Sales, LLC, 313-268-3996
Chicago—Robert Purdy & Associates, 312-726-7800
West Coast—On Course Media Sales, 310-710-7414
Toronto—American Publishers Representatives Ltd., 416-363-1388
Atlanta and Miami—Rickles and Co., 770-664-4567
South America—Netcorp Media, Ltd., 51-1-222-8038
National Direct Response—Smyth Media Group, 914-693-8700
Market Classified—Media Options, 800-442-6441

TODD HAPPER *Vice President, Science Education*

Educational Advisory Board
David Chesebrough *COSI Columbus*
Stephanie Ratcliffe *Natural History Museum of the Adirondacks*
Ronen Mir *MadaTech–Israel National Museum of Science*
Carol Valenta *Saint Louis Science Center*

NATURAL HISTORY MAGAZINE, INC.

Charles E. Harris *President, Chief Executive Officer*
Judy Buller *General Manager*
Cecile Washington *General Manager*
Charles Rodin *Publishing Advisor*

To contact us regarding your subscription, to order a new subscription, or to change your address, please visit our Web site www.naturalhistorymag.com or write to us at

Natural History
P.O. Box 5000, Harlan, IA 51593-0257.

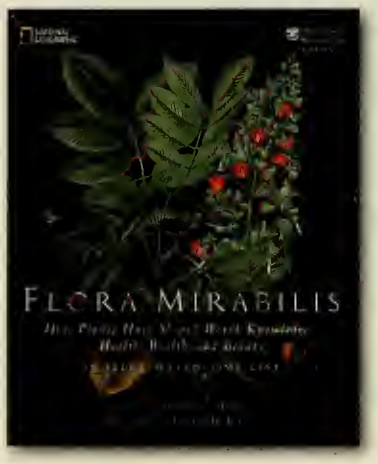
Natural History (ISSN 0028–0712) is published monthly, except for combined issues in July/August and December/January, by Natural History Magazine, Inc., in affiliation with the American Museum of Natural History, Central Park West at 79th Street, New York, NY 10024. E-mail: nhmag@naturalhistorymag.com. Natural History Magazine, Inc., is solely responsible for editorial content and publishing practices. Subscriptions: $30.00 a year; for Canada and all other countries: $40.00 a year. Periodicals postage paid at New York, NY, and at additional mailing offices. Canada Publications Mail No. 40030827.

If you would like to contact us regarding your subscription or to enter a new subscription, please write to us at Natural History, P.O. Box 5000, Harlan, IA 51593-0257. Postmaster: Send address changes to *Natural History*, P.O. Box 5000, Harlan, IA 51537-5000. Printed in the U.S.A.

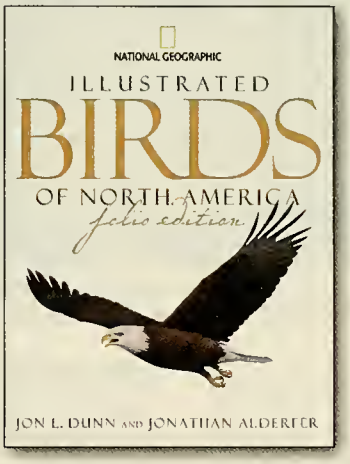
Holiday Fact:

BOOKS ARE GIFTS THAT LAST A LIFETIME

Give the gift of knowledge that lasts forever. Whether it's the **past** with Charles Darwin, powerful plants that changed the world, and the history of science and invention; a bird's eye view of the **present** with spectacular avian illustrations; or insights about the **future** of threatened polar wildlife and our oceans. National Geographic has your interests—and your gift list—covered.



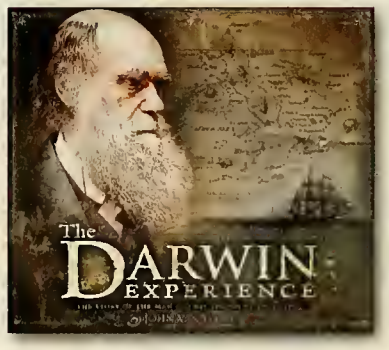
FLORA MIRABILIS
How Plants Shaped World Knowledge, Health, Wealth, and Beauty
$35.00 / $42.00 CAN
256 pages, 200 color photographs and illustrations



NATIONAL GEOGRAPHIC ILLUSTRATED BIRDS OF NORTH AMERICA, FOLIO EDITION
$50.00 / $62.00 CAN
4,000 color illustrations, 700 color maps, 504 pages

NATIONAL GEOGRAPHIC CONCISE HISTORY OF SCIENCE & INVENTION
An Illustrated Timeline
$40.00 / $47.00 CAN
350 color photographs and illustrations
352 pages

POLAR OBSESSION
$50.00 / $62.00 CAN
150 color photographs, 240 pages



THE DARWIN EXPERIENCE
The Story of the Man and His Theory of Evolution
$50.00 U.S. only
30 facsimile memorabilia
200 color photographs, 64 pages

THE WORLD IS BLUE
How Our Fate and the Ocean's Are One
$26.00 / $32.00 CAN
30 color photographs, 4 maps
320 pages
e-Book: $26.00 / $32.00 CAN

NATIONAL GEOGRAPHIC

Available now wherever books are sold
For more holiday gift ideas visit, nationalgeographic.com/holidaybooks

Discover the World of Discrete Mathematics

Discrete mathematics—the study of quantities that can be broken into neat little pieces—is a subject off the beaten track that most of us followed in school. Yet it has vital applications in computer science, engineering, and problem solving of all types. Explore this modern realm of math in **Discrete Mathematics**, 24 mind-expanding lectures taught by Professor Arthur T. Benjamin, a math educator repeatedly honored by the Mathematical Association of America for his outstanding teaching.

Delve into three of discrete mathematics' most important fields: combinatorics (the mathematics of counting), number theory, and graph theory. Along the way, examine a generous selection of problems, proofs, and applications that are both intriguing and insightful. Regardless of your mathematical background, this course will enlighten you, entertain you, and provide you with an ideal point of entry for thinking more mathematically.

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.

Discrete Mathematics

Taught by Professor Arthur T. Benjamin, Harvey Mudd College

Lecture Titles

1. What Is Discrete Mathematics?
2. Basic Concepts of Combinatorics
3. The 12-Fold Way of Combinatorics
4. Pascal's Triangle and the Binomial Theorem
5. Advanced Combinatorics—Multichoosing
6. The Principle of Inclusion-Exclusion
7. Proofs—Inductive, Geometric, Combinatorial
8. Linear Recurrences and Fibonacci Numbers
9. Gateway to Number Theory—Divisibility
10. The Structure of Numbers
11. Two Principles—Pigeonholes and Parity
12. Modular Arithmetic—The Math of Remainders
13. Enormous Exponents and Card Shuffling
14. Fermat's "Little" Theorem and Prime Testing
15. Open Secrets—Public Key Cryptography
16. The Birth of Graph Theory
17. Ways to Walk—Matrices and Markov Chains
18. Social Networks and Stable Marriages
19. Tournaments and King Chickens
20. Weighted Graphs and Minimum Spanning Trees
21. Planarity—When Can a Graph Be Untangled?
22. Coloring Graphs and Maps
23. Shortest Paths and Algorithm Complexity
24. The Magic of Discrete Mathematics

Order Today!
Offer Expires Tuesday, January 19, 2010

ACT NOW!

Discrete Mathematics
Course No. 1456
24 lectures (30 minutes/lecture)

DVDs ~~$254.95~~ NOW $69.95
+ $10 Shipping, Processing, and Lifetime Satisfaction Guarantee

Priority Code: 33587

1-800-TEACH-12
www.TEACH12.com/8nh

THE TEACHING COMPANY®
The Joy of Lifelong Learning Every Day™
GREAT PROFESSORS. GREAT COURSES. GREAT VALUE GUARANTEED.™

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 55 HARLAN IA 51593-2091

POSTAGE WILL BE PAID BY ADDRESSEE

NATURAL HISTORY

P.O. BOX 3030
HARLAN, IA 51593-2091

SUFFERING FROM CURIOSITY?

Did dinosaur meat taste like chicken? Is invisibility possible? Do you find yourself searching tidal pools for life forms? Do you experience heart palpitations when you spot a Pileated woodpecker?

You have chronic curiosity. Since 1900, millions of people—just like you—have found temporary relief by taking *Natural History*.

"Ten issues a year help me manage my insatiable need to know."

~Beulah Henderson
Fairfield, Maine

SUBSCRIBE NOW & SAVE!

- 10 issues for just $25—a savings of 37% off the regular newsstand price
- FREE (one-time only) general admission pass to the American Museum of Natural History
- Discount on a ticket to the Museum's spectacular IMAX® theater during your visit
- Discounts on unique items in Museum gift shops, including books, crafts, jewelry, and collectibles

WARNING: Side effects may include uncontrollable urge to travel, increased appetite to read, heightened activity in community and public affairs, higher expectations of products and services, improved quality of life.

TO ORDER ~

Visit naturalhistorymag.com
or call 1-800-234-5252.

(Outside the U.S., please add $10 for postage and call 515-247-7631 for customer service.)

GUARANTEE: If you don't feel better after three issues, stop taking *Natural History* immediately and request your money back for the unused portion of your subscription.

CURE & PREVENTIVE FOR THE ORDINARY

NATURAL HISTORY

EST. 1900

Female Grant's gazelles, Serengeti Plain

RIM CARO

A Horny Proposition

Males of most even-toed ungulates have horns or antlers, which biologists agree evolved as weaponry to compete for mates. The origin of headgear in females, however, has remained enigmatic. Now, two evolutionary biologists think they've figured out why some species' females have horns and others don't.

Theodore Stankowich at the University of Massachusetts Amherst and Tim Caro at the University of California, Davis, studied the question in 117 species of bovids—a family that includes antelopes, cattle, goats, and sheep. They statistically tested the relative ability of several hypotheses to predict the occurrence of female horns in each species. Did they evolve in large bovids unable to easily hide or flee from predators? In group-living bovids with intense competition for food? Or in bovids whose females compete for territory?

The answer: none of the above—at least not completely. Only when they considered how conspicuous a species is in its natural habitat did they find a strong correlation. Large species living in open habitats are visible to faraway predators; in almost every one, females have horns, presumably for defense. But in small species, or species living in brush or forest, females go bareheaded. In African duikers and a few other bovids, females fight each other for land; they, too, have horns.

The pattern holds for eighty of the eighty-two cases of horned females, and the researchers think it may apply to other hoofed mammals as well. (*Proceedings of the Royal Society* B) —*Lindsey Konkel*

Agri-Invasion

About 7,500 years ago, farming supplanted hunting and gathering as the main lifestyle in central Europe. But whether the switch was caused by an influx of new people or just by the spread of farming techniques has long puzzled experts.

In search of an answer, Barbara Bramanti of the University of Mainz in Germany teamed up with fifteen colleagues to compare the mitochondrial DNA (mtDNA) of twenty-five early farmers and twenty hunter-gatherers. They'd managed to extract the mtDNA from bones between 4,300 and 15,000 years old unearthed mainly in Germany, but also in Poland, Lithuania, and Russia.

The mtDNA of the two groups turned out to be markedly different, leading Bramanti's team to conclude that the first farmers were immigrants who did not mingle—at least genetically—with the established inhabitants. Where those immigrants came from is now the new question. Archaeological evidence suggests Hungary and Slovakia; Turkey is another possibility. Future genetic studies will undoubtedly bring answers.

The team also went a step further, comparing the mtDNA of the ancient hunter-gatherers and farmers with that of 484 living Europeans. The modern Europeans resembled the farmers a little more than the hunter-gatherers, but, quite unexpectedly, they resembled neither group very strongly. During the last four millennia, subsequent waves of immigrants from parts unknown may have mixed with the farmers to produce today's European stock. (*Science*) —*Stéphan Reebs*

Floral Fraud

Some orchids are exquisite cheats: instead of offering a nectar reward to their pollinators, they trick insects into alighting on their flowers by simulating the shape, color, or odor of potential mates. The great variety in orchid deception has been known for a long time, yet new examples keep turning up.

Take the orchid *Dendrobium sinense*. Restricted to the Chinese island of Hainan, the species has lovely white flowers with red centers. A team, led by Jennifer Brodmann and her graduate adviser Manfred Ayasse of the University of Ulm in Germany, observed the hornet *Vespa bicolor* regularly visiting the flowers, pollinating them inadvertently in the process. The hornets didn't just drop in casually on the flowers, however; they pounced on the red centers with the same vigor they exert hunting honeybees to feed to their larvae. In a series of experiments, the team established that the flowers produce a volatile compound also made by honeybees, which is what attracts the hornets. Normally, the hornets cue in on the compound to locate victims.

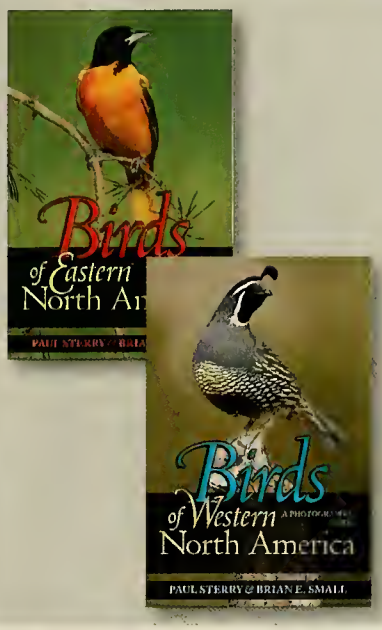
Some orchids imitate the shape of a pollinator's prey—the genus *Brassia* bears spider-shaped flowers pollinated by spider-parasitizing wasps—but *D. sinense* is the first known to mimic a prey's scent. (*Current Biology*) —*S.R.*

JENNIFER BRODMANN

SONG XI-QIANG

Dendrobium sinense orchid, above, and its pollinator, the hornet Vespa bicolor, right

Natural Selections



Birds of Eastern North America

A Photographic Guide

Paul Sterry & Brian E. Small

336 pages. 1,118 color photos. 405 maps.
Paper $18.95 978-0-691-13426-0
Cloth $45.00 978-0-691-13425-3

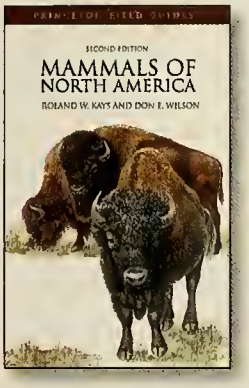
Birds of Western North America

A Photographic Guide

Paul Sterry & Brian E. Small

416 pages. 1,341 color photos. 449 maps.
Paper $18.95 978-0-691-13428-4
Cloth $45.00 978-0-691-13427-7

- ✓ The best, most lavishly illustrated photographic guides to the regions' birds
- ✓ Larger color photos than most other field guides
- ✓ Fresh contemporary design—clear, easy-to-use, and attractive
- ✓ Informative, accessible, and authoritative text
- ✓ Range maps from the Cornell Laboratory of Ornithology
- ✓ *Birds of Eastern North America* covers entire eastern half of mainland North America and the arctic and subarctic territorial islands of the U.S. and Canada
- ✓ *Birds of Western North America* covers entire western half of mainland North America (excluding Mexico) and the arctic and subarctic territorial islands of the U.S. and Canada (excluding Hawaii)



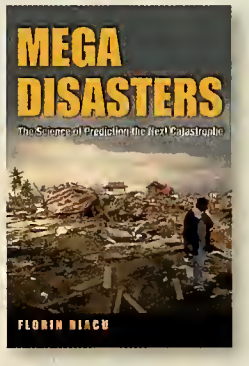
Mammals of North America

Second Edition

Roland W. Kays & Don E. Wilson

The best-selling field guide that "sets new standards" (*New Scientist*) and "makes all other field guides for mammals of the United States . . . and Canada obsolete" (*Journal of Mammalogy*) is now even better. Covering 20 species recognized since 2002 and including 13 new color plates, this fully revised edition illustrates all 462 known mammal species in the United States and Canada—each in beautiful color and accurate detail.

Princeton Field Guides
Paper $19.95 978-0-691-14092-6
Cloth $45.00 978-0-691-14278-4



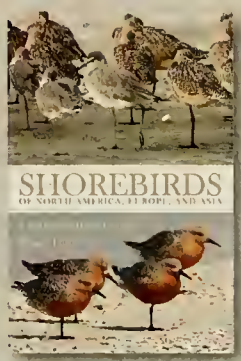
Megadisasters

The Science of Predicting the Next Catastrophe

Florin Diacu

"Florin Diacu takes the reader on a gripping tour of all the forces of nature that wreak havoc on our species, forcing us all, in the end, to cherish every day that Earth does not manage to kill us."
—Neil deGrasse Tyson, author of *The Pluto Files*

Cloth $24.95 978-0-691-13350-8
For sale only in the United States, Canada, & Mexico



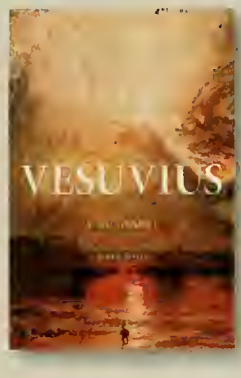
Shorebirds of North America, Europe, and Asia

A Photographic Guide

Richard Chandler

An illustrated guide to all 134 shorebird species found in the Northern Hemisphere, written by one of the world's leading shorebird experts.

Paper $35.00 978-0-691-14281-4
Not for sale in the Commonwealth (except Canada) & the European Union



Vesuvius

A Biography

Alwyn Scarth

"In his latest book on volcanoes (after *La Catastrophe*, *Vulcan's Fury*, and *Savage Earth*), Scarth confronts the legendary Vesuvius. A veritable eruption of words is required to do the story justice, and Scarth is up to the task."
—Walter L. Cressle, *Library Journal*

Cloth $29.95 978-0-691-14390-3
Not for sale in the United Kingdom or Republic of Ireland

PRINCETON UNIVERSITY PRESS

800.777.4726
press.princeton.edu

Room and Board

Munidopsis andamanica

In the deep sea, food is scarce and the menu short—so short that at least one organism eats the table along with the fare. In fact, the table may be the main course for *Munidopsis andamanica*, a crustacean known as a "squat lobster," related to true lobsters. Although the 850-plus squat lobster species are thought to be generalist scavengers, *M. andamanica* is the first to be found that eats wood.

Log, trawled from the deep sea near the Solomon Islands, was cross-sectioned to reveal tunnels made by wood-boring bivalves.

If that seems an improbable diet for a deep-sea crustacean, consider that most logs that wash out to sea eventually sink, delivering precious nutrients to the seafloor in irregular loads that biologists have lately recognized as important ecosystems.

Trawling off Vanuatu in the Pacific Ocean, a team led by Caroline Hoyoux and her graduate adviser, Philippe Compère of the University of Liège in Belgium, hauled up many sunken logs from as deep as 3,000 feet. The woodfalls were teeming with bivalves, limpets, and crustaceans, including abundant *M. andamanica*. Wood fragments packed the squat lobsters' guts. Also present were bacteria and fungi, some of which appeared to be gut residents helping to digest the wood; others the squat lobsters had grazed off the old logs.

M. andamanica found elsewhere had bits of plant matter, algae, and coral in their guts. The team thinks the crustaceans specialize in hard-to-digest food, wood being their favorite fodder, garnished with bacteria or fungi. In a habitat as barren as the deep sea, it seems no meal is too tough to pass up. (*Marine Biology*) —*S.R.*

Spot Check

Parasites can lessen a young bird's chance of survival. If parents can detect signs of infection early, they may cut their losses by reducing their efforts to feed and care for parasitized broods—thus saving energy for healthy offspring or future breeding attempts. A new study suggests that such parental vetting begins even before eggs hatch.

Nests of spotless starlings, *Sturnus unicolor*, are often infested with bloodsucking *Carnus hemapterus* flies. The flies' feces stain the birds' bluish-green eggs with brown spots; the more spots, the greater the risk the baby birds will be parasitized once they hatch.

Curious whether spotless starling parents gauge the parasite load of their future offspring from the eggs' spottiness and adjust their care accordingly, Jesús Miguel Avilés, now at the Spanish National Research Council's research station in Almería, studied a colony breeding in nest boxes. He and three colleagues first ascertained that as a nest's fly population increases, nestling weight—a reliable predictor of survival to adulthood—decreases. Then, using wet cotton, they cleaned the spots off eggs in some nest boxes, but not others.

Fly feces mark the eggs of a spotless starling.

Once the eggs hatched, they found that broods from experimentally cleaned eggs received more parental visits than broods from naturally spotty ones. But, intriguingly, only males gave them extra attention, not females. Unlike females, males can sire several broods at a time; perhaps their attention to egg spottiness evolved because it enabled them to dote on the most promising nestful of offspring. (*Animal Behaviour*) —*Lesley Evans Ogden*

Good Dingo

Dingoes were semidomesticated village dogs once, in Southeast Asia. Then, about 4,000 years ago, they got loose in Australia, where their behavior reverted to that of their ancestor, the wolf. They howl, live in packs, and fear humans. But even after so long on the lam they've retained at least one mark of domestication: an ability to read human gestures.

At the tender age of four months, ordinary dogs will spontaneously investigate objects that we point to or even just gaze at. In contrast, wolves—even when reared by people—only attend to such gestures after months of intensive training.

Bradley P. Smith and his graduate adviser, Carla A. Litchfield of the University of South Australia in Magill, wondered how dingoes measure up. They presented seven tame but untrained dingoes with two flowerpots, one containing meat. (Both were meat-scented to preclude olfactory clues.) In a series of trials, an experimenter tried out ten gestures to indicate the pot hiding the treat. The dingoes raced straight to it in response to most of the gestures, such as pointing at, tapping on, or standing directly behind the pot. When the experimenter merely gazed at it, however, the dingoes didn't get the message.

In the course of domestication, dogs' ability to understand human gestures was probably selected for. In spite of their wild ways, dingoes have kept most of that skill. It's nice to know that our long-lost best friends still have a connection with us. (*Animal Cognition*) —*S.R.*

Female dingo, Queensland, Australia

Anytime is a good time to visit the Land of the Taj.
But there is no time like now.

Incredible India

For information visit
www.incredibleindia.org
ny@itonyc.com 1-800-953-9399

Reversible Coat

Freshwater turtles' skin and shells often match the color of their habitat's substrate, which may help them deceive predators and prey alike. But what happens if turtles change abodes, from a black swamp, say, to a sandy-bottomed pond?

John W. Rowe, of Alma College in Michigan, and three colleagues collected gravid female midland painted turtles and red-eared sliders from the wild, brought them to the lab, and injected them with oxytocin, a hormone that induces egg laying.

They assigned the hatchlings to two control groups, which they kept for 160 days on either a white or a black substrate, and to two "reversal" groups, which they kept for 80 days on white or black and then switched to a substrate of the opposite color for another 80 days. The researchers periodically used a spectrometer to measure the color intensity of spots on each turtle's carapace and head.

JOHN ROWE

Dark- and light-colored midland painted turtles

By day 80, all the turtles had lightened or darkened, approaching the color of the substrates they were living on. By day 160, the controls were staying the course, but both reversal groups had switched and were now well on their way to the color intensity of their new substrate, confirming that turtles can completely reverse melanization. That puts freshwater turtles in the same league as chameleons and squid—even if their melanization process is, true to form, much slower. (*Journal of Herpetology*)

—*Graciela Flores*

JOE SHARKEY

Bat ray (artist's rendering)

Ray-dar

Off the coast of California, the bat ray *Myliobatis californica* glides over the seafloor looking for buried clams to eat. Well, "looking" isn't the right word. The ray's eyes, after all, are on top of its head, not great for looking down. So how does the bottom dweller detect prey?

One way, already observed in another ray species, would be by sensing the jets of water buried clams sometimes expel. So Laura K. Jordan, of the University of California, Los Angeles, and two colleagues simulated clam jets at the bottom of a large tank, and then watched the effect on wild-caught bat rays. The rays did indeed stop over the jets to bite at their source. They sensed the jets through their undersides, which are equipped with a well-developed lateral line system—the series of pores and canals that enables all fishes to detect water movements. Jordan's team also tried the trick with two other ray species that don't eat clams; their lateral line systems are much less complex, and they responded to the jets less than half as often as did the bat rays.

The team also studied the rays' sensitivity to the electrical fields that all living organisms (including buried clams) produce—a sensory specialty of sharks and rays. All three species bit enthusiastically at dipole electrodes the scientists hid at the bottom of the tank, but the bat rays may have set a new record by detecting signals weaker than 0.1 nanovolt per centimeter. That's less than a billionth of the electrical field generated between the poles of an AA battery. (*Journal of Experimental Biology*) —*S.R.*

THE WARMING EARTH

Save the Conifers

When fire destroys forests, or when discarded wood products are burned at the dump, carbon dioxide (CO_2) escapes into the air. Hence, in part, the uproar denouncing the slash-and-burn destruction of tropical jungles. But let's not overlook another great woodland biome: the boreal forest.

That's the plea voiced in a recent opinion paper by Corey J.A. Bradshaw of the University of Adelaide in Australia and two colleagues. They point out that far northern forests represent a third of all remaining woodlands and 30 percent of all terrestrially stored carbon on Earth. Those vast coniferous tracts covering much of Alaska, Canada, Scandinavia, and Russia are still relatively unscathed, but they face increasing threats.

In Russia, for example, forest fires occur at twice the annual rate seen in the 1960s. Most are ignited by human activity along an ever-expanding network of roads built to support mining, damming, and logging—projects that themselves eliminate trees. Elsewhere, tree-killing insects leave decaying, CO_2-emitting logs in their wake, and development and logging fragment pristine forest swaths. Climate change only increases the risk of fires and insect outbreaks.

Bradshaw and colleagues call for new forest-management strategies and the establishment of large reserves to bank against destruction, as well as to provide a safe haven for the 20,000 or so species that call boreal forests home. The opportunity, they warn, won't last long. (*Trends in Ecology and Evolution*) —*S.R.*

JARI MITCHELL

BRADSHAW, WARKENTIN & OLIVER, TREE, ELSEVIER

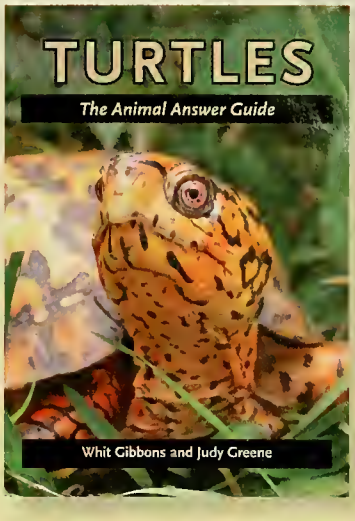
Background: Farmland fragments boreal forest in Newfoundland, Canada. Right: Map shows density of boreal forest in shades of green.

Adventures in Science

Turtles
The Animal Answer Guide
Whit Gibbons and Judy Greene

"Whit Gibbons and Judy Greene have been faced with every conceivable question about the 300 or so species of these endearing reptiles, and in this book they have succeeded splendidly in coming up with the answers."
—Peter C. H. Pritchard, Chelonian Research Institute

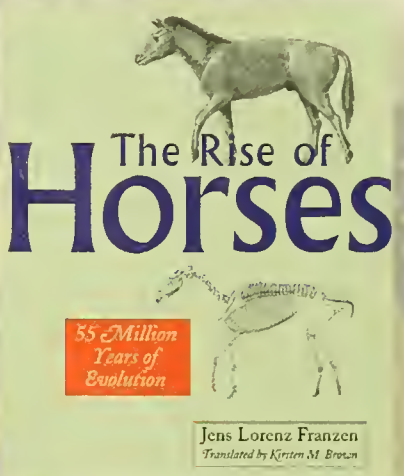
$24.95 paperback



The Rise of Horses
55 Million Years of Evolution
Jens Lorenz Franzen
translated by Kirsten M. Brown

One of the world's leading experts on horse evolution traces the origins, evolution, and diversification of the equines.

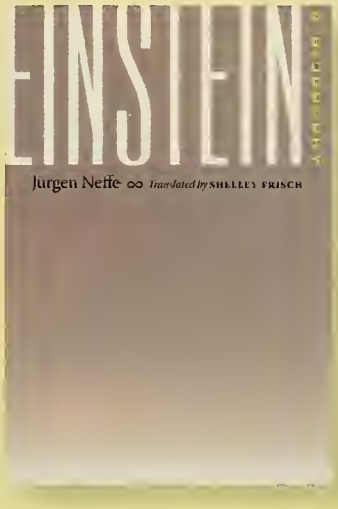
$65.00 hardcover



Einstein
A Biography
Jürgen Neffe
translated by Shelley Frisch

"Stellar research and prose combine in a splendid biography of physics' most luminous supernova."
—*Kirkus Reviews*
(starred review)

$29.95 paperback



The Magnetic Universe
The Elusive Traces of an Invisible Force
J. B. Zirker

A main selection of Scientific American Book Club

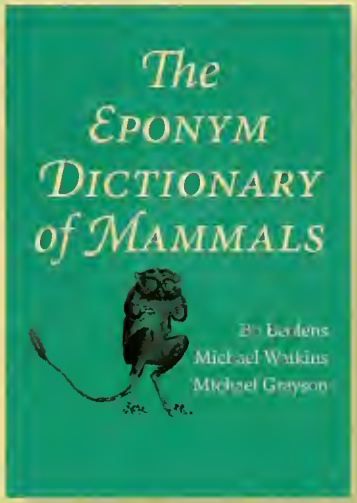
Zirker guides readers on a fascinating journey of discovery to understand how magnetic forces are created and how they shape the universe.

$35.00 paperback

The Eponym Dictionary of Mammals
Bo Beolens, Michael Watkins, and Michael Grayson

A highly readable and informative guide to the people whose names are immortalized in mammal nomenclature.

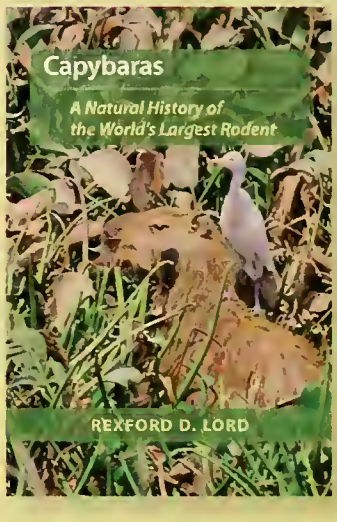
$65.00 hardcover



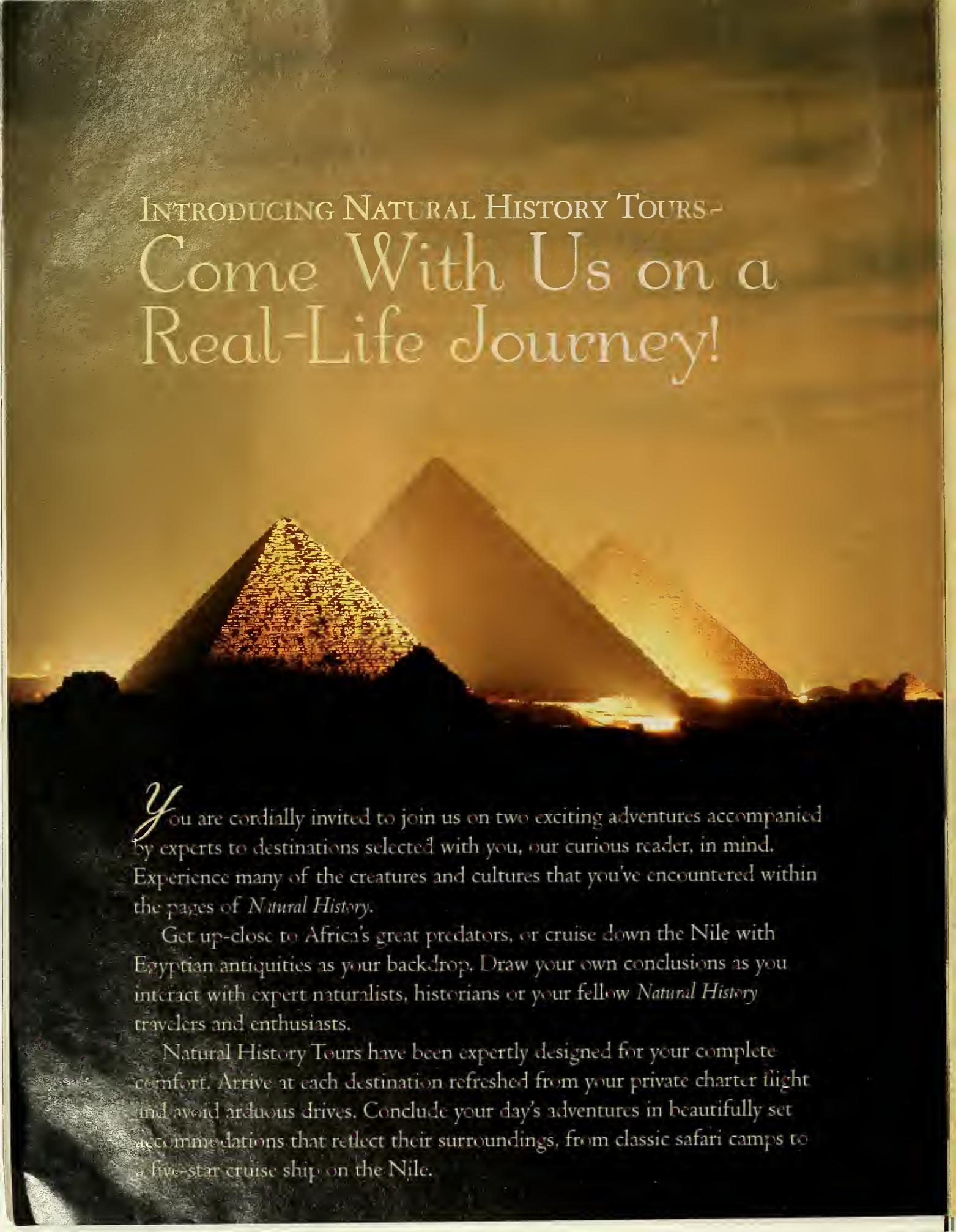
Capybaras
A Natural History of the World's Largest Rodent
Rexford D. Lord

Capybaras—the largest rodents in the world—show little resemblance to their guinea pig relatives. This volume is the most extensive reference work on capybaras that has ever been produced.

$50.00 hardcover



THE JOHNS HOPKINS UNIVERSITY PRESS
1-800-537-5487 • www.press.jhu.edu



Introducing Natural History Tours–

Come With Us on a Real-Life Journey!

You are cordially invited to join us on two exciting adventures accompanied by experts to destinations selected with you, our curious reader, in mind. Experience many of the creatures and cultures that you've encountered within the pages of *Natural History*.

Get up-close to Africa's great predators, or cruise down the Nile with Egyptian antiquities as your backdrop. Draw your own conclusions as you interact with expert naturalists, historians or your fellow *Natural History* travelers and enthusiasts.

Natural History Tours have been expertly designed for your complete comfort. Arrive at each destination refreshed from your private charter flight and avoid arduous drives. Conclude your day's adventures in beautifully set accommodations that reflect their surroundings, from classic safari camps to a five-star cruise ship on the Nile.

SOUTHERN AFRICA WING SAFARI

South Africa, Botswana and Victoria Falls

August 30 - September 9, 2010

$9,995 per person,
double occupancy

Take a private air safari to some of Africa's finest reserves and World Heritage sites in Botswana, Zimbabwe and South Africa. Naturalist guides bring you up-close to a variety of game on walking and jeep safaris, boat excursions in the Okavango Delta, and a guided historical tour of Victoria Falls. Stay in luxury tented camps and lodges throughout.

A third generation Southern African, Russell Gammon *has led expeditions throughout Africa for over 20 years. Passionate about natural science and the outdoors, Gammon also imparts his historical perspective as an authority on the Victorian explorer David Livingstone.*

EGYPT BY PRIVATE AIR

With Optional Extension to Jordan

December 17- 24, 2010

$7,995, per adult, double occupancy
$6,595, per child (11 years and under), double occupancy

Your journey includes Cairo's great pyramids and antiquities, a four-night Nile cruise from Luxor to Aswan on a five-star cruise ship, and the Temples of Abu Simbel. Enjoy the comfort of private air travel within Egypt to St. Catherine's Monastery and other exciting destinations. An optional, five-day trip extension continues to Jordan to explore the architectural and historical marvels of Petra, Kerak, Jerash and the Dead Sea. Scheduled to coincide with winter holidays, this cultural tour is a marvelous one to experience with children or grandchildren.

Professor Scott Pearson *has spent over 40 years leading economic development research projects in eight African countries. One of our most popular lecturers, Scott will decode Egypt's historical and cultural underpinnings with a focus on the rise and fall of empires.*

NATURAL HISTORY TOURS

For more information call 1-877-628-4478 (1-877-NATHIST) or visit us online at www.bushtracks.com/naturalhistory.

Starry-Eyed Entrepreneur

Building institutions and telescopes, George Ellery Hale advanced the frontier of American astronomy.

By Marcia Bartusiak

George Ellery Hale with the spectroheliograph he invented

COURTESY OF THE ARCHIVES, CALIFORNIA INSTITUTE OF TECHNOLOGY

Among the many scientific accomplishments of the noted solar astronomer George Ellery Hale (1868–1938) was his discovery of magnetic fields in sunspots—the first magnetic fields detected beyond Earth. But Hale made his most valuable contributions to astronomy as an administrator. He cofounded the *Astrophysical Journal* and helped build the California Institute of Technology. And he almost single-handedly orchestrated the construction of four great telescopes in the United States, each larger and more advanced than the one before. That colossal endeavor allowed the astronomers who followed to reveal the true vastness of the universe and the amazing diversity of its celestial inhabitants.

George was a precocious, curious boy, always devising new ways to study the natural world. His father, William, had secured a sizable fortune by manufacturing hydraulic elevators during the dawning age of skyscrapers. As a teenager, George was able to construct his own spectroscopic observatory in the attic of the family's Chicago mansion. There he avidly studied the Sun's spectrum in the company of his books, laboratory equipment, and fossil collection. His home observatory grew more elaborate over time, and there, shortly after his twentieth birthday, in 1888, he confirmed that the Sun contains carbon, then a matter of great debate. Before Hale even graduated from college, he developed a new instrument—the spectroheliograph—that enabled astronomers to photograph the Sun's surface as never before.

Upon graduation from the Massachusetts Institute of Technology, class of 1890, Hale married his childhood sweetheart and took an extended honeymoon trip across the U.S. He stopped at the Lick Observatory, near San Jose, California, and was mightily impressed. Hale never forgot his first glimpse of the 36-inch refracting telescope, then the world's largest. Within two years of his return home, Hale became an associate professor at the newly founded University of Chicago. The university promised future funding for a large telescope; in return, he and his father donated to the university the instruments in his personal observatory, by now a freestanding building next door to the family mansion.

Thanks to Hale's resourcefulness, the prospect of a larger telescope arrived sooner rather than later. In 1892, Hale learned of two 40-inch lenses that had been made for a planned observatory in southern California whose funding had dried up. A lens forty inches wide had nearly 25 percent more surface area than the Lick's 36-inch lens, and so would gather 25 percent more light, a treasured gain. Hale convinced Chicago's streetcar magnate, Charles Tyson Yerkes, to fund construction of the giant instrument.

With great pomp and circumstance, the Yerkes Observatory opened in 1897, in Williams Bay, Wisconsin. Hale, at the age of twenty-nine, was appointed its director. At a time when other observatories strictly took images, Hale made sure Yerkes had photographic darkrooms, spectroscopic labs, and instrument shops devoted to examining the chemistry of the heavens.

Hale was the astronomical equivalent of an industrial entrepreneur, always on the lookout for new technologies. Before the Yerkes's magnificent dome was even finished, Hale had already persuaded his father to buy the optical components for yet another telescope, this time a large reflector. A lens any larger than the Yerkes 40-inch was unfeasible; to go bigger required a mirror.

After a visit there in June 1903, Hale selected Mount Wilson, near Pasadena, California, as "*the* place" to erect his 60-inch scope. With

the University of Chicago unwilling to fully finance a California outpost, the young astronomer sought other funding sources. Fortuitously, Andrew Carnegie had just established the Carnegie Institution of Washington, with a generous endowment of $10 million to fund scientific projects. Hale began lobbying for a grant without delay, but funding was not immediately forthcoming.

That didn't hamper Hale one bit, and in late 1903 he moved his family to Pasadena. The following spring, Carnegie offered a small grant to co-sponsor, with the University of Chicago, the relocation of a solar telescope from Yerkes to Mount Wilson—and so work on the mountain began in the summer of 1904. When that grant ran out, Hale dipped into his own pocket. Finally, just before Christmas, the Carnegie Institution agreed to sponsor his grand plan for the 60-inch reflector atop the mountain. Hale promptly resigned as Yerkes director to devote his full attention to the Mount Wilson Solar Observatory of the Carnegie Institution of Washington. ("Solar" was later dropped from the name.)

Construction took a Herculean effort. Hundreds of tons of material were hauled up by mules and by a generator-powered, mule-assisted truck. The tensest moment was the transport of the nearly two-ton mirror itself; one misplaced wheel and it would have plummeted to the canyon floor. To everyone's relief, the mirror arrived intact in late August of 1908. Once the telescope was operational, in December, astronomers could see stars one hundred million times fainter than the brightest stars in the sky.

Meanwhile, Hale was thinking ahead to an even bigger telescope, one with a mirror one hundred inches wide that would gather nearly three times as much light as the 60-inch. No glass that large had ever been made; it was uncertain whether it could be cast, polished, or mounted. When the giant glass blank arrived from France in December 1908, it was seriously flawed by numerous entrapped bubbles. A new disk was ordered, but the best candidate broke while cooling. Then the Los Angeles businessman who had pledged the money to construct the mirror balked at any new expenditure. With his funds exhausted and facing multiple struggles, Hale experienced the first of many nervous breakdowns. Yet eventually a 9,000-pound mirror made from the original glass was installed on Mount Wilson. It saw first light on November 1, 1917, performing exquisitely despite its defects.

George Ellery Hale died of heart trouble at age sixty-nine in 1938, a decade after beginning efforts to erect a 200-inch telescope atop Palomar Mountain, outside San Diego. To venerate his leadership in the telescope's design and construction, as well as his achievements as the Mount Wilson Observatory director from 1904 to 1923, the new instrument was named the Hale Telescope at its 1948 dedication. Six decades later, it continues to make major contributions to astronomical research.

Marcia Bartusiak is a science writer with a master's degree in physics who has been covering astronomy and physics for three decades. She is the author of five books on astronomy, including Archives of the Universe *(Pantheon Books, 2004) and* Einstein's Unfinished Symphony *(Joseph Henry Press, 2000).*

In recognition of 2009 being the International Year of Astronomy, this article is the third of several on the events and scientists that have advanced our understanding of the cosmos during the last hundred years. This article was adapted from *The Day We Found the Universe*, by Marcia Bartusiak, © 2009. Reprinted with permission from Pantheon Books. All rights reserved.

Confessions of a Gall

Thousands of species of insects induce plants to grow fanciful and nutritious nurseries for their larvae.

BY RON RUSSO

Back in 1969, while I was working as a naturalist for the East Bay Regional Park District in Oakland, California, my boss, Chris Nelson, dropped a bunch of purple spiny things on my desk. "What are they?" he wanted to know. Well, I might have said they were miniature purple sea urchins, except that those strange objects were attached to the leaves of a blue oak, *Quercus douglasii*. Was he playing some sort of botanical prank on me? At that nascent stage in my career I aspired to pursue research on a grand scale, involving, say, entire forest ecosystems. But with his simple (and innocent) action, Nelson had sparked my curiosity about something small and wonderful, helping to define the course of my life.

The search for a better understanding of those natural "plant urchins" quickly led me to the late Sara S. Rosenthal, then a young wasp biologist from the University of California's Essig Museum of Ento-

Above: Urchin gall was the first kind of gall that the author encountered. The gall pictured, growing on the underside of a leaf of blue oak, provides shelter and nutrition for a larva of the urchin gall wasp, Antron quercusechinus. *Left: Alfred C. Kinsey described these urchin galls as a variety produced by* A. quercusechinus, *but they may ultimately be the work of a separate species—given their distinct appearance. Opposite page: Oak apple galls, produced by the wasp* Trichoteras vaccinifoliae *on huckleberry oak, measure about two inches in diameter and are often mistaken for fruit.*

ons Hunter

mology at Berkeley. Together we visited an old blue oak in Briones Regional Park, in the hills above Martinez, California. In the space of an hour or so, she pointed out twenty-one structures of every imaginable shape and color on the leaves and stems of that single tree. They were galls, casings built by the tree in response to the manipulation of insects—in this instance, all species of wasps belonging to the family Cynipidae. Each cynipid species had made a distinct gall (you can identify the species of wasp by the shape, size, and color of the gall). One type of gall matched the purple bumps I had seen earlier: it was the product of the urchin gall wasp, *Antron quercusechinus* [*see photographs on opposite page*]. I was nearly speechless. Living inside all those different kinds of galls were insects, some barely visible to the naked eye—but their homes were now so obvious! In all the time I had spent in woodland and forest habitat, how could I not have noticed them before?

Plant galls are tumorlike swellings initiated mostly by insects, but also by mistletoe and by some bacteria, fungi, and mites. With around a million species of insects known worldwide, their inventive feeding choices know no bounds: carrion, dung, pollen, fungi, leaves, nectar, sap, and blood, for starters. But only 13,000 species have evolved the ability to induce galls in specific host plants, thus co-opting the plants' resources. Overshadowed by more dramatic species—ants, honeybees, disease-bearing mosquitoes, butterflies, and crop-damaging caterpillars—gall insects exist in our midst with little fanfare or publicity. They rarely have any economic or agricultural impact, despite their large numbers and widespread ranges. But they leave behind clues to their existence as distinctive as mountain lion tracks imprinted in the mud or an eagle feather fallen by a lakeshore. The diversity of those gall insects and their bizarre biology have fascinated me for forty years.

Midges—those in the family Cecidomyiidae—make the most galls, accounting for about 20 percent of all species of gall inducers worldwide. Next come a variety of wasps: tenthredinids (sawflies), tanaostigmatids, pteromalids, eurytomids, agonanids (fig wasps), and cynipids. Other inducers include some aphids, psyllids, thrips, moths, beetles, and fruit flies. For many such insects, a gall serves as a larval nursery, a protective, nourishing lodge for their young. A gall may house one larva or many, depending on the species of insect.

I have focused on cynipid wasps. They provided my introduction to galls, and they also have an interesting claim to fame: Alfred C. Kinsey (prior to embarking on his controversial work on human sexuality in the 1930s) described many new species and varieties of cynipids [*see "The Other Kinsey Report," July–August 2006*]. But those are not the main reasons I have stuck with them for so long. Instead, the approximately 1,400 species of cynipids intrigue me because theirs are among the most extravagant galls, assuming the shapes of sea urchins, stars, baskets, bowls, clubs, horns, and coral, to name just a few, in endless color combinations.

Cynipids rely primarily on oaks, sycamores, and certain members of the rose family as their hosts. Most of those wasps are quite small, some the size of a comma on this page, while others are about the size of a housefly. They are lilliputian architects, masters of grand alien designs, keepers of biological secrets that have defied naturalists and scientists since Hippocrates wrote about galls' medicinal properties nearly 2,400 years ago.

A shell of plant tissue forms around each cynipid egg soon after it is deposited. However, the gall doesn't really begin to grow around the shell—or group of shells—until after the hungry larvae hatch and begin feeding. Through their chewing, the wasp larvae release complex compounds that redirect the growth of different plant tissues to form the protective outer structures of the gall.

FAR LEFT: BARRY GRIVETT WWW.BUGGUIDE.NET; NEAR LEFT AND ABOVE: RON RUSSO

Adult cynipid gall wasp on a scrub oak near its gall, which has been cross-sectioned

its larval chamber, and its inner nutritive lining. While all cynipid nurseries have similar amenities on the inside, the gall's outward shape, color, and size is unique to each species. Galls form on every plant organ—including roots, flowers, and fruits—but most seem to appear on twigs and leaves, where high metabolic activity occurs over a short period of time, particularly in the spring.

After several months or more of development in those larval nurseries, the adult wasps emerge to live for about a week. During that time they generally fly short distances to locate a host, reproduce, deposit eggs, and start the cycle again. In many North American cynipid species there is a spring generation, with the galls developing in March and April and issuing adults by May or June. Those adults initiate a second, summer–fall generation that develops between July and October, with galls that look totally different from the spring galls. The adults from those summer–fall galls sometimes emerge in the fall, or, more commonly, in the early spring of the following year.

Cynipid wasps that induce galls on oaks and sycamores are unique, however, in that many of them alternate between sexual and asexual reproduction. That is, one generation, born in spring, will be "bisexual" (meaning that it includes both males and females), and the next generation, born in summer or fall, will be all females. Those latter females reproduce parthenogenetically, without the aid of male genes, essentially creating clones of themselves—though some lay eggs that result in male "clones." Some species are exclusively parthenogenetic: they produce only a single generation per year, with no males known in the population. That's the case with *Andricus quercuscalifornicus*, which induces the largest insect gall in the western United States, approximately the size and shape of a baking potato.

Adult cynipid wasps don't always complete their reproductive journey. Many are eaten, sometimes immediately upon emergence, by spiders, lizards, and such birds as kinglets, vireos, chickadees, and nuthatches. And even larvae, in the relative safety of the gall, fall prey to numerous parasitoids and inquilines. Parasitoids live in or on the larvae, ultimately killing them; I am reminded of one species in which every gall I examined in the field had been parasitized. Inquilines are specialized moths, weevils, beetles, wasps, and other insects that feed on gall tissue. While they are vegetarian by nature, many inquilines will destroy any larvae they contact while foraging. In spite of the hazards, from season to season enough gall wasps survive to continue their species. I once found a valley oak, *Q. lobata*, whose every leaf seemed to have dozens of saucer galls, made by the wasp *Andricus gigas*—perhaps tens of thousands of galls on that single looming tree. Their long-term survival certainly didn't seem to be a problem.

Although certain galls are common, others are elusive. In one frustrating case, I have been hunting for the galls of *Paracraspis insolens*, a wasp whose tubular leaf gall was first recorded in 1926. Even though I have examined thousands of its hosts—canyon live oaks, *Q. chrysolepis*—over the course of several years, I have yet to find a single specimen. Is the wasp's range extraordinarily restricted? Is it in a downswing of its population cycle? I don't know. I have hunted at least half a dozen such elusive species for years. Every time I drive through woodland with canyon live oak, my imagination starts racing until I can't stand it any longer: the species I have long sought could easily be hidden in one of those trees. I'll stop and sometimes spend hours in each grove, searching every leaf within reach until I am exhausted.

I have been tracking different gall wasp species through much of the western U.S., and am currently compiling a survey of the distributions and population levels of several. I record the timing of the appearance of galls and the emergence of adults, and I also rear the wasps to adult-

hood in the laboratory. Such observations help to clarify the behavior of known as well as new species. Whenever I find a new species, I rely on taxonomist colleagues to assign the genus name, where possible. Occasionally I find an insect that doesn't fit any known classification, as happened recently with a strange midge I reared from a bristly tube gall on catclaw, *Acacia greggii*. I will need several more adults before the species can be named.

Perhaps the trickiest part of the hunt for cynipids is to collect galls at the right time to rear the larvae to adulthood for identification purposes. With gall midges in the family Cecidomyiidae, generic determinations can be made using preserved larvae. But with cynipids and moths, adults are necessary for a definitive identification. If galls are collected too early, before the larvae have completed their development, chances of rearing adults are slim. If galls are collected closer to or after completion of larval development, then there is a greater chance adults will emerge later in the laboratory. Knowing exactly when to collect varies with each species and region. Sometimes the trick is just being systematic. For example, late one April I collected several bright green, melon-like leaf galls from Muller's oak, *Q. cornelius-mulleri*, in the southern Mojave Desert. I had never seen galls of that type before, and was unsure of their stage of development. Nevertheless, hopeful that the month for collecting them might be right, I put the galls in a specimen jar. Two days later, while on the way home in my warm car, the adults emerged—safe in the container. Had I not been careful, I might have lost them in the car or out an open window. That species still awaits classification.

One long-standing challenge that haunts me has involved several attempts at rearing adults from galls first recorded more than fifty years ago, in a book by Lewis H. Weld entitled *Cynipid Galls of the Pacific Slope*. Weld depicted a vein gall that he had found on the leaves of canyon live oak, *Q. chrysolepis*. He had failed to rear the adults, however, so he left the adult wasp as "undescribed"—and so it has re-

Galls of newly discovered species of wasps, yet to be scientifically named, clockwise from top left: basket gall on blue oak, black vein gall on canyon live oak, flange gall on blue oak, pink bow tie gall on scrub oak

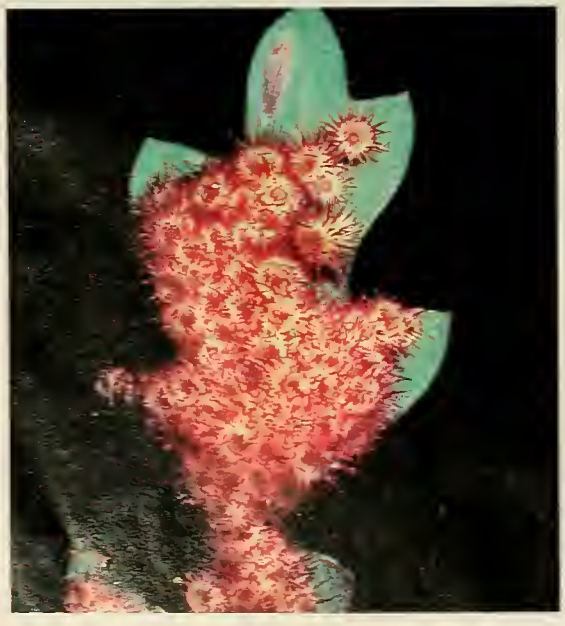
OPPOSITE PAGE: STURGIS MCKEEVER, GEORGIA SOUTHERN UNIVERSITY; BUGWOOD.ORG; THIS PAGE: RON RUSSO

mained. With several canyon live oaks on my property in Mount Shasta, California, and an abundance of those galls, I decided to solve the puzzle. Easier said than done!

The egg of that wasp is laid directly into a leaf's vein, usually at the leaf margin. The vein is essentially extruded out of the leaf and enlarged at its tip to form a gall, which thus enjoys a direct "main line" of nourishment into the larval chamber. The purple, clublike galls begin development in June or July. Although I have collected specimens for rearing in September, October, November, February, March, and May, I have had no results to date. I have found several galls in the field with small exit holes bored in the center, so something most likely came out. But when and under what circumstances the adults emerge, no one yet knows. That species may simply remain undescribed for several more years.

Another mystery has involved the paper gall wasp, *Trichoteras vaccinifoliae*, originally described in 1896. It induces paper-thin, hollow galls in the buds of canyon live oak in the summer. To date, no one has found or described an alternate generation. Every summer a tree on my property produces dozens of that wasp's galls. Last spring, for the first time, I found a tiny new pyramidal leaf gall on that same tree in March and April, with adults emerging in May. Shortly thereafter, the galls of *T. vaccinifoliae* began to appear. Since no other galls appear in similar sequence on that tree, circumstantial evidence suggests that the spring leaf galls might belong to the bisexual generation of *T. vaccinifoliae*. Now that I have adults from both galls, I hope that morphological studies will help clarify their relationship.

Years ago I discovered a previously undescribed gall that I dubbed the "pink bow tie gall" on scrub oak, *Q. berberidifolia*. It was the work of an unknown species of wasp. For six years I frequented the host trees, always late in the summer. Then, to monitor development of the galls, I finally visited the trees in early summer and then came back at regular two-week intervals. At first I saw flat pink disks. Those disks morphed over the summer into the bow-tie shape with which I was familiar. It seems that while larvae are feeding, the disks remain flat. Once they stop feeding, the edges of the galls pinch inward, creating the bow-tie look by late summer or early fall. [*See photograph on page 23.*]



Top left: Striped volcano gall, about one-quarter inch in height, on a blue oak leaf harbors a larva of the wasp Andricus atrimentus. *Above: Beaked twig gall, about one-half inch in diameter, is unique to the wasp* Disholcaspis plumbella *and its host plant, scrub oak. Left: Crystalline tube galls, from the wasp* Trichoteras tubifaciens, *blanket the leaf of an Oregon oak.*

California is a great laboratory for cynipid wasp research, with at least eighteen species of host oaks (about 4 percent of the world's oak species) and several recognized varieties. There is an even richer diversity of gall wasps. In fact, it has been reported that California has more recognized cynipid species than North Africa, Europe, and Asia combined. In his book, Weld listed more than a hundred scientifically named species in California, and another hundred undescribed species. Since then, scientists have successfully connected the two alternating generations of many single species through rearing and morphological studies, thus eliminating some erroneous taxa.

In the U.S. as a whole, about 800 species of cynipids are scientifically named from oaks, roses, and a few miscellaneous host plants. The actual number of species out there is likely

Spined turban gall of the wasp Antron douglasii *grows from the leaf of a valley oak.*

much higher. That thought keeps teasing and pushing me into virgin stands of oaks that I have not examined.

A 2005 report from the University of California, Davis, estimated that about 30,000 acres of oak woodland are lost each year in California owing to development. Even as I help to clarify the biology of some known and new species of wasps, so much about the ecological role of oaks remains just beyond our grasp. That adds a sense of urgency to documenting the diversity of species in oak woodland environments. A single blue oak on a dry foothill slope can be a universe unto itself, with all sorts of predators, prey, and other beneficiaries, including birds, squirrels, and deer—more wildlife associates than any other kind of tree I am familiar with.

Moreover, from what I have seen, I believe that the white oaks of the western U.S., and particularly the blue and valley oaks of the Central Valley and foothills of California, sport some of the most colorful, exotic, and oddly shaped galls found anywhere in the world. The urchin galls that I originally saw in 1969 remain among the most flamboyant of all. Yet they represent only the "tip of the gall-berg," with those of the spined turban gall wasp (*Antron douglasii*), the crystalline tube gall wasp (*Trichoteras tubifacieus*), the sunburst gall wasp (*Andricus stellaris*), the saucer gall wasp (*A. gigas*), and the striped volcano gall wasp (*A. atrimentus*)—and others yet to be discovered—pushing the edge of the envelope of our imagination even further.

The exact mechanisms that lead to species-specific galls remain unknown. As some have suggested, that may be the Holy Grail of entomology. How are the blue oak's leaf cells, for example, being manipulated by the secretions of *A. quercusechinus* to consistently result in galls of the same size, shape, and color? Are the plant's genes being permanently altered? Several researchers in North America and Europe are working hard to understand the complexities of those relationships. The potential applications, in medicine and agriculture, for example, would be intriguing, to say the least.

But the thrill of discovery is what really keeps me in the field. Recently, my wife and I hiked up a heart-pounding 18-percent-grade trail for a mile into the Owen's Peak Wilderness on the eastern side of the Sierra Nevada Mountains. We were looking for a small group of Palmer's oaks, *Q. palmeri*, a shrubby species whose gall associates were relatively unknown. We found only three of the trees growing amid what must be tens of thousands of juniper, cactus, and various desert shrubs—three island specks in an ocean of treeless desert.

An intense two hours of searching paid off: the trees yielded three new species of cynipid galls! How did the wasps find those isolated hosts? For several minutes at the top of the ridge we pondered the evolutionary pairing of plant and insect, and the strange circumstances of their being together. Even though we were exhausted from the climb, the hunt—part of an ongoing quest, more than forty years in the making—was worth every step.

Ron Russo retired six years ago as chief naturalist of the East Bay Regional Park District in Oakland, California. He has published *Field Guide to Plant Galls of California and Other Western States* (University of California Press, 2007), among other field guides. To date he has discovered sixty-five new species of gall-inducing organisms, including bacteria, fungi, aphids, moths, midges, and wasps. Visit www.californiaoaks.org for more information about oak trees and their associates.

Web links related to this article can be found at
www.naturalhistorymag.com

PHOTOS ON THESE TWO PAGES: RON RUSSO

LILIES OF THE SEA

Crinoid fossils posed a puzzle to those who first collected them: were they animal, vegetable, mineral—or otherworldly?

BY ANNA MARIE ROOS

TOP: KEVIN WALSH; © M. J. HANSHART

Lindisfarne Castle, a sixteenth-century fort, rises above the shores of Lindisfarne, the Holy Island, where crinoid fossils have been collected for centuries.

LINDISFARNE, OR HOLY ISLAND, lies just off the coast of northeastern England, picturesquely connected to the mainland at low tide. In July 1671, the English naturalist John Ray made a point of trekking there on one of his "simpling voyages" to gather specimens of medicinal plants for the second edition of his *Catalogue of the Plants of England*. A Cambridge don and Royal Society member, Ray was experiencing a degree of fame. The first edition of his *Catalogue*, the country's first such comprehensive botanical work, had been published in 1670, and his *Experiments Concerning the Motion of Sap in Trees* had appeared a year earlier. Today he is widely recognized as the first person to use the term "species" in the modern biological sense, and his work is credited with inspiring the taxonomist Carl Linnaeus.

BRITISH LIBRARY, YATES THOMPSON 26

St. Cuthbert sails home from the land of the Picts, in what is now Scotland, as depicted in a twelfth-century illumination of the Venerable Bede's eighth-century Life and Miracles *of the saint.*

The island's isolation may have made it a choice place to gather rare plants, but its remote location and spare beauty were also conducive to spiritual practice. In the seventh century, King (later Saint) Oswald of Northumbria invited the Scottish monks who had converted him at Iona (founded earlier by missionaries from Ireland) to build a monastery on Lindisfarne. There monk scribes later created the *Lindisfarne Gospels*, a manuscript famous for its illuminated pages of Celtic knots and iconic saints decorated with gold and red lead.

At the time of Ray's arrival, Holy Island was also famous for its associations with Saint Cuthbert (ca. 634–687). Originally a shepherd boy, Cuthbert became bishop of Lindisfarne, where during his life he was renowned for his holiness and miracles. According to the eighth-century chronicler the Venerable Bede, Cuthbert carried out an all-night prayer vigil while up to his neck in the ocean, and when he emerged from the water, sea otters came and warmed his feet with their breath [*see illustration on following page*]. But it was owing to circumstances following his death that Cuthbert attained his sainthood. According to Bede, the monks exhumed Cuthbert eleven years after his death, to enshrine his bones for veneration, and found his corpse had not undergone any decay. Cuthbert's body, kept on display at Holy Island, became a magnet for pilgrims until repeated Viking raids, beginning late in the eighth century, made the monks quit their monastery around 875. The monks took Cuthbert with them to the mainland, and traveled with his remains for more than a hundred years until he could be laid to rest at Durham Cathedral in England.

Ray delighted not only in those tales, but also in the plants he found on Holy Island, such as German madwort, an herb with hairy leaves and delicate blue flowers. When not plant hunting, he spent his time examining the island's geology. In this he collaborated with his traveling companion, Thomas Willisel, the Royal Society's official collector of minerals, flora, and fauna, and probably England's first professional field naturalist. The two men "gathered on the sea-shore under the town, those stones which they call St. Cuthbert's beads." The "beads," which ranged in size from the diameter of a pea to that of a half dollar, were the ridged and perforated fossil disks of stalked crinoids, or sea lilies.

RAY AND WILLISEL probably found the beads on the northeastern part of Lindisfarne, amid the limestone quarries mined since the fourteenth century for building material and lime plaster. The base of the island is part of the Carboniferous Middle Limestone Group, a geological stratum laid down between 363 million and 325 million years ago. At that time the region that would become northern England was near the Earth's equator, and was covered with warm, shallow seas. The ancient sea bed had thronged with the sea lilies, echinoderms related to starfish and sea urchins. They persist today, though with far less diversity.

While some crinoids, called "feather stars," are mobile and free-swimming, a sea lily's base is stuck to the seafloor, and from it grows a flexible stem supporting a head, or calyx. From the head grow five (or multiples of five) branched and movable arms, which filter food particles and tiny organisms from the seawater. Cilia lining grooves on the insides of the arms manipulate the food down to the mouth, which is situated in the center of a membrane that covers the base of the arms. The flexible branches and stem are made up of waferlike calcareous plates stacked on each other and strung together by ligaments. In the center of the stem and each arm is a fluid-filled body canal through which a nerve cord passes.

In ancient times, when sea lilies died, their remains accumulated along with shells and other hard parts of

corals and brachiopods to create a calcium layer. All those remains, cemented together by carbonate mud and subjected to geothermal heat and pressure, became the consolidated limestone.

Crinoid paleontologists William J. Ausich of Ohio State University and the late N. Gary Lane have noted that when fossilized, the individual plates of the stem and arms usually separate. At the center of each is the hole that once accommodated the nerve, thus creating the impression of a perforated bead. Local legend claimed that Cuthbert had made the beads for his brethren, to string together for their rosaries. And after his death Cuthbert's spirit supposedly continued making nocturnal visits to his "forge" on the island to replenish the supply. The shore is still found strewn with the beads after a storm, attesting to the saint's continued ghostly presence—or at least to the continued abundance of fossil sea lilies in the area.

©BRITISH LIBRARY BOARD/THE BRIDGEMAN ART LIBRARY

St. Cuthbert prays in the sea, and then otters dry his feet, as another monk watches: the legendary event, recorded by Bede around 721, illuminates a twelfth-century manuscript.

In other parts of England, the coinlike beads were known as fairy money, and intact cylindrical stems, ringed with ridges, as screw stones. Beads with pentagonal shapes were called star stones, and legend had it that they were created in the clouds and dropped to the Earth during thunderstorms. The sixteenth-century German author Georgius Agricola, in his work *De Re Metallica* ("Of Metallic Things," a work also devoted to other minerals and to fossils), described the same sorts of stones. But the Germans called them *Bonifatiuspfennige,* or Saint Boniface's pennies, displaying pride in their own local religious luminary.

IN THE SEVENTEENTH century, natural history practitioners, such as John Ray, were not just interested in the bare empirical details of their objects of study, but in the connections of the natural world with local legends, religious lore, and practical or economic uses. In accord with the original mission of the Royal Society, of which Ray had been a member since 1667, nature was to be examined in the context of human purpose and activity. Ray was surely bemused by local legends. But he speculated that rather than being sacred jewelry, the small beads were "nothing else but a sort of entrochi," the Latin term for stones in the shape of tiny wheels. The question remained, how were the "entrochi" formed?

Although today we regard fossils as the traces of living creatures, many seventeenth-century investigators thought they could be created spontaneously by nature. They postulated that metals and minerals were generated and nurtured in deep mines, considered to be Mother Nature's womb. In that view, underground aquifers carried waters with generative seeds that, in the heat below ground, could develop into stones resembling living creatures. Perhaps the beads were the result of such processes. Trilobites and other intriguing stones had been found that did not resemble any existing living creatures, giving weight to the idea that fossils were merely "formed stones." (Since the Christian creed taught that all species were created by God as described in the book of Genesis, any thought of extinct species was considered heterodox.)

Most likely Ray later consulted Martin Lister, a physician and fellow naturalist, to see what he thought about the matter. One of those "virtuosi" who dabbled in everything and excelled at much, Lister is considered to be the first English arachnologist, the father of conchology, and the inventor of the histogram and the stratigraphic geological map. Ray met the younger man when Lister was a medical student in Montpellier in the mid-1660s. They subsequently traveled together in France and in the area around the home of Lister's parents in Lincolnshire to collect flora and fauna, and the two men were frequent correspondents. Because physicians were expected to have ready knowledge of mineral, botanical, and animal products to prepare drugs, Ray would have valued Lister's thoughts on St. Cuthbert's beads. (Later, however, they had a falling-out over Lister's claim to have discovered ballooning spiders first.)

IN A PAPER PUBLISHED in the *Philosophical Transactions of the Royal Society* in 1673, Lister mentioned having found the beads in the Yorkshire villages of Braughton and Stock. His wife, Hannah, a relative of England's first royal botanist, John Parkinson, had inherited a house in the area, so Lister was well acquainted with the local geological wonders, such as Malham Cove, the Gordale Scar, and the Craven Fault. (Another notable landmark today is the Lister Arms, a local pub that commemorates the naturalist's family.)

The Craven Fault is actually a series of geological faults that runs along the southern and western edges of the Yorkshire Dales, a region also composed of carboniferous limestone, consisting of the folded and faulted layers of former marine beds and coral atolls. Crinoid fossils abound in the exposed rock. Most specimens just consist of the columnar stem—or parts of it—and Lister used vinegar to dissolve some of the limestone and break apart the stem sutures to look at individual beads. But one rare whole specimen also has a radix, or root structure, and a calyx, or head, which Lister called a "top stone." In life, the calyx held the soft parts of the animal, from which rose the crown of jointed arms. A landscape artist named William Lodge, whose mother came from a village in the vicinity of Craven Fault, did engravings of Lister's specimens for his scientific paper. The specimens seem to have included the spines of sea urchins intermixed with the crinoids.

Lister quite reasonably thought the branching nature of the crinoids meant they were plantlike, although, as John C. Thackray has noted, he was "confusing arms with roots, calyx with radix." Lister did not think his finds were actually plants—just shaped like them. His previous publications on fossils noted that because their composition was the same as the stone in which they were embedded, they were *lapides sui generis,* or stones spontaneously created by nature alone—not the remains of living organisms. For his part, Ray commented in an appendix to Lister's paper:

> Those Roots, that you have observed, are a good argument, that these Stones were originally pieces of Vegetables. Wonderful it is, that they should be all broken, and not one plant found remaining entire: And no less wonderful, that there should not at this day be found the like vegetables growing upon the Sub-marine rocks; unless we will suppose them to grow at great depths under water. And who knows but there may be such bodies growing on the rocks at this day, and that the Fishers for Coral may find of them; tho being of no use they neglect and cast them away. Certain it is, there is a sort of Coral jointed.

Taking a cue from Ray's comments, John Beaumont, a Somerset physician and naturalist, also compared the crinoids to coral. In two 1676 letters, also published in the *Philosophical Transactions,* Beaumont postulated that corals and crinoids were a kind of stone intermediate between the mineral and vegetable kingdoms. He argued

DEREK SMETER, OUMNH

©THE NATURAL HISTORY MUSEUM, LONDON

Above: Sea lilies, Woodocrinus *macrodactylus, are preserved in ca. 300-million-year-old Carboniferous limestone beds in Yorkshire, England. These specimens were described in 1854 by Belgian paleontologist L.G. de Koninck, who knew them to be marine animals. Below: At Lindisfarne, the separated segments of fossil crinoid stalks, called St. Cuthbert's beads, were often used for rosaries. The central holes in the "beads" are natural; in the living animal they allowed passage of a nerve cord through a fluid-filled canal.*

the crinoids were produced in the same way as the crystallization of cave stalactites and snowflakes. Or, he speculated, perhaps "mineral steams" and smells arising from ores had a potent force that would spontaneously engender these "rock-plants." Beaumont's ideas were not unusual for the time. Iron ore smelled oily, and pyritic ore had a sulfurous odor; miners would use those smells to take them to rich seams of minerals. The German mining theory of *witterung* postulated that the smells themselves could produce the ore. Beaumont even suggested that the new "statical baroscope" invented by chemist Robert Boyle could be used to detect such mineral "steams" by measuring their effect on atmospheric pressure.

Although Beaumont's hypotheses about the mysterious effluvia that emanated from minerals were a scientific dead end, the legend of the beads continued to fascinate folklorists in the eighteenth and nineteenth centuries. Sir Walter Scott, who often drew upon ballads and medieval lore for his poetry, most famously told the story of Cuthbert and the beads in his narrative poem *Marmion* (1808). A great commercial success that cemented his literary reputation, Scott's poem told the story of the nefarious designs of Lord Marmion, a court favorite of Henry VIII, upon the wealthy heiress Clara de Clare. To accomplish his evil deeds, Marmion enlisted the help of his mistress Constance De Beverley, a fallen nun, but then later abandoned her. Constance was subsequently condemned to death for breaking her religious vows and walled up alive in the convent of St. Hilda on the Holy Island, Lindisfarne. Scott wrote:

> But fain Saint Hilda's nuns would learn
> If, on a rock, by Lindisfarne,
> Saint Cuthbert sits, and toils to frame
> The sea-born beads that bear his name:
> Such tales had Whitby's fishers told,
> And said they might his shape behold,
> And hear his anvil sound:
> A deadened clang—a huge dim form,
> Seen but, and heard, when gathering storm
> And night were closing round.
> But this, as tale of idle fame,
> The nuns of Lindisfarne disclaim.
> —Canto the Second, Verse XIV

Stalked crinoid in the Gulf of Mexico is a filter-feeding animal that lives anchored to the seafloor, as did the fossil crinoids responsible for St. Cuthbert's beads.

NURC/UNCW AND NOAA/FGBNMS

CRINOIDS REMAIN an important subject of scientific research. Despite their dominance in the Paleozoic fossil record, they nearly died out at the end of the Permian period, reduced to a single subclass [*see "The Search for Evidence of Mass Extinction," September 2009*]. Sea lilies are now the only echinoderms that attach themselves to the sea bottom and filter feed. Most modern stalked crinoids inhabit very deep water, but despite the difficulties in observing them, paleontologists are keen to study them because of their resemblance to their extinct ancestors.

In a recent review of the literature, crinoid experts William Ausich and Thomas Kammer, a geologist at West Virginia University in Morgantown, emphasize that "the immediate challenge for the study of crinoids is to establish a phylogenetic classification for the entire class." They also stress how difficult it is to distinguish species, many of which go unrecognized. The abundance of crinoids in the fossil record will continue to provide new clues to their own evolution as well as insights into the changes in ancient marine ecosystems. The legends of St. Cuthbert's beads are not needed to capture the scientific imagination—but they continue to add to the intrigue.

Anna Marie Roos is a historian of early modern English science and medicine and a research fellow in the Modern History Faculty at the University of Oxford. She is editing the correspondence of Martin Lister for publication as part of the Cultures of Knowledge Project at the University of Oxford. Her third book—*Spiderman: Martin Lister (1639–1712), Naturalist and Physician*—will be published by Brill in 2010.

BOOKSHELF BY LAURENCE A. MARSCHALL

For the Coffee Table

Extreme Birds: The World's Most Extraordinary and Bizarre Birds, by Dominic Couzens; Firefly Books, 2008; 288 pages, $45.00
Waterbirds, by Theodore Cross; W.W. Norton & Co., 2009; 344 pages, $100.00

You expect outstanding graphics from Firefly Books, but *Extreme Birds* also excels at wit. It's a sort of illustrated Guinness Book of Ornithological Records, highlighting the birds with the biggest eyes, heaviest testes, and warmest nests. Some of the delight is in the author's choice of categories: Pallas's sandgrouse, native to central Asia, wins the "snuggest underwear" prize for the thickness and coverage of the downy feathers beneath its decorative plumage. But Mother Nature provides plenty of wit herself. The "funniest forager," for instance, is the bassian thrush of eastern Australia, which farts repeatedly when feeding. The flatulence, we are told, startles earthworms into revealing their location. As with so many of the feathered factlets in this book, who knew?

Equally extraordinary is the avian album of Theodore Cross, an octogenarian lawyer, entrepreneur, social activist, and *very serious* birder. In an introductory section, he recounts visits to some of the most remote birding sites on the planet, from the high Arctic desert of Ellesmere Island, northern breeding ground of the Patagonian red knot, to Johnston Atoll in the central Pacific, where the rarely seen Bulwer's petrel makes its nest. The color photographs, so richly detailed that you can see texture in each feather, convey deep empathy with the natural world. The birds preen, strut, and pose—as if the photographer were not just watching from a distance, but sharing intimate moments with good friends.

Great Plains: America's Lingering Wild, by Michael Forsberg with Dan O'Brien, David Wishart, and Ted Kooser; University of Chicago Press, 2009; 260 pages, $45.00

One of Michael Forsberg's most arresting photographs shows a female bobcat staring at the camera. The felines are relatively common in parts of the Great Plains, we're told, but being shy of humans and well camouflaged, they're rarely glimpsed. The bobcat is emblematic of the Great Plains—both are natural treasures that most Americans are barely aware of. We travel over or through the vast swath of Midwestern landscape as fast as we can, missing the beauty of seasonal flowers, secretive wildlife, and prairie wetlands. Thanks to Forsberg and his essayist collaborators, we now may linger and learn. The images range from panoramic cloudscapes over seas of grass to group portraits of bison, bighorn sheep, and sandhill cranes. The book's subtitle calls the region "America's Lingering Wild," but Forsberg sounds a note of caution: "only a fraction of the habitat from a century ago remains."

AntArctic: A Tribute to Life in the Polar Regions, by Michael Poliza; teNeues, 2009; 408 pages, $125.00

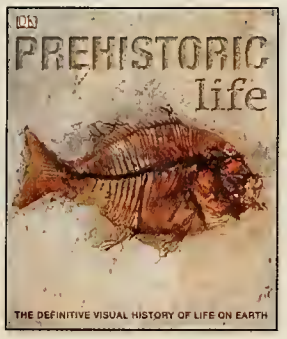
Aside from a few testimonials at the beginning, 182 short captions sequestered at the back, and a concluding biographical essay on the photographer, there's not a word of text throughout this monumental book. All to the good: Michael Poliza's photo-essay on both polar regions will dazzle you with detail and give you plenty to think about. Most of his photographs tell stories about creatures we seldom get to see in the wild. One series shows polar bears sparring half playfully amid rugged drifts of ice. Another shot shows a group of Adélie penguins marching in platoon formation along a shoreline—with one contrarian bird enigmatically heading the other way. Poliza's cinematic style conveys an indelible impression of two of the few places on Earth where humans are conspicuous by their absence.

Evolution: The Story of Life, by Douglas Palmer, illustrated by Peter Barrett; University of California Press, 2009; 374 pages, $39.95

If time machines were real, this would be the book to carry on nature hikes into the distant past. Science writer Douglas Palmer and natural history illustrator Peter Barrett have created a field guide to evolution that should win the praise of scholars and armchair paleontologists alike. Barrett's 100 double-page illustrations and two gatefold spreads trace the development of life on Earth from the stromatolites of 3.4 billion years ago through eras of fantastic, vanished diversity to modern-day *Homo sapiens*. Complementing the drawings are Palmer's explanatory text, a section showing family trees of the various species, a listing of the fossil species by groups, and a "gazetteer" describing the geologi-

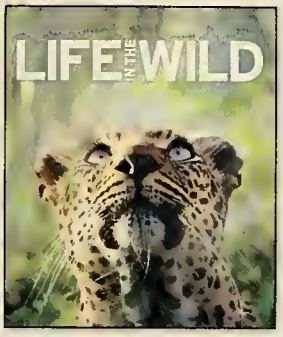
Continued on page 36

Great Gift Books for the Entire Family



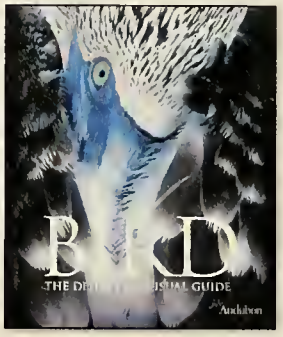
A fascinating and revealing encyclopedia to hundreds of prehistoric species.

$40 / hc / 512 pages



Discover the diversity and beauty of the world's most amazing animals.

$35 / hc / 360 pages

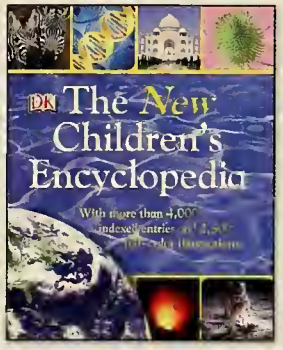


An unrivaled guide to more than 1,400 species from around the globe.

$27.95 / pb / 512 pages

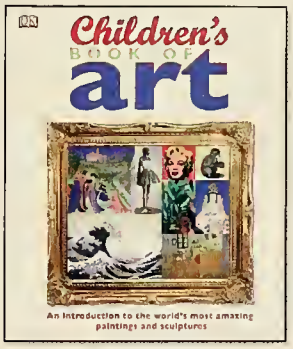
Discover some of the most incredible wildlife habitats on the planet.

$24.95 / pb / 360 pages



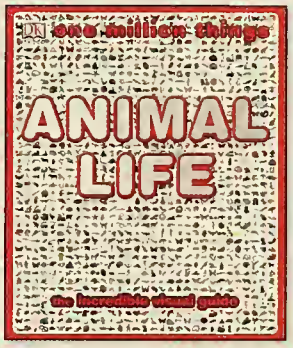
Open the pages and find the answers to all the questions children love to ask.

$29.99 / hc
304 pages / ages 6+



A colorful and comprehensive tour of international art through the ages.

$24.99 / hc
144 pages / ages 8+



Full of incredible facts, it's like a natural history museum and the world's biggest zoo rolled into one.

$18.99 / hc
128 pages / ages 8+

From coral reefs to magnificent meteorites, there are millions of things to learn about planet Earth.

$18.99 / hc
128 pages / ages 8+

Available wherever books are sold.

DK

us.dk.com
www.kiddk.com

Gifts for Budding Scientists

By Diana Lutz

FOR YOUNG READERS

Down Down Down: A Journey to the Bottom of the Sea, *by Steve Jenkins; Houghton Mifflin Books for Children, 2009; 40 pages, $17.00*

A bestiary of sea creatures in cut paper, *Down Down Down* is this year's gift to children from master illustrator Steve Jenkins. Flipping the pages, we sink gradually lower in the western Pacific Ocean and finally plummet to the Challenger Deep, a seafloor canyon people have visited only once. Text on each spread describes inhabitants' adaptations to the increasing depth. Animals living at 330 feet, for example, have fluid-filled bodies without air pockets that might collapse under pressure. At 6,500 feet, meals are so infrequent that some animals have stretchable stomachs so they can eat prey many times their size. The deeper we go, the more outlandish the creatures become, until finally we are in the fantastic company of the loosejaw stoplight fish, the black swallower, and the fangtooth, all rendered in astonishing cut-paper collages.

Marsupials, *by Nic Bishop; Scholastic Nonfiction, 2009; 48 pages, $17.99*

What child would not want to learn about boodies, dibblers, potoroos, noolbengers, and quolls—especially when they turn out to be small furry animals with pockets and large, luminous eyes? Nic Bishop's photos of the marsupials of Australia are technically superb, and, as a PhD biologist, he can be counted on to provide accurate context, as well as offbeat details about particular animals. (Who knew that mother koalas make a special kind of poop, called pap, that the joeys eat during weaning?) In an afterword, Bishop explains how he set up camera traps with infrared triggers to photograph the mostly nocturnal animals.

FOR INTERMEDIATE READERS

The Frog Scientist, *by Pamela S. Turner, photographs by Andy Comins; Houghton Mifflin Books for Children, 2009; 64 pages, $18.00*

The latest addition to the remarkable series *Scientists in the Field* describes the research of Tyrone Hayes, of the University of California, Berkeley, on the effect of pesticides on frog development. Hayes, a far from stereotypical scientist, nearly flunked out of Harvard but was rescued by a professor who saw beyond his grades. Turner describes Hayes's research in detail, and significantly, the featured experiment has an ambiguous outcome, perhaps because of an error in experimental design. But of course Hayes's willingness to expose that failure is what makes him a true scientist. Like many environmental problems, frog declines are proving maddeningly complex. The pesticides Hayes worries about are clearly implicated, but, says Turner, so are a fungus, ultraviolet light, introduced species, parasites, and habitat loss. Yet *The Frog Scientist* doesn't belabor that downbeat message: instead, the tone is set by Hayes's irreverent comments and warm smile, and by the excitement of his students.

Written in Bone: Buried Lives of Jamestown and Colonial Maryland, *by Sally M. Walker; Carolrhoda Books, 2009; 144 pages, $22.95*

I can't remember ever having seen forensic anthropology covered so well in a children's book. *Written in Bone* describes five skeletal mysteries from America's early colonial period, investigated by Smithsonian Institution anthropologist Douglas Owsley. Through careful attention to the bones, Owsley and his colleagues make the skeletons of people otherwise lost to history speak movingly of their lives. In one riveting chapter, the skeleton of a boy is found in a trash pit that once lay beneath the floor of a planter's house. Given the hugger-mugger burial and the skeleton's broken bones, the boy was probably an indentured servant, perhaps one who died after a beating and was secretly

buried by his employer. Thickening of the bones where the muscles attached and concave depressions in certain vertebrae suggest the boy was overworked. Other subtle bony signs indicate he was Caucasian, suffered from tuberculosis, and hadn't lived in America long. The five cases are fascinating, but what sticks in the mind is Owsley's skill at reading the bones.

HONORABLE MENTIONS

How to Scratch a Wombat, *by Jackie French, illustrated by Bruce Whatley; Clarion Books, 2009; 96 pages, $16.00*
A woman who has studied the Australian marsupials for three decades gives us a diverting mixture of wombat science and stories. Illustrated with pencil drawings of wombats being adorable, this is a book no child will be able to resist.

A Place for Birds, *by Melissa Stewart, illustrated by Higgins Bond; Peachtree Publishers, 2009; 32 pages, $16.95*
Eleven case histories, illustrated with colorful acrylic paintings, demonstrate the impact of human behavior on the well-being of birds. Problems are accompanied by possible solutions, and the book's tone is spot on: practical, informed, and optimistic.

FOR ADVANCED READERS

The Evolution of Calpurnia Tate, *by Jacqueline Kelley; Henry Holt and Co., 2009; 352 pages, $16.95*
The protagonist of this historical novel lives in Fentress, Texas, in 1899. Calpurnia, a girl with six brothers, has just become aware of her impending metamorphosis into a woman. The only available role model, her mother, suffers in the summer heat from her supercargo of hairpieces, while servants do most of the housework. Calpurnia is alternately depressed and enraged by pressure to learn the domestic arts. She turns to her grandfather, a Civil War captain and amateur scientist who has corresponded with Darwin himself. Grandfather introduces Calpurnia to *The Origin of Species* and teaches her to observe, record, and experiment. Together they discover a distinctive hairy vetch that they send to taxonomists at the Smithsonian Institution as a candidate new species. While they await a verdict, her mother suggests Calpurnia should make her debut in society, and she begins to feel that she will be trapped in the traditional female role. It is a pleasure to read a coming-of-age novel by a writer who understands science and its call to the intellect, regardless of age or gender.

Almost Astronauts: 13 Women who Dared to Dream, *by Tanya Lee Stone; Candlewick Press, 2009; 144 pages, $24.99*
Everyone knows the 1959 portrait of the Mercury Seven astronauts: seven grinning guys in seven shiny silver suits looking smashing. *Almost Astronauts* tells the story of the thirteen female pilots who never made it into the silver suits. They passed the

preliminary tests to qualify as astronauts, but were shut out at the behest of then vice-president Lyndon Baines Johnson. He explained privately that if he let women into the space program, "we'd have to let blacks in. . . . We'd have to let every minority in, and we just can't do it." In the end, the men defeated the women with a catch-22: women could not become astronauts because they hadn't been jet test pilots—but only men were allowed to be jet test pilots. Stone tells the story in the words of the time, lifted from old copies of *Life*, *Look*, and other popular accounts. Sadly, John Glenn, Scott Carpenter, and other American heroes made demeaning comments, in line with the sexism of their day. *Almost Astronauts* is an upsetting book, but a much truer portrait of an era than the many self-congratulatory celebrations of the Moon landing published this year.

HONORABLE MENTION

Our Farm: Four Seasons with Five Kids on One Family's Farm, *written and photographed by Michael J. Rosen; Darby Creek, 2008; 144 pages, $18.95*

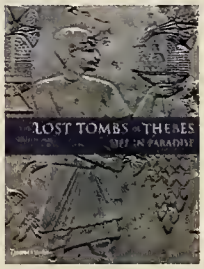
Too few children's books cover working farms realistically; this one, published too late for review last year, is particularly deserving of recognition. A photographic journal of one year in the life of an Appalachian farm, it evokes farm life in the words of the five kids who live there. The kids work hard, but they also play with abandon. Their commonsense attitudes about sex, death, and manure will be a revelation to most young readers.

DIANA LUTZ is a freelance science writer and editor, as well as the former editor of Muse, *a science magazine for young people. She lives in St. Louis, Missouri.*

Continued from page 32

cal sites that yielded fossil evidence for each illustration.

The Lost Tombs of Thebes: Life in Paradise, *by Zahi Hawass, photographs by Sandro Vannini; Thames and Hudson, 2009; 288 pages, $80.00*



As secretary general of Egypt's Supreme Council of Antiquities, archaeologist Zahi Hawass recently helped relocate an entire village built over a warren of tombs on the west bank of the Nile, to permit the tombs' preservation and examination. Now Hawass and his long-time collaborator, Italian photographer Sandro Vannini, have documented a wealth of artifacts from those tombs, which hold denizens of the ancient capital city, Thebes. Only a few scholars have ever seen the tombs or their contents, and—given the tombs' fragility—few members of the public ever will. Exquisitely detailed color photographs of murals and wall carvings record the religious and social scene in Egypt thirty-six centuries ago, as experienced not by pharaohs, but by lesser court figures, viziers, generals, architects, and priests.

Endless Forms: Charles Darwin, Natural Science and the Visual Arts, *edited by Diana Donald and Jane Munro; Yale University Press, 2009; 358 pages, $75.00*

Kudos to the Fitzwilliam Museum in Cambridge, England, and the Yale Center for British Art in New Haven, Connecticut, for mounting a major exhibition on the connections between Charles Darwin and the visual arts, in cel-

ebration of his 200th birthday. The dozen essays in this handsome volume provide much more than a catalog of the works displayed. They illuminate how the depiction of nature in paintings and illustrations influenced Darwin, who, unlike many great naturalists, could not draw. Darwin's writings, in turn, inspired works by contemporary painters, photographers, and illustrators, including the oft-reproduced engraving showing a progression of skeletons from gibbon to chimpanzee to man, and darkly humorous oils depicting apes contemplating works of art.

Smithsonian Atlas of Space Exploration, *by Roger D. Launius and Andrew K. Johnston; HarperCollins, 2009; 240 pages, $34.99*
Moon 3-D: The Lunar Surface Comes to Life, *by Jim Bell; Sterling Publishing Co., 2009; 160 pages, $19.95*

Here are two books that celebrate the blossoming of the space age in different ways. The *Smithsonian Atlas of Space Exploration* is a pictorial compendium of everything space-related, neatly arranged in sections covering the birth of rocketry, the first manned missions, the pioneering of Earth orbit, the exploration of the Moon, and the unmanned probing of the solar system. There are cutaway drawings of classic rockets, maps of lunar landing sites and the world's spaceports, and a host of other remarkable photographs, diagrams, and tables. For the confirmed space buff and the appreciative lay reader alike, this is transport to seventh heaven.

Rendering the Moon in 3-D might be just a bit of techno-fakery, especially since most lunar missions didn't carry stereo cameras. But *Moon 3-D* author Jim Bell, a Cornell University astronomer who leads the imaging team for the Mars rovers, explains that NASA's archives of lunar photography contain many views of the same landscapes from different angles, which can be computer-processed to create accurate 3-D images. Just look through the red and blue gels of the flip-up viewer mounted on the front cover, and—voila!—craters, mountains, and even the footprints of the astronauts leap from the page.

Laurence A. Marschall is W.K.T. Sahm Professor of Physics at Gettysburg College in Pennsylvania and coauthor, with Stephen P. Maran, of Pluto Confidential: An Insider Account of the Ongoing Battles over the Status of Pluto, *published by BenBella Books.*

Discover an easy way to enjoy better wines. And SAVE $120 now.

(under $6 a bottle)

Only $69.99 worth $189.99

With wine, a little insider advice is always very useful. The Discovery Club from WSJwine offers you precisely that.

Start with this superb case of reds – and a $120 savings!

Look forward to sumptuous Sonoma Cabernet, chocolaty-rich Barossa Shiraz, silky Pinot Noir from a ten-time California Winery of the Year and fine Bordeaux handmade on a small estate in the heart of the region.

Taste why critics are so excited about Argentina's Malbecs with an inky-black trophy winner. Enjoy deep, dark Italian Primitivo (50 awards in 6 vintages). Then authentic vanilla-oaky Rioja and top estate Chilean Cabernet of terrific black currant purity.

Your wine, your choice. No fees, no obligation.

Every three months, we will reserve a special 12-bottle case of reds for you – priced at $139.99, with satisfying savings. We tell you in advance about the wines. If you're happy with them, you need do nothing – they'll be delivered to you with tasting notes on each. Perhaps you'd prefer a mixed or all-whites case – just call us for the details.

If you don't need wine at that time, simply let us know. You have no obligation at all – and there are no membership fees. The Discovery Club is just a wonderfully convenient way to keep your wine rack well-stocked. Every wine guaranteed to please, or your money back.

WSJwine
from
THE WALL STREET JOURNAL.

12 delicious reds
ONLY $69.99 – SAVE $120
($12.99 shipping plus applicable sales tax)

***Your* FREE GIFT**
$49.99 value

Order now and you'll also receive a FREE deluxe lever-action corkscrew set.

Call now 1-877-975-9463
or visit wsjwine.com/90018

To order please quote code 2090018
Lines open Mon–Fri 8am-11pm,
Sat & Sun 8am-8pm EST

"TV Ears saved our marriage!"

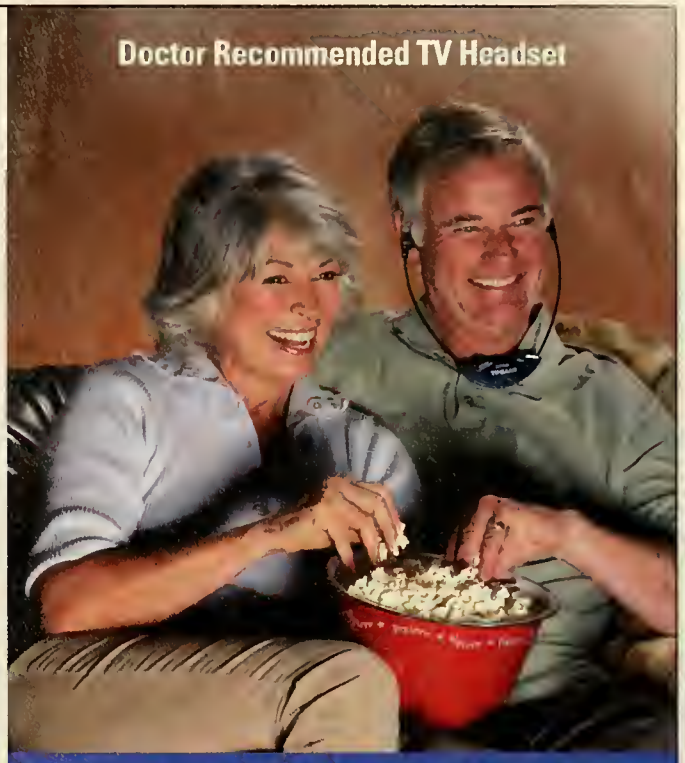
—Darlene and Jack B., CA

Doctor Recommended TV Ears has helped thousands of people with hearing loss hear the television clearly without turning up the volume! With TV Ears wireless technology, you set your own headset volume and tone, while family members set the television volume to a pleasant level or mute the volume altogether. Imagine watching television with your family again and hearing every word clearly... as thousands of our customers have said, "TV Ears has changed our lives!"

TV Ears Patented Technology includes a revolutionary noise reduction ear tip, not used in any other commercially available headset. The TV Ears patented Comply™ foam tip creates an acoustically sealed chamber with the ear that reduces outside noise and increases word discrimination so that television dialog is clear and understandable. Get the technology that has proven to help the most demanding customers. That's why TV Ears has earned the trust and confidence of audiologists nationwide as well as world renowned doctors.

From George Dennis, president and founder of TV Ears, Inc. "Driven by my personal understanding of the impact that hearing loss has on a family, I set out to create a product to relieve one of the most frustrating aspects of hearing loss...watching television. Put on TV Ears and enjoy television once again!"

#1 Dr. Recommended TV Headset. "My wife and I have used TV Ears almost daily for the past two years and find them an invaluable help in our enjoyment of television—we would not be without them. As a retired otologist, I heartily recommend TV Ears to people with normal hearing as well as those with hearing loss."
—Robert Forbes, M.D., California



Hear television dialog clearly without disturbing others with loud TV volume!

Transmitter also charges headset!

"Now my husband can have the volume as loud as he needs...and I can have the TV at my hearing level. "TV Ears" are so comfortable that Jack forgets he has them on! He can once again hear and understand the dialog."
— Darlene & Jack B., CA

Risk Free Trial. TV Ears 2.3 comes with a 30-day risk free trial. If you're not completely satisfied, return it for a full refund of the purchase price.

TV Ears $99.95

Call now and get FREE shipping!†

For fastest service, call toll-free 24 hours a day

1-866-611-9935

Or visit

www.tvearsproducts.com

Please mention Promotional Code 33439

30-day risk free trial

To order by mail please send a check to:
TV Ears Direct • 2810 Via Orange Way #A
Spring Valley, CA 91978

Doctor Recommended...Consumer Tested!

- Works better than hearing aids!
- Comfortable lightweight design (only 1.6 oz.)
- Over 1,000,000 satisfied customers!
- Rechargeable lead free battery
- The most powerful headset (120 decibels)

TV·EARS®
Dr. Recommended TV Listening Devices

† Free shipping within the contiguous 48 states only.

NATURAL HISTORY Marketplace

STATEMENT OF OWNERSHIP

Statement of Ownership, Management, and Circulation (required by PS Form 3526). Publication Name: Natural History. Publication Number: 374-800. Filing Date: September 30, 2009. Issue Frequency: Monthly, with combined issues in December/January and July/August. Number of Issues Published Annually: Ten. Annual Subscription Price: $30. Complete Mailing Address of Office of Publication and General Business Office: Natural History Magazine, Inc., 36 W. 25th Street, New York, NY 10010. Publisher: Charles E. Harris; Editor in Chief: Vittorio Maestro, 36 W. 25th Street, New York 10010. Owner: Natural History Magazine, Inc., 36 W. 25th Street, New York 10010. Stockholders: Peter G. Brown, 310 W. 85th Street, New York, NY 10024; Exeter Capital Partners, One Post Office Square, 12th fl., Boston, MA 02109; Todd Happer, 36 W. 25th Street, New York 10010; Charles E. Harris, 36 W. 25th Street, New York 10010; Robert E. Marks, 5 Greenwich Office Park, Greenwich, CT 06831; David W. Niemiec, 535 Madison Ave., New York, NY 10022. Known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities: None. Tax Status: N.A. Publication Title: Natural History. Issue Date for Circulation Data Below: October 2009. Extent and Nature of Circulation. Average number copies of each issue during preceding 12 months: a. Total average number of copies printed: 225,638. b. Paid Circulation: (1) Mailed Outside-County Mail Subscription: 213,340. (2) Mailed In-County Paid Subscription: 0. (3) Paid Distribution Outside the Mails including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside the USPS: 5,489. (4) Paid Distribution by Other Classes Mail through the USPS: 0. c. Total Paid Distribution: 218,829. d (3). Free or Nominal Rate Distribution by Mail: 0. d (4). Free or Nominal Rate Distribution outside the Mail: 2,582 e. Total Free or Nominal Rate Distribution: 2,582. f. Total Distribution: 221,411. g. Copies not Distributed: 4,227. h. Total: 225,638. i. Percent Paid: 98.8%. Number Copies of Single Issue Published Nearest to Filing Date (October 2009): a. Total Number of Copies: 180,578. b. Paid Circulation: (1) Mailed Outside-County Mail Subscription: 173,967. (2) Mailed In-County Paid Subscription: 0. (3) Paid Distribution Outside the Mails including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside the USPS: 3,173. (4) Paid Distribution by Other Classes Mail through the USPS: 0. c. Total Paid Distribution: 177,140. d (3). Free or Nominal Rate Distribution by Mail: 0. d (4). Free or Nominal Rate Distribution outside the Mail: 1,676 e. Total Free or Nominal Rate Distribution: 1,676. f. Total Distribution: 178,816. g. Copies not Distributed: 1,676. h. Total: 180,578. i. Percent Paid: 99.0%. I certify that all information above is true and complete. Charles E. Harris, President & CEO.

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO.14 MAPLE SHADE, NJ

Postage will be paid by Addressee

NATURAL HISTORY

PO Box 9000

Maple Shade NJ 08052-9600

fyi READER SERVICE

For free information from the advertisers listed below, circle the corresponding numbers on the attached postage-paid card. Mail card, fax it to 856-380-4101, or visit us at www.naturalhistorymag.com. If the card is missing, mail your request to: P.O. Box 9000, Maple Shade, NJ 08052.

ADVENTURE TRAVEL/TOURS

1. AMAZONIA EXPEDITIONS
Award-winning Jungle Lodge in the Tamshiyacu-Tahuayo Reserve, shown to have the greatest diversity of mammals in all of the Amazon.

2. BUSHTRACKS
Tailor-made adventures by private air to exotic destinations in Africa, India, and South America. Expert guides and educational experiences.

3. CHEESEMANS' ECOLOGY SAFARIS
In-depth wildlife tours to unique destinations: Antarctica, Africa, Bhutan, more! Maximum field time, small groups.

4. FOREIGN INDEPENDENT TOURS
We are your travel experts for the Mediterranean, Europe and Africa.

5. GALAPAGOS TRAVEL
Comprehensive, educational, professionally-led natural history tours of the Galapagos Islands. 11- or 15-day tours of all the significant outer islands.

6. MAYA RESEARCH PROGRAM
MRP offers opportunities to participate in archaeological excavations and study tours in Belize.

7. MAYATOUR
Pioneered Maya Archaeology Tours in Central America and Mexico. Now offering Inca Archaeology Tours in Peru and Bolivia.

8. SERIOUS TRAVELER
Small groups to Iran, Silk Road, Mongolia, Tibet, Uzbekistan, Myanmar, Libya, Jordan, Egypt, Morocco and Ethiopia.

9. TARA TOURS
Specialists in travel to Central and South America since 1980. Free brochures and quotes.

10. WILDSIDE NATURE TOURS
Small group photo workshops, birding tours and family adventures! Alaska and Galapagos cruises, African Safaris and much more!

11. ZEGRAHM EXPEDITIONS
Offers small-group expeditions to remote locations. Our expertly led programs provide the finest adventure travel experience imaginable.

CANADA

12. NEW BRUNSWICK
Walking on the ocean floor…just one of the Magnifique moments waiting in New Brunswick.

13. NEWFOUNDLAND & LABRADOR
It's a short trip to the very end of the Earth, where the dawn breaks first at the most easterly edge of the continent.

14. NOVA SCOTIA
You're invited to explore scenic beauty, rich heritage and vibrant culture of Nova Scotia on Canada's seacoast.

15. TOURISM PRINCE EDWARD ISLAND
Come experience our unique red cliffs and parabolic sand dunes and hike or bike the Confederation Trail.

CRUISES

16. AMERICAN CANADIAN CARIBBEAN LINE
Cruise historic American waterways and Caribbean to places usually only accessible by private yacht. Spectacular itineraries, 100 guests.

17. CANODROS
Canodros offers up-scale services in Ecuador with the Galapagos Explorer II. Enriching experience of the culture and natural history.

18. LINDBLAD EXPEDITIONS
Live an issue of National Geographic with Lindblad Expeditions. Special offers on expedition cruises.

19. SWAN HELLENIC
See the world from a different point of view with Swan Hellenic's country house style.

20. VOYAGES TO ANTIQUITY
Unique cruises to classical civilizations of the Mediterranean aboard the Aegean Odyssey with shore excursions and gratuities included plus free $199 air add-ons.

21. VOYAGES OF DISCOVERY
Voyages of Discovery takes you to Asia, India, Africa, Northern Europe and the Mediterranean on *mv Discovery*.

INTERNATIONAL TRAVEL

22. BELIZE
Catch the Adventure! From rainforest resort to Barrier Reef. Belize is only 2 hours from the USA. Belize. Mother Nature's best kept secret.

23. INDIA
India offers incredible experiences for travelers on journeys of self-discovery. Come visit India for an experience that is truly incredible!

24. PAPUA NEW GUINEA
Over 850 different tribes and 800 languages are found in PNG. Our unique and untouched culture will exceed all your expectations.

MARYLAND

25. CALVERT COUNTY
Experience the Chesapeake Bay lifestyle, fossil hunt, enjoy our museums, lighthouses, festivals, and savory succulent seafood.

26. DORCHESTER COUNTY
Home to Blackwater National Wildlife Refuge; explore the heart of Chesapeake Country.

27. FREDERICK COUNTY
Maryland's Crossroads of History. Antiques, battlefields, covered bridges, parks, wineries and more, close to Gettysburg and DC.

28. KENT COUNTY
A scenic peninsula on the Chesapeake Bay, offering fishing, boating, kayaking, small beaches, great shopping, and museums.

29. MARYLAND VACATIONS
Beaches, mountains, big cities, small towns. Maryland has so many things to do, so close together.

30. WORCESTER COUNTY
Maryland's only seaside. Discover Assateague Island National Seashore. Kayak, birdwatch, cycle, golf and explore our historic towns.

MISCELLANEOUS

31. ATHENA REVIEW
Athena Review, journal of archeology, history and exploration, invites you to send for more information on a free issue.

32. BBC AMERICA SHOP
Bringing you the very best in British entertainment: award-winning DVDs and videos, audio books and other British gifts.

33. HYDRO-SIL
Families have saved up to 50% on heating costs. Unique room-by-room heating system that can save you hundreds of dollars.

34. MASHANTUCKET PEQUOT MUSEUM
The Pequot Museum brings to life the Native American and natural history of New England through engaging interactive exhibits.

35. WSJ WINES
Take the fast track to the world's best value wines. Delivery is to your door and every bottle guaranteed to please, or your money back.

U.S. TRAVEL

36. ALABAMA'S GULF COAST
Necessities: Time together to enjoy the simple pleasure and beautiful treasures of Alabama's Gulf Coast.

37. BATON ROUGE
Need a good reason to stick around? We don't have one, we've got 225. Dive into the colorful political history of Louisiana's capital city, Baton Rouge.

38. DELAWARE
Discover natural history from life-sized dinosaurs to tiny fossils. Explore cultural treasures, wildlife areas and birding hot-spots in Delaware!

39. SIERRA VISTA VISITORS CENTER
Enjoy the natural beauty, the world-renowned birding experience, the thousands of years of history and the diverse cultural activities.

40. THE GREAT STATE OF TEXAS
Create your perfect vacation with your FREE Texas State Travel Guide.

41. TUCSON
Entertainment options are as wide open as the landscape—first-rate golf, esteemed spas and fine outdoor dining.

42. VILLAGE OF RUIDOSO
Ruidoso, New Mexico is a cool mountain playground full of outdoor adventure and value for your fall getaway.

MARKET CLASSIFIED

ALASKA WILDLIFE ADVENTURES
907-783-2928 • www.kenaifjordesglacierlodge.com

FINE ANTIQUE PRINTS.COM
610-687-2552 • www.fineantiqueprints.com

MATH TUTOR DVD.COM
877-MATH-DVD • www.mathtutordvd.com

PARROT SAFARI
603-421-1900 • www.parrot-safari.com

SAN FRANCISCO HERB & NATURAL FOOD CO.
800-227-2830 • www.herbspicetea.com

SKYLOG BY JOE RAO

The Geminid meteor shower—usually the best of the annual "shooting star" turns—is due to peak on the night of December 13–14. As the shower's name implies, the point from which the meteors appear to radiate is in the constellation Gemini, the Twins. The radiant is already fairly high above the horizon at 10 P.M. local time, presenting a broad area of sky in which to look for meteors. Geminids are relatively slow and quite bright; many are yellow. The meteor rate builds gradually in the week prior to the peak, at which, if the night is clear, as many as 120 may be observed per hour. The rate then drops off fairly sharply. Late Geminids, however, can be especially bright.

Noteworthy on a longer time scale is the increasing conspicuousness of Mars. The Red Planet is growing bigger and brighter because Earth, in a faster orbit around the Sun, is catching up to it. On January 27 Mars is only 61.7 million miles from Earth, closer than it will be again until March 2014.

During January Mars outshines all stars and other planets in the night sky except Sirius and Jupiter. It also looms large enough for amateur telescopes of medium size (6 to 8 inches) to reveal not only the bright north polar ice cap but also dark surface details, and perhaps ice clouds and "limb haze." The latter is the haze of water ice, carbon dioxide, and dust that arises on Mars along the border between night and day—as a result of the transition in temperature—and which from our point of view shows up on the planet's limb, or edge.

Mars is in opposition to the Sun (on the opposite side of Earth from the Sun) on the 29th, rising at sunset, reaching its highest point in the southern sky at midnight, and setting at sunrise. That provides ample time to train a telescope on it. The planet's north pole is tilted 12 degrees toward us—and toward the Sun—making the season mid-spring in the planet's northern hemisphere.

JPL/NASA/STSCI

Hubble Space Telescope image of Mars, when it was springtime in the planet's northern hemisphere

Joe Rao is a broadcast meteorologist and an associate and lecturer at the Hayden Planetarium in New York City (www.haydenplanetarium.org).

DECEMBER NIGHTS OUT

1 Venus appears as the Morning Star just above the east-southeast horizon, but is obscured in minutes by the brightening twilight. The planet is approaching superior conjunction, on January 11, when it passes on the far side of the Sun. Venus's return as the Evening Star is not readily apparent before late February.

2 The Moon becomes full at 2:30 A.M. eastern standard time (EST).

8 The Moon wanes to last quarter at 7:13 P.M. EST.

10 During the predawn hours, the Moon shines in the southeast, with Saturn well above it and a bit to the left.

13 The Geminid meteor shower peaks late tonight and during the predawn hours of the 14th (see story above).

16 The Moon is new at 7:02 A.M. EST.

21 The Sun reaches its southernmost point south of the celestial equator (Earth's equator projected onto the heavens) and begins its six-month return northward. The solstice occurs at 12:47 P.M. EST, initiating winter in the Northern Hemisphere and summer in the Southern.

24 The Moon waxes to first quarter at 12:36 P.M. EST.

31 Beginning at 1:53 P.M. EST the Moon's southern edge dips into the Earth's umbra—the hard-edged shadow—and is tinged black or brown for just over an hour. This is a predawn show for most of Alaska; a New Year's Eve show for Europe, Africa, and western Asia; and a post-midnight (early 2010) show from central Asia to central Australia. At 2:13 P.M. EST, the Moon is full for the second time this month.

JANUARY NIGHTS OUT

2 Soon after 8 P.M. local time look for the rising Moon in the east-northeast. Well off to its left shines Mars (see story above).

5 In the hour before midnight, the Moon rises in the eastern sky, followed by Saturn well to its left.

7 The Moon wanes to last quarter at 5:39 A.M. EST.

13 Mercury rises in the southeast about an hour and a quarter before sunrise. With binoculars, look for the Moon, a razor-thin sliver about 6 degrees below and to Mercury's right.

15 The Moon is new at 2:11 A.M. EST. Also, an annular (ring) eclipse of the Sun sweeps over parts of Africa, India, and China.

18 In the west-southwest, about a half hour after sunset, Jupiter sits well below the slender crescent Moon.

23 The Moon waxes to first quarter at 5:53 A.M. EST.

27 Mercury is at its greatest western elongation, 25 degrees from the Sun, rising about ninety minutes before sunup. At 2:01 P.M. EST, Mars and Earth reach their closest approach for the year, a distance of 61,720,695 miles (see story above).

29 Mars is at opposition to the Sun (see story above).

30 The Moon is full at 1:18 A.M. EST.

FEBRUARY NIGHTS OUT

2 The Moon rises a couple of hours before midnight local time. The yellowish-white "star" shining above and to its left, about 10 degrees away, is Saturn.

5 The Moon wanes to last quarter at 6:48 P.M. EST.

13 The Moon is new at 9:51 P.M. EST.

16 Venus and Jupiter come within about half a degree of each other. You might be able to spot them through binoculars if you scan the sky close above and to the left of where the Sun has just set.

21 The Moon waxes to first quarter at 7:42 P.M. EST.

28 The Moon is full at 11:38 A.M. EST.

EXPLORER GUIDE

Audubon Revisited in Masterful Prints

Treasures abound in the American Museum of Natural History, from its famous dinosaur fossils to the Star of India sapphire and other dazzling finds in the Halls of Minerals and Gems. As for fine art, the exquisite landscapes of the habitat dioramas are there for all to see.

But visitors may be surprised to learn that the Museum's collections include more than 2,500 original works by some of the greatest natural history artists of their time, including such iconic painters as John James Audubon, Louis Agassiz Fuertes, Francis Lee Jaques, Titian Ramsay Peale, and Joseph Wolf.

Two years ago, the Museum put on view more than 50 original oil paintings, watercolors, and hand-colored stone lithographs in the exhibition *The Unknown Audubons: Mammals of North America*—so named because Audubon is best known for painting birds. The mammals appeared in the naturalist's last great work, *The Viviparous Quadrupeds of North America*, which was completed with the help of his two sons, John Woodhouse Audubon and Victor Gifford Audubon, and their father-in-law, the Reverend John Bachman. Early in the last century, many of the original paintings were gifted to the Museum by Audubon's granddaughters, Florence and Maria R. Audubon.

Now, through a special collaboration with Joel Oppenheimer Gallery, full-size, fine-art prints of 14 of these rare mammal paintings, plus a portrait of Audubon painted by his son John, will be made available in limited editions. Oppenheimer, which has similar partnerships with New-York Historical Society and The Field Museum in Chicago, reproduces original works using ultra-high resolution digital imaging that takes into account the fragility and light-sensitivity of the works being captured. Some of the original paintings have penciled notes by the artist to the printmaker that would not have appeared in subsequent published lithographs but are faithfully reproduced in these prints.

Prices run from $600 to $1,500 for individual prints and $10,000 for a complete set of all 15, boxed as *Audubon's Quadrupeds: The Watercolors; The American Museum of Natural History Edition*. Each print bears on the back the numbered and signed stamp of Joel Cracraft, Lamont Curator of Birds and Curator-in-Charge of the Department of Ornithology, where the original collection is housed.

COURTESY OF JOEL OPPENHEIMER GALLERY

The Canada Lynx, *an Audubon watercolor, was among the paintings gifted to the Museum by the artist's granddaughters in the early 20th century.*

In retrospect, the works in Audubon's *Viviparous Quadrupeds* stand as a telling ecological statement. As the artist traveled the Missouri River in 1843 gathering images, the prairie—the largest ecosystem in North America—was being converted to towns and farmland, the commercial exploitation and slaughter of the buffalo had begun, and the wildlife he set out to document was starting to disappear. Today, less than one percent of this landscape remains unchanged by human activity.

"Having this spectacular body of Audubon's work available to a wider audience is truly exciting," says Cracraft, "The exacting standards used to produce these prints will further demonstrate the greatness of Audubon as an artist and naturalist."—*Joan Kelly Bernard*

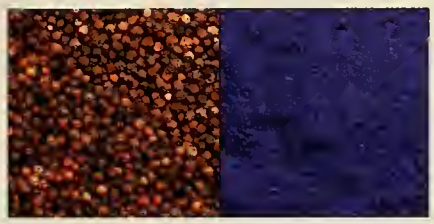
Each original, such as Rocky Mountain Hare, *will be reproduced in editions of 200, not to be reprinted far 75 years.*

COURTESY OF JOEL OPPENHEIMER GALLERY

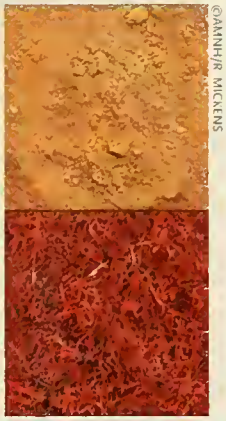
Silk Road for the Epicurious

The Silk Road might have been called the Spice Route for all the herbs, seeds, and other aromatics regularly traded along this ancient network that ran from China to West Asia. In fact, so entwined are food and spices with the legacy of the Silk Road that a recipe for a spice-laden treat made with dates will be given out to visitors to the Turfan night market featured in the Museum's current exhibition *Traveling the Silk Road: Ancient Pathway to the Modern World*. The recipe, typical of dishes served in the period AD 600 to 1200, is from *Delights from the Garden of Eden: A Cookbook and a History of the Iraqi Cuisine* by scholar and author Nawal Nasrallah.

To further mark this gastronomic connection, over the coming months the Museum will present an exciting series of tastings to highlight Silk Road cuisine, culminating with a gourmet tasting menu. The popular program Global Kitchen starts things off on **Tuesday, December 8**, with Nirmala Narine, owner and founder of Nirmala's Kitchen, who will show how to incorporate traditional Silk Road flavors into everyday cooking. Mandy Aftel, an award-winning perfumer and co-author of the cookbook *Essence and Alchemy: The Natural History of Perfume and Aroma*, follows on **Wednesday, January 20**, with the fascinating history of perfumes and aromatics such as frankincense, myrrh, patchouli, and jasmine. Wine will be the topic on **Wednesday, February 17**, when sommelier Mollie Battenhouse, who is the wine director of New York's Maslow 6, will lead tastings of modern wines and discuss the early history of viticulture with grape geneticist Peter Cousins of Cornell University.



Perhaps the most elaborate event will take place on **Thursday, January 21**, when perfumer Aftel will explore the exciting culinary uses of oils and aromatics at "Caravanserai: A Perfumed Tasting Menu," an evening tasting lecture inspired by gustatory sensations of a roadside inn in ancient Persia. Joining her in serving up an original tasting menu of delicacies will be Johnny Iuzzini, executive pastry chef of Michelin-starred restaurant Jean Georges; Sam Mason, chef and host of the popular Independent Film Channel cooking series *Dinner With the Band;* and Audrey Saunders, a renowned mixologist and owner of the trendsetting Pegu Club in New York City. Seating is limited to 30 lucky gourmets.



©AMNH/R. MICKENS

—Joan Kelly Bernard

Celebrating Two Decades of Summer Science for College Students at AMNH

Allyse Hellmich walked swiftly through the dark room to the podium, eyes widening at the laser pointer. "Oooh," said the Grinnell College student, snatching it to point the red beam at her first slide. Her research on the genetic relationships of scarlet macaws in a Guatemalan zoo, which will help launch a breeding program to replenish the endangered wild population, was about to be presented to a group of American Museum of Natural History scientists who had trained her over the summer.

Allyse was just one of three dozen undergraduates who counted galaxies, measured bones, analyzed volcanic rock, or photographed microscopic fontanelle last summer as part of the Museum's 2009 Research Experiences for Undergraduates, paid summer internships that offer college students the chance to conduct research at the Museum.

"One of my students will be presenting a poster at the next national geology meeting," says Jim Webster, Curator of Physical Sciences. "It's a fantastic program. You get wonderful students with lots of questions that breathe a bit of new life into the Museum."

Last summer marked the 20th year of the Museum's biology REU program, currently shepherded by Curator Mark Siddall. "This program has mentored nearly 200 students over the years," he says. "These students go on to graduate school, work in scientific laboratories, and have even penned 20 peer-reviewed publications in the last five years."

©KARI SCHMIDT

Research carried out by the Museum's REU students will help launch a breeding program for the scarlet macaw in Central America.

For more information about this National Science Foundation-funded program, please visit the Richard Gilder Graduate School at AMNH online at rggs.amnh.org. *—Kristin Elise Phillips*

Applications for summer 2010 are due February 1.

At the Museum

AMERICAN MUSEUM ō NATURAL HISTORY

www.amnh.org

© AMNH/J. SHACKELFORD

Camel caravans were the transport of choice on the *Silk Road*.

EXHIBITIONS

Traveling the Silk Road: Ancient Pathway to the Modern World
Through August 15
This intriguing exhibition transports visitors to one of the greatest trading routes of all time, showcasing the technologies and cultures of four representative cities: Xi'an, China's Tang Dynasty capital; Turfan, once the crossroads of Central Asia; Samarkand, one of the world's oldest cities; and ancient Baghdad, a hub of trade and scholarship. Don't miss live performances on Sunday afternoons, organized by the Silk Road Project.

Traveling the Silk Road is organized by the American Museum of Natural History, New York (www.amnh.org), in collaboration with Azienda Speciale Palaexpo, Roma, Italy and Codice. Idée per la cultura srl, Torino, Italy; the National Museum of Australia, Canberra, Australia and Art Exhibitions Australia; and the National Museum of Natural Science, Taichung, Taiwan and United Daily News, Taipei, Taiwan.

The Presenting Sponsor of *Traveling the Silk Road: Ancient Pathway to the Modern World* is MetLife Foundation.

Additional support has been provided by Mary and David Solomon.

The Silk Road Project residency is generously supported by Rosalind P. Walter.

Extreme Mammals: The Biggest, Smallest, and Most Amazing Mammals of All Time
Through January 3
Entering its last month, this remarkable exhibition features fossils and modern mammals from the Museum's collection and explores the distinctive qualities and shared ancestry that unite this diverse class of animals.

Extreme Mammals is organized by the American Museum of Natural History, New York (www.amnh.org), in collaboration with the California Academy of Sciences, San Francisco; Canadian Museum of Nature, Ottawa, Canada; and Cleveland Museum of Natural History.

Major funding for *Extreme Mammals* has been provided by the Lila Wallace-Reader's Digest Endowment Fund.

Additional generous support for *Extreme Mammals* has been provided by the Bill and Ann Ziff Foundation, the Eileen P. Bernard Exhibition Fund, and Harlan B. Levine, M.D. and Marshall P. Levine.

Frogs: A Chorus of Colors
Through January 3
Catch this delightful exhibition, which features more than 200 live frogs in re-created habitats, before it closes.

This exhibition is presented with appreciation to Clyde Peeling's Reptiland.

The Butterfly Conservatory: Tropical Butterflies Alive in Winter
A perennial favorite, the *Butterfly Conservatory* lets visitors mingle with up to 500 live, free-flying tropical butterflies.

Highway of An Empire: The Great Inca Road
The Inca Empire owed its reach and power to an extensive network of roads, the focus of this stunning photo exhibition.

Courtesy of the Consulate General of Peru in New York.

The presentation of *Highway of An Empire* at the American Museum of Natural History is made possible by the generosity of the Arthur Ross Foundation.

Spider Silk Textile
This spectacular and extremely rare textile, on display in the Grand Gallery, was woven from golden-colored silk thread produced by one million spiders in Madagascar.

SPECIAL EVENTS

SciCafe
Wednesday, 12/2, 7 pm
Wednesday, 1/6, 7 pm
Wednesday, 2/3, 7 pm
The new after-hours series continues this winter with science, cocktails, and conversation. Free admission and cash bar for guests 21 and up. See amnh.org/scicafe for a complete schedule.

Proudly sponsored by Judy and Josh Weston.

Media Partner for SciCafe is Seed Magazine.

Additional support provided by National Institutes of Health Science Education Partnership Award (SEPA).

©AMNH/R. MICKENS

Kwanzaa Spirits 2009
Sunday, 12/27, 12-5 pm
The annual celebration includes a Kwanzaa marketplace, live performances, culinary delights for the entire family, and more.

Origami Tree
Through Sunday, 1/3
A beloved Museum tradition, the Origami Tree is back for the holiday season in the Theodore Roosevelt Memorial Hall. This year's decorative theme—**Origami, A to Z**—features an alphabetical menagerie of ornaments.

TALKS AND TASTINGS

Global Kitchen: The Silk Road Through Spices
Tuesday, 12/8, 6:30 pm
Nirmala Narine, founder of Nirmala's Kitchen, will share spices, recipes, and stories from around the world. Tastings included; $20.

Curry Economics: Food as a Driving Force of Economic Development
Thursday, 1/14 6:30 pm
The evening features *The Economist*'s Tom Standage, Cornell University's Eric

Tagliacozzo, and culinary expert Julie Sahni discussing food as a driving force behind economic growth. Sasha Issenberg, author of *The Sushi Economy*, will moderate; $15.

Global Kitchen:
Aromatics Along the Silk Road
Wednesday, 1/20, 6:30 pm
Renowned perfumer Mandy Aftel examines the history of aromatics; $20.

Caravanserai:
A Perfumed Tasting Menu
Thursday, 1/21, 7 pm
Delight your senses with a Persian tasting menu presented at a special evening with perfumer Mandy Aftel, chef Johnny Iuzzini, chef Sam Mason, and mixologist Audrey Saunders. Limited to 30 guests; $150 per person.

Global Kitchen:
Wines with Ancient Lineage
Wednesday, 2/17, 6:30 pm
Sommelier Mollie Battenhouse of Maslow 6 and grape geneticist Peter Cousins of Cornell University discuss viticulture. Wine tasting included; $20.

HAYDEN PLANETARIUM PROGRAMS

TUESDAYS IN THE DOME

Using Light to Reveal the Darkness with Eric Gawiser
Tuesday, 12/1, 6:30 pm

The Grand Tour with Brian Abbott
Tuesday, 1/5, 6:30 pm

CELESTIAL HIGHLIGHTS

Planet Watching with Steve Beyer
Tuesday, 12/29, 6:30 pm

Public programs are made possible, in part, by the Rita and Frits Markus Fund for Public Understanding of Science.

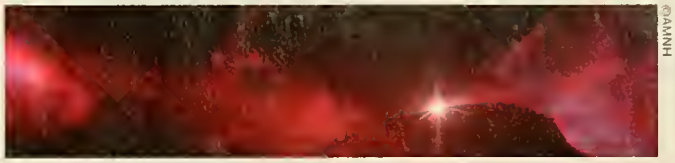
INFORMATION

Call 212-769-5100 or visit www.amnh.org.

TICKETS AND REGISTRATION

Call 212-769-5200, Monday–Friday, 9 am–5 pm, or visit www.amnh.org. A service charge may apply. All programs are subject to change.

AMNH eNotes delivers the latest information on Museum programs and events monthly via email. Visit www.amnh.org to sign up today!



Discover stellar formations in *Journey to the Stars*.

LECTURE

Unmasking Europa: The Search for Life on Jupiter's Ocean Moon
Monday, 12/7, 7:30 pm
Europa's global ocean contains twice the water of Earth's oceans combined, making this moon of Jupiter the most likely place for extraterrestrial life in our solar system.

JOURNEY TO THE STARS

This spectacular new Space Show launches visitors through time and space to experience the life cycle of the stars in our night sky. Tour stellar formations and discover the fascinating, unfolding story that connects us to the stars.

Journey to the Stars was developed by the American Museum of Natural History, New York (www.amnh.org), in collaboration with the California Academy of Sciences, San Francisco; GOTO INC,Tokyo, Japan; Papalote • Museo del Niño, Mexico City, Mexico; and Smithsonian National Air and Space Museum, Washington, D.C.

Journey to the Stars was created by the American Museum of Natural History, with the major support and partnership of NASA, Science Mission Directorate, Heliophysics Division.

Made possible through the generous sponsorship of **Lockheed Martin Corporation.**

And proudly sponsored by **Accenture.**

Super-computing resources provided by The Texas Advanced computing center (TACC) at the University of Texas at Austin through the TeraGgrid, a project of the National Science Foundation.

IMAX MOVIES

Through January 3

Beavers
Follow a family of beavers on a series of adventures in a rare look at these industrious creatures.

Wild Ocean
Experience the massive feeding frenzy that takes place each year as billions of fish migrate up the KwaZulu-Natal Wild Coast of South Africa.

A Rosy Return

By Helen Hays

In 1995, when I embarked on a search for the southern winter home of North American roseate terns, one colleague dismissed it as a "needle-in-a-haystack project." Indeed, it was. Yet, with determination and hope, I started laying plans in New York on Great Gull Island (GGI for short) at the eastern end of Long Island Sound—an island owned by the American Museum of Natural History.

Since 1969 I have monitored Great Gull Island's breeding colony of roseate terns (*Sterna dougallii*), the largest in North America, as well as one of the world's largest nesting concentrations of common terns (*Sterna hirundo*). In 1987, because the roseate's numbers fell on GGI and elsewhere in the Northeast, the United States Fish and Wildlife Service listed the region's population as endangered. Yet nothing on our island seemed to account for the decline. It was critical to determine where roseate terns went after the nesting season.

Two GGI colleagues and I began the search in 1995 in Argentina. Some common terns reportedly wintered there, and I thought roseates might be traveling with them. The nonbreeding plumages of the two species look very similar, and in mixed flocks they might be confused. At Punta Rasa, about 190 miles southeast of Buenos Aires, we were astonished to find an assembly of more than 20,000 common terns. But we saw no roseates. Finally, seven miles from the coast of the Brazilian state of Bahia, on our way to the rocky Abrolhos islands, we heard familiar cries from a flock of fishing terns. I asked the captain to approach the birds, and he anchored near them. Soon roseate and common terns were landing on the water near us. Cameras clicked to record the exciting moment; we had discovered the needle in the haystack.

In 1997 we began working with veterinarian Pedro Lima, the best bird netter in Brazil. Together we found five roosting locations for roseate and common terns in Bahia. In 2002 members of our team visited the state of Ceara; there on a beach outside the village of Quixaba, our translator encountered a fisherman wearing a necklace made of metal bands—bands that we had put on the legs of roseate and common terns on GGI! I scheduled a stop in Quixaba in 2006, in a group that included Pedro Lima and a biologist whom Pedro had introduced to us: Alberto Campos, who runs the nongovernmental organization Aquasis.

On reaching Quixaba, we went to a *barraca*, a place serving food and drinks on the beach. Pedro explained to the fishermen that we were studying the terns and wanted to see the numbers on any tern bands they might have. Reassured that their necklaces would be returned, the fishermen brought the metal rings and spread them out on a table. I immediately noticed that the bands were closed, which meant that the fishermen had either broken the legs of birds to remove the bands or pulled the bands off over their feet, also injurious. I was so startled and dismayed that I blurted out, "We must do something about this!" Campos quickly spoke: "We will help you." I will never forget his words or what they would mean for the terns' future.

Five months later an education program was in place, run by Vinicius Lima (no relation to Pedro), who works with Campos at Aquasis. Vinicius visited Quixaba once a week for several months, talking with local fishermen and captivating schoolchildren with cartoon booklets about the terns. He explained the purpose of our bands, emphasizing that they were not worth any money, despite their silver color. In talking with the fishermen, Vinicius Lima learned that they had always wanted to hold a regatta in which to race models of their *jangadas*, the traditional fishing boats. They used the models to teach their children about the boats and how to sail.

Vinicius arranged for the village to have a regatta in November of 2006, timing it to coincide with the arrival of the terns. Participants and their families received T-shirts as well as sails for the model boats, both imprinted with a large tern. The regatta was a great success and has been repeated every year since. In the second year the villagers did a beach clean-up the same days as the regatta; in the third year, the women in the village ran races with laundry bundles on their heads. The villagers have decided to call the day when all of those events take place the Tern Festival.

Most important, Vinicius Lima reports that the fishermen are no longer taking bands. And though roseates remain endangered, more nested on GGI in 2009 than 2008. The villagers of Quixaba probably played only a small part in that rise, yet it bodes well for tern conservation in South America.

Helen Hays is an ornithologist at the American Museum of Natural History in New York City. She currently serves as Chair of the Great Gull Island Committee.

VINICIUS LIMA

Be one with the unbelievable. Be one with this Hemisphere's largest barrier reef. Be one with this Caribbean gateway to the Maya world. As one of the last unspoiled places on earth, you'll feel an intimate connection to authentic experiences in Belize. All just a two-hour flight from the U.S., in the only English-speaking country of Central America. ***Call now 800-624-0686 or visit TravelBelize.org/his.*** *And just be, in Belize.*

BELIZE
MOTHER NATURE'S
BEST KEPT SECRET

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.
NEW YORK

ROLEX