NATURAL HISTORY

3/09

THE CORMORANT RANTS

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foundation
for innovative new diagnostics

About 1.6 million people die of tuberculosis (TB) each year[1] mostly in developing nations lacking access to fast, accurate testing technology.

TB is the current focus of the Foundation for Innovative New Diagnostics (FIND), established with funding from the Bill and Melinda Gates Foundation. FIND is dedicated to the advancement of diagnostic testing for infectious diseases in developing countries. For more information, visit www.finddiagnostics.org.

A young girl reveals hope in India, which carries one-fifth of the global burden of TB.

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World TB Day
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[1] Source of all statistics cited: StopTB/World Health Organization, 2007.
[2] FORTUNE, March 2008
[3] *Ethisphere® Magazine,* June 2008

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NATURAL HISTORY

MARCH 2009 VOLUME 118 NUMBER 2 www.naturalhistorymag.com

FEATURES

DEPARTMENTS

ON THE COVER: Double-crested cormorant sports breeding plumage—feather tufts on its head that give the species its common name. Martin B. Withers / FLPA

THE NATURAL MOMENT

BAIT BALL SEASON

Photograph by Doug Perrine

See preceding two pages

THE NATURAL EXPLANATION BY ERIN ESPELIE

When sardines squirmed down Doug Perrine's wet-suit collar for refuge, he began to question the safety of his vantage point. It wasn't the tickling baitfish that concerned him, it was the chance of being accidentally speared by striped marlin in a feeding frenzy. Dozens of the high-speed predators (*Tetrapturus audax*) encroached upon Perrine as he was free diving off the tip of the Baja Peninsula late last November.

With the help of sea lions and even a few dolphins, the marlin had corralled a "bait ball" up and away from a massive shoal of fish, millions strong, that lay down below. Near the surface the predatory bunch competed in picking apart the swirling ball. Frigates and other seabirds joined the action from above; the sea lions barked and blew bubbles as they worked the crowd below. Most fearsome, though, were the dexterous marlin, juveniles that on average measured six feet long and weighed ninety pounds. They slashed, snatched, stunned, and impaled their prey—even torpedo-chased individual fish out of the water to body-slam them on the surface with their bills.

According to fishermen, 2008 holds the record for the most "stripies" around Baja in the last quarter century. Michael L. Domeier, director of the Offield Center for Billfish Studies in Fallbrook, California, suggests that withdrawal of a Japanese longline fleet may be responsible. Yet accurate population estimates are elusive. That's one reason why Domeier is spearheading an arduous archival-tagging program, launched in the fall. (Data collection by satellite, though easier in practice, had proved inadequate.)

Other major unknowns persist in marlin biology—including the purpose of the creatures' rapid color changes, made possible by special skin cells called *iridophores* that are controlled by the nervous system. Perrine reports that marlin "light up in a bright neon blue as they herd the baitfish, maneuver, and communicate."

As for the danger, Perrine said, "It was like I was in a fencing match with a dozen expert swordsmen at once." And when one marlin swam by with another marlin's broken bill impaled in its side, he realized with a sinking feeling that even experts miss.

Doug Perrine holds B.S. and M.A. degrees in marine biology from the University of Miami. He founded SeaPics.com, which he operated for eighteen years before moving on and winning the top prize in the 2004 BBC Wildlife Photographer of the Year competition. In 2007 two of his photographs were declared by *Scuba Diving* magazine to be among the twenty-five best dive photos ever taken. He lives in Kailua-Kona, Hawaii.


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BELIZE
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WORD EXCHANGE

Out of Print

Olivia Judson's "Life Zone" column on fingerprints ["Sticky Fingers," 12/08-1/09] was a great story but didn't address the effects of aging. After 9/11, needing security clearance, I had a full set of fingerprints taken and filed with the FBI. But now, at the age of seventy-three and a half, my fingerprints are all but gone. My right thumb appears to have a full print, but the other digits on both hands are now virtually smooth. A senior-citizen friend of mine was denied clearance for a job, because of a lack of fingerprints. Can digital equipment still read the prints even if an ink pad doesn't register any?

Don Cook
Skokie, Illinois

OLIVIA JUDSON REPLIES: Don Cook raises an important point that has been generally overlooked in the scientific literature. However, a recent report on biometrics commissioned by the British government did note the difficulty in obtaining high-quality fingerprints from the elderly—and suggested that identification schemes should take that into account. Three factors appear to contribute to making fingerprints more difficult to read as one ages. The first is that the skin smoothes—because skin cells are no longer replaced quickly enough to keep up with wear—decreasing the contrast between ridges and valleys. The second is that wrinkles in the skin add noise to the print that is obtained. A third factor is a drop in fingerprint moisture. To my knowledge, digital readers can't resurrect ridges and valleys. Various computer algorithms, though, have been developed to try to filter out the noise from wrinkles, and also to enhance any remaining attributes of a fingerprint.

Art of Evolution

Thanks for Robert McCracken Peck's article on the nineteenth-century artist Benjamin Waterhouse Hawkins ["The Art of Bones," 12/08-1/09]. It is intriguing that Hawkins brought to life the fossil evidence of evolution without embracing Darwinian theory. However, there were important areas of conceptual overlap among competing schools of natural history. The belief in human superiority, an interest in the fitness of creatures to their environments, an acknowledgment of extinction: those were all points on which Hawkins, who believed in the fixity of species, could agree with various sorts of evolutionists including, to a large degree, Darwin himself.

Jessica Riskin
Stanford University
Stanford, California

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nature.net by robert anderson

KHAN-QUEST

AFTER READING anthropologist Jack Weatherford's *Genghis Khan and the Making of the Modern World* (Crown, 2004), I turned to the Internet to learn more. A site called TimeMap (http://www.timemap.net) features an applet that assists in visualizing such things as environmental change, weather patterns, traffic flow, urban growth—and, yes, the spread of empires. Their Animations page includes a sample map that shows how the Great Khan's realm rapidly expanded to link most of Asia, the Middle East, and Eastern Europe for the first time. For my guide to Web sites exploring the archaeology of the Mongol Empire and its legacy—by no means all bad—please visit the magazine online (www.naturalhistorymag.com).

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

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NATURAL HISTORY

EST. 1900

Colors show spaces in a T. rex skull (computer rendering).

Feeling Light-headed

Was *T. rex* an airhead? That's what wags might say following a study by Lawrence M. Witmer and Ryan C. Ridgely of Ohio University in Athens. The two paleontologists used CT scans and 3-D computer imaging to measure, for the first time, the spaces inside the fossilized skulls of four dinosaur species.

In the skulls of *T. rex* and another predator, *Majungasaurus,* sinuses, the hollow spaces that connect to the nasal cavity or the middle ear, take up a lot of space—more total volume, in fact, than the brain. Witmer and Ridgely think the point may have been to lighten the head, which the sinuses did by as much as 8 percent. That's no trivial savings in an animal whose noggin, the scientists calculated for *T. rex,* weighed more than 1,100 pounds, four times the heft of a male rhino's. The advantages would have included ease of movement and the energetic savings from growing and maintaining less bone.

The skulls of two armored vegetarian dinosaurs, *Panoplosaurus* and *Euoplocephalus,* held a different surprise. Their sinuses were relatively small, but the nasal airways made uniquely complex loops inside the snout. The airways probably helped regulate temperature, Witmer and Ridgely say, and may have affected the sound of the dinos' vocalizations.

Dinosaurs might even have experienced the misery of sinus colds. After all, birds (their living relatives) can get sinus-clogging respiratory infections. Had all *T. rex*'s nasally connected sinuses been plugged at once, a sneeze to clear them would have yielded no less than seven gallons of snot—that's how big they were. *Gesundheit! (The Anatomical Record)*

—Stéphan Reebs

WITMER & RIDGELY / OHIO UNIVERSITY

You Can't Hide, Glycolaldehyde

To the great delight of earthlings who yearn for extraterrestrial companionship, glycolaldehyde ($C_2H_4O_2$) has just been detected in a star-forming region of our galaxy. The substance, you see, can easily react with other molecules to form ribose ($C_5H_{10}O_5$), the backbone of RNA. Experts believe RNA fulfilled the reproductive role of DNA in the early stages of life on Earth—and perhaps elsewhere.

Molecules in outer space betray their presence by emitting radio waves at specific frequencies. An international team of astronomers led by Maite T. Beltrán, of the University of Barcelona,

Grow Your Own Oasis

Most desert plants have small leaves to prevent desiccation, but the desert rhubarb takes a contrarian approach. *Rheum palaestinum,* a rare plant from the Negev desert in Israel and Jordan, grows leaves up to two feet wide. Together, the leaves—only a few per plant—make up a large rosette covering the ground. Why defy desert convention with such an extravagant carpet?

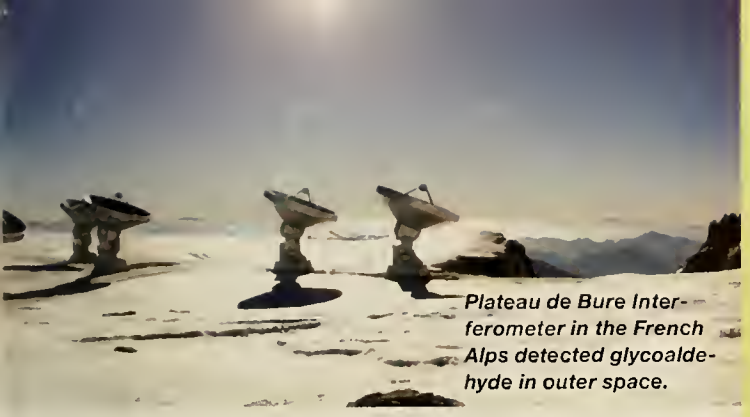
Up close, the leaves look like miniature mountain ranges with steep drainage systems. Taking topography as a clue, Simcha Lev-Yadun and two colleagues at the University of Haifa surmised that the leaves might collect raindrops—ever so rare in the desert—and channel them toward the plant's main root at the center of the rosette.

To test their hypothesis, the team measured the soil's water absorption, both near and away from the root, under natural and simulated rainfall. The root, they calculated, receives sixteen times as much water annually as it would without runoff from its leaves—as if the desert rhubarb lived in a Mediterranean climate instead of the Negev.

Desert rhubarb leaf

To avoid dehydration, the leaves have a thick, waxy coating that seems to prevent water loss even as it speeds rainwater's way to the root. (*Naturwissenschaften*)

—S.R.



Plateau de Bure Interferometer in the French Alps detected glycoaldehyde in outer space.

aimed a French radio telescope at a coalescing disk of gas and dust called G31.41+0.31, which lies 26,000 light years away in the constellation Serpens, the Serpent. There they detected the telltale emissions of glycolaldehyde.

The molecule had already been espied in the center of our galaxy, where there is too much radiation for life to develop. G31.41+0.31, by contrast, has lower radiation; there, amid an abundance of glycolaldehyde, stars are forming and planets could one day develop. And the same may be true of other planet-forming regions. But whether complex molecules such as $C_2H_4O_2$ can actually survive the chaotic process of planet formation remains unknown. (*Astrophysical Journal Letters*) —*S.R.*

The Spark of Love

What's not to love about elephantfishes? Not only do they have extended jaws resembling their namesakes' trunks—they're electric! Modified muscle cells near their tails discharge pulses of electricity into the water. The fish use the resulting electric field to detect nearby objects, a useful trick in the murky African rivers they inhabit. They also use the pulses—which can vary in strength, frequency, and duration—to communicate with one another and, as a recent study shows, to recognize mates of their own species.

In a laboratory at the University of Potsdam in Germany, Philine G.D. Feulner and colleagues exposed ready-to-spawn female *Campylomormyrus compressirostris* elephantfish to different computer-simulated pulses. At one end of the tank, the pulses mimicked a male of the same species; at the other end, they mimicked a closely related species that occupies the same habitat. The pulses of the related species last a hundred times longer than those of any self-respecting *C. compressirostris*—and sure enough, the females shunned them.

Feulner and her team say that female preference for certain electric signals may be what led the two elephantfish species to separate. Alternatively, other factors may have caused the original rift, with a discriminating taste in sparks evolving later, perhaps owing to the high costs of mating with the wrong species. (*Biology Letters*) —*S.R.*

SIMCHA LEV-YADUN

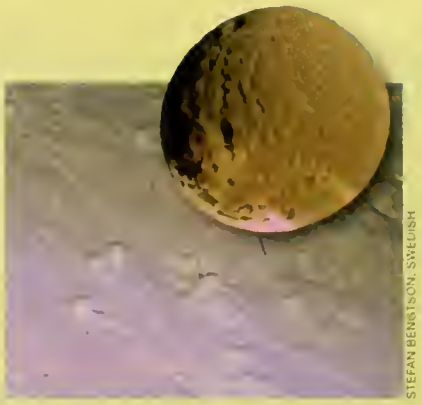
Elephantfish (false color)

FRANK KIRSCHBAUM

The Blobs

On a submersible dive off the Bahamas, Mikhail V. Matz of the University of Texas at Austin and several colleagues were seeking big-eyed, glowing animals adapted to darkness.

Yet as they cruised above the seafloor, the team was distracted by hundreds of bizarre, sediment-coated balls the size of grapes. Each sat at the end of a sinuous track in the seafloor ooze. Indeed, the balls appeared to have made the tracks; some even seemed to have rolled upslope.



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Gromia sphaerica: *making tracks on the seafloor (above) and life size (top)*

The team collected specimens and identified the creatures as giant protozoans, *Gromia sphaerica*, each one a single large cell with an organic shell, or "test." When cleaned of sediment, the test feels like grape skin, but squishier, Matz says.

Surprisingly, the tracks on the Bahamian seafloor resemble grooves found in sedimentary rocks formed as long as 1.8 billion years ago. The ancient grooves, bisected by a low ridge, had constituted the only evidence that multicellular, bilaterally symmetrical animals, such as worms, might have evolved so early in Earth's history. Matz's discovery suggests that protozoans could have made those fossil traces rather than more advanced animals, which probably appeared much later. The next earliest evidence of multicellularity and bilateralism in animals occurs in fossils 580 million and 542 million years old, respectively.

G. sphaerica are rhizopods, an ancient protozoan group. Matz is planning further studies of the species, about which little is known. (*Current Biology*)

—*Sarah Hoffman*

Buzzing Bodyguards

Even a novice naturalist can tell a bee from a wasp. So shouldn't caterpillars, which are unharmed by the former but destroyed by the latter, be able to do so too? Apparently not.

Researchers at the University of Würzburg in Germany discovered that the beet armyworm, an infamous crop pest, displays the same defensive behavior toward bees as it does toward wasps. In fact, the mere presence of bees deters armyworms from munching leaves.

Armyworms, like many caterpillars, have sensory hairs near their heads that detect air vibrations stirred by wasps' wings. When a wasp approaches, an alerted caterpillar freezes and drops off the plant. Thus, depending on the wasp species, it avoids being eaten or receiving an injection of wasp eggs into its body.

Aware that bees' wingbeat frequency is similar to wasps', Jürgen Tautz and Michael Rostás studied the behavior of beet armyworms inside tents containing crop plants as well as bee feeders filled with sugar water. Bees could access only half the tents, and the researchers found that the caterpillars there ate 60 to 70 percent less leaf area than in the "silent" tents. Energy wasted by dropping in response to a harmless bee is apparently well spent to avoid the possibility of becoming a wasp lunch or nursery.

As for the plants, they were the unmistakable winners. Conceivably, interspersing insect-pollinated plants with crops could generate some positive buzz in pest control. (*Current Biology*)

—*Graciela Flores*

Zippety Zoo Dah

When the mood strikes her, Bonnie whistles. She's not very good at it—she utters only single notes and can't carry a tune. But don't judge her too harshly; as an orangutan, she's the first nonhuman primate ever documented to whistle, or to spontaneously mimic the sound of another species.

Now thirty years old, Bonnie lives at the Smithsonian's National Zoological Park in Washington, D.C. In the 1980s, she probably heard a happy caretaker whistling, and she soon made whistles of her own, seemingly just for the fun of it.

Recently, a team of primatologists, led by Serge A. Wich of the Great Ape Trust of Iowa in Des Moines, took a closer look at Bonnie's abilities. By comparing recordings, they confirmed that the sounds she makes are nothing like normal orangutan sounds or vocalizations, and that her whistling tends to be imitative. For example, she usually replicates the duration and number of whistles (one or two) that caretakers produce in front of her.

Other orangutans and chimpanzees known to produce unusual sounds have typically received extensive training—yet Bonnie isn't alone in her spontaneous whistling. Another National Zoo orangutan named Indah also took up the habit, but died before she was recorded. And Wich says that since publishing, he's heard from workers at other zoos with whistling orangutans in their care. (*Primates*) —*S.R.*

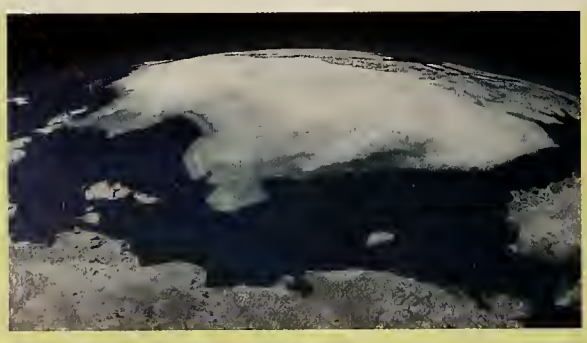
SMITHSONIAN NATIONAL ZOOLOGICAL PARK

Bonnie

THE WARMING EARTH

Broken A.C.

In the Arctic, rising greenhouse-gas concentrations are producing a variety of unprecedented climate effects, which scientists around the world have been scrutinizing as part of the International Polar Year ending this month. Here are a couple of highlights, presented at the December meeting of the American Geophysical Union (AGU) in San Francisco.



Satellite view of Siberian coast

The Arctic is warming faster than the Northern Hemisphere as a whole, said Julienne C. Stroeve of the National Snow and Ice Data Center in Boulder, Colorado. For years, computer models have predicted that such "Arctic amplification" would unfold during cold seasons toward the end of this century, as retreating summer sea ice changes regional heat dynamics. By examining recent temperature data, however, Stroeve and colleagues showed that Arctic amplification is happening right now. The increase in the autumn temperatures of the Arctic is already three times bigger than that of the Northern Hemisphere as a whole, she later elaborated.

As sea ice melts and the ocean warms along the Arctic coast of eastern Siberia, methane long trapped in seafloor permafrost is escaping to the atmosphere. The phenomenon has been known for a while, but not its extent. From a research vessel, Igor Semiletov, of the University of Alaska Fairbanks, and several colleagues recently documented large clouds of methane bubbles rising through the water. The methane effervescence is so voluminous, Semiletov said, that it affects global atmospheric methane levels, thereby contributing to further warming.

"The Arctic is the Northern Hemisphere's air conditioner," Stroeve said; as summer sea ice vanishes, the hemisphere's climatic system must respond. Exactly how will be the subject of much future research. (*AGU Fall Meeting*) —*Harvey Leifert*

Peak Oil—Then What?

Burning all the world's remaining conventional oil and natural gas reserves would not raise atmospheric carbon-dioxide levels above the widely accepted "safe" level of 450 parts per million (ppm), according to Pushker A. Kharecha of NASA's Goddard Institute for Space Studies in New York City. But that isn't necessarily good news.

Kharecha spoke at a session on "peak oil" at the AGU meeting in December. Peak oil is defined as the point at which conventional oil production will begin to decline, probably well before midcentury. According to Kharecha, 450 ppm is too high and might trigger irreversible global warming. Instead, he advocated a new goal of 350 ppm—below the current level, 385 ppm—that he, James E. Hansen, also at Goddard, and several colleagues had calculated from evidence of past and present climate.

But the important question for the climate is not when oil will peak, but what will replace it, said Kharecha. Coal is the most abundant conventional fossil fuel—and it releases by far the most carbon dioxide per energy unit. And unconventional fuel sources, such as tar sands, probably hold even more carbon than all the conventional ones combined.

Kharecha said society could stay under 450 ppm and even achieve 350 ppm by late century—but only by capturing or ending all coal emissions by 2030, avoiding substantial unconventional fossil-fuel emissions, and undertaking reforestation and other active mitigation measures. (*AGU Fall Meeting*) —*H.L.*

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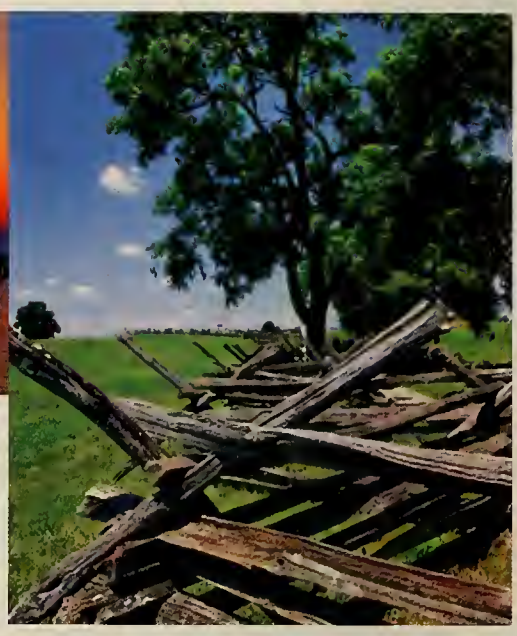

Maryland has been called "America in Miniature," and this small state contains a country's worth of diverse landscape and attractions from the Chesapeake to the Alleghenies. You'll find seashore, mountains, historic towns, battlegrounds, vibrant cities and serene countryside within easy driving distance.

WESTERN MARYLAND

Western Maryland stretches out to the Allegheny Mountains like a long arm beckoning those seeking historic places to contemplate and outdoor adventures to pursue. Washington County, the gateway to western Maryland, points the way to historic battlegrounds. Next, explore the Eastern Continental Divide to discover transportation history and captivating mountain communities. Deep Creek Lake, the state's largest, offers boating, swimming and fishing in a state park where wildlife and native fauna are flourishing in a protected setting.

CAPITAL REGION

The Capital Region, which includes the three Maryland counties in the vicinity of Washington, D.C., is not just a great base for exploring D.C.'s museums and monuments. You'll find historical sites, state and national parks, and first-rate restaurants, theaters and cultural attractions to keep you in Maryland. And you'll also find some great places to enjoy the outdoors, like the C&O Canal National Historical Park in Montgomery County, with walking trails and superb educational exhibits.

CENTRAL REGION

Central Maryland takes in the stately state capital, Annapolis, and the vibrant city of Baltimore, as well as charming small towns and the pleasures of life along Chesapeake Bay. Annapolis has the highest concentration of Georgian-style buildings in the U.S., but its attractions go beyond Federal-era authenticity. Its colonial buildings hold lively art galleries, fashionable shops and restaurants. Baltimore has its history, too, dating back to 1729, and maritime history is on display around the city's Waterfront Peninsula and celebrated Inner Harbor.

SOUTHERN MARYLAND

Although European settlers first reached what is now Southern Maryland in 1634, many have only recently begun to discover its bounties, and there are lots of open spaces in this still rural area for nature lovers to enjoy. You'll find great fishing and boating opportunities and charming waterside towns nestled between the Chesapeake Bay and the Patuxent and Potomac rivers. The state's original capital, St. Mary's City, has been preserved as a living history museum on the banks of the St. Mary's River and is celebrating its 375th anniversary.

EASTERN SHORE

Maritime heritage is alive and well on Maryland's Eastern Shore. You'll find well preserved waterfronts, majestic lighthouses dotting the seashore, and watermen still plying the waters and supplying fresh seafood, including Maryland's famed steamed crabs. Maryland's portion of the Delmarva Peninsula has thousands of miles of shoreline, hundreds of rivers, and acres and acres of salt marshes, including Assateague Island National Seashore and State Park, with its wild ponies, and two major wildlife refuges harboring bald eagles and all manner of waterfowl.

Click VisitMaryland.org or call 1-800-984-9502 to start planning your trip to Maryland.

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MARYLAND
WELCOME
Martin O'Malley, Governor
Anthony G. Brown, Lt. Governor

Photo: www.merlavageimages.com

Cumberland's arts and entertainment district provides R&R for outdoor enthusiasts as the mid-point of the 300 mile Great Allegheny Passage trail.

ALLEGANY COUNTY is the historic hub of the Mountain Side of Maryland, the long arm of the state that stretches west into the Potomac highlands, populated by charming towns and vast stretches of public wildlands. Green Ridge State Forest encompasses more than 40,000 acres with numerous opportunities for outdoor adventure. A great way to see the county is to ride the Western Maryland Scenic Railroad, the heritage railroad based in Cumberland that connects to Frostburg, on the county's farthest boundary, traveling through a gorge called the Narrows. The Western Maryland Railway Station, in Cumberland's charming Canal Place, is a beautifully restored, working landmark. A walk through the nearby Allegany County Museum is a passage through the region's past, including the eras of thriving coal and glass industries. Cumberland is also the terminus point of the C&O Canal and departure route for scenic trips through the Alleghenies. A portion of the Allegheny Highlands Trail of Maryland, part of the Great Allegheny Passage bike trail from Cumberland to Pittsburgh, Pennsylvania, runs along the route of the Western Maryland Scenic Railroad. Cyclists can put their bikes on board for the climb up the mountain to Frostburg.

CAROLINE COUNTY has stunning landscapes that are steeped in history. The Museum of Rural Life in Denton and the Linchester Mill in Preston tell stories of early American rural life and highlight the County's agricultural history. Underground Railroad pathways traversed by Harriet Tubman weave through the county. A self-guided driving tour, "Finding a Way to Freedom", takes visitors through the landscape that helped shape the nation.

Though landlocked, the Marshyhope, Tuckahoe and Choptank rivers flow through the county, creating a haven for those seeking adventures on the water. Newcomers can get a bird's eye view from the sky hang gliding in Ridgely. People looking for recreation can take a swing at the golf courses; clay shooting courses, hunting preserves and retreats with more than 25,000 acres of prime hunting available.

Caroline County has more than 5,000 acres of parkland and wildlife preserves and miles of trails for hiking and cycling. Rich in heritage and natural resources, Caroline is ideal for the lovers of the outdoors and early American history.

Photo: Ellis Davison

Left: Kayaking along one of Caroline County's unspoiled waterways; right: sunset at Turkey Point Lighthouse, Cecil County

CECIL COUNTY

In Cecil County, located along upper Chesapeake Bay, the connection between land and water is deep and historic. Some of its most memorable natural and historical sites are set on the waterfront, including Elk Neck State Park and Turkey Point Lighthouse, where the Northeast and Elk rivers flow into the Chesapeake Bay. On your way to Chesapeake City, you'll cross the graceful Chesapeake & Delaware Bridge that spans the mouth of the C&D Canal, still in operation. The C&D Canal Museum is set in the canal's original pumphouse located along the banks of the canal with a view of the majestic bridge and historic South Chesapeake City. The beautifully restored Mount Harmon Plantation has a spectacular waterfront setting. And don't miss the Fair Hill Natural Resource Management Area, an ethereal setting for equestrian, hike and bike trails that even includes a covered bridge.

Frederick's 44-acre Baker Park provides a great vantage point to enjoy the "clustered spires."

DORCHESTER COUNTY

History and natural landscape are entwined in Dorchester County, which has retained much of the traditional way of life along the Chesapeake Bay. The county, which curves out into the Chesapeake from Delmarva Peninsula, has preserved much of the unspoiled Eastern Shore landscape associated with the history of this region. With its pristine rivers, marshlands, working farms, fishing boats and historic waterfront towns, this heart-shaped county is known, appropriately, as the Heart of Chesapeake Country.

Every March, Dorchester commemorates its link to two beloved symbols of freedom and American history. On March 14, the historic town of Cambridge celebrates Harriet Tubman Day with an event commemorating the life of this former slave who became an early human rights activist and brave conductor of the Underground Railroad. The Harriet Tubman Museum and Education Center is an excellent starting point for a tour of the Underground Railroad Trail, a Maryland Scenic Byway.

On that same day in March, you can join the Blackwater Eagle Festival for exhibitions and special events at the nearby Blackwater National Wildlife Refuge, home to a large population of bald eagles. The refuge, located south of Cambridge, encompasses more than 250,000 acres of woodland, rich tidal marsh, freshwater ponds and managed cropland, where the landscape is little changed from Harriet Tubman's day.

Blackwater National Wildlife Refuge is a haven for the bald eagle

FREDERICK COUNTY

Shop, dine, and experience the beautifully preserved 50-block historic district of Downtown Frederick, Maryland, recognized in the past few years by the National Trust for Historic Preservation as both a "Great American Main Street" and one of America's "Dozen Distinctive Destinations." Scenic byways lead to orchards, antiques and specialty shops, parks, and other great downtowns, including more Main Street communities than anywhere else in the state.

The award-winning Frederick Wine Trail connects half a dozen wineries throughout the scenic countryside. Tour historic sites and museums such as the National Museum of Civil War Medicine and Monocacy National Battlefield, where a new visitor center features exhibits interpreting "the battle that saved Washington." Visit the National Shrine of Saint Elizabeth Ann Seton who arrived in Emmitsburg two hundred years ago in 1809, or nearby state and national parks that include the highest cascading waterfall in Maryland.

Follow Civil War Trail driving tours to see what the soldiers saw en route to Antietam and Gettysburg, within the Heart of the Civil War and Journey Through Hallowed Ground heritage areas. Bike the C&O Canal, hike the Appalachian Trail. Just a short drive to Gettysburg, Harpers Ferry, Washington D.C. and Baltimore.

Historic Chestertown

KENT COUNTY occupies a pastoral peninsula bounded by the Chester and Sassafras rivers on the upper Chesapeake Bay. Its scenic roadways and waterways wind through rolling farmlands, historic towns and important wildlife refuges. Many of the two-lane roads in this tidewater county have been included in Maryland's first National Scenic Byway, Chesapeake Country. Kent County's portion of the byway includes the routes from the Chester River Bridge to Georgetown and the Sassafras River, from Chestertown to Rock Hall, and from Rock Hall to the Eastern Neck National Wildlife Refuge. In Chestertown, where the Chester River curls past grand 18th-century buildings, history buffs can celebrate the annual Memorial Day reenactment of the Chestertown Tea Party. The town's Main Street is lined with quaint shops and restaurants. And, don't miss Rock Hall's Waterman's Museum, its lively marina and the great sunsets from its boardwalk.

Towpath along the Chesapeake & Ohio National Historical Park

MONTGOMERY COUNTY

borders Washington, D.C., and it's an ideal base for exploring D.C.'s monuments and museums. But it has its own special historic and cultural attractions, and the western section of the county along the Potomac River is downright rural, with green farmlands dotted with charming little towns and villages.

A longtime favorite with visitors is magical Glen Echo Park, on the Potomac palisades near Bethesda. Originally a Chautaqua retreat, and then an amusement park, this National Park now hosts arts, environmental and history programs. Near Glen Echo, you can tour the Clara Barton National Historic site, home to the founder of the American Red Cross.

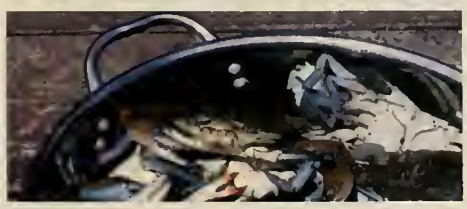
In Potomac, visit the Chesapeake & Ohio National Historical Park, where you can see an original lock house, hike or bike on the historic tow path, or take in the spectacular view of the Great Falls of the Potomac River from the Olmstead Bridges. For more outdoor adventures, visit Black Hill Regional Park, near Germantown, and follow the trail to Little Seneca Lake, a popular area for birds and birders.

WORCESTER COUNTY, located on Maryland's lower Eastern Shore, is the state's only coastal county. Assateague Island State Park and National Seashore is home to the state's famous wild pony herd, and Ocean City, just to the north of Assateague, is known for its sandy beaches and steamed crabs.

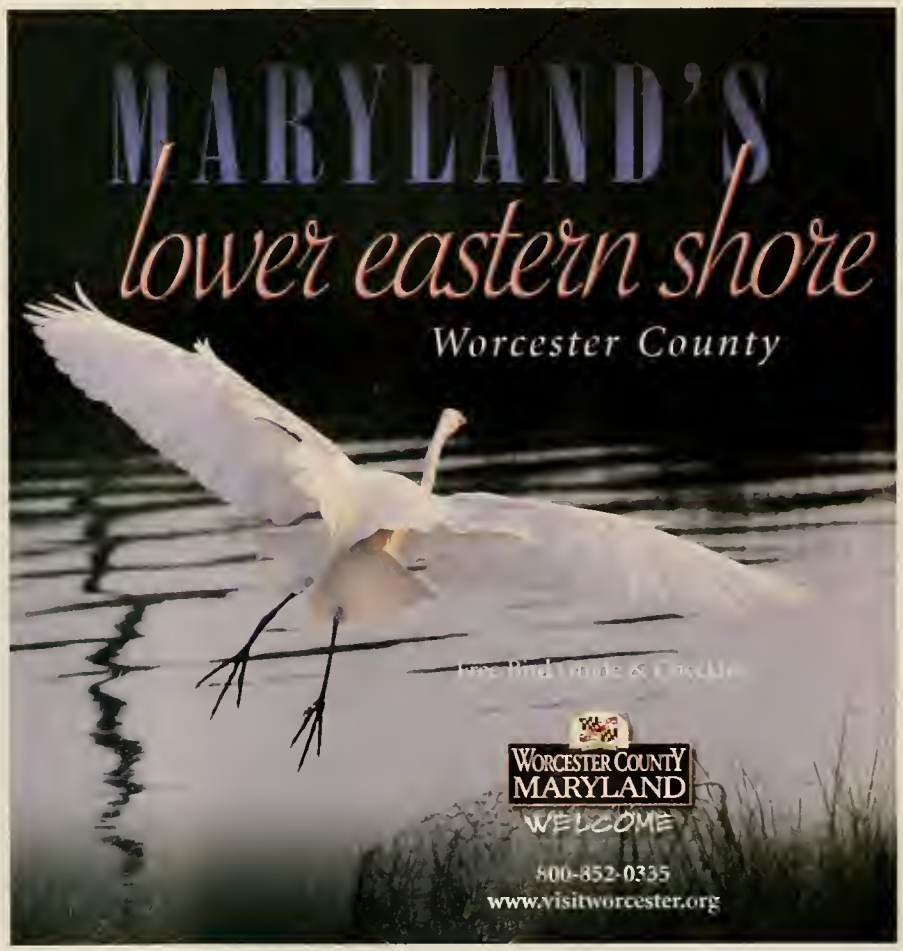
But there is far more to Worcester than its inviting shores. With the beautiful black-water Pokomoke River and its forests and cypress swamps as well, the county's varied habitats play host to more than 300 species of birds, the most in the state. The Delmarva Discovery Center on the Pocomoke River in downtown Pocomoke City is a great introduction to the history of the Pocomoke River, including shipbuilding, trading, fishing and local Native American historical culture.

For exploring the river, the Nature Conservancy maintains a mile-long trail through the Pocomoke Forest and over the Nassawango Cypress Swamp, along Nassawango Creek, shaded by ancient bald cypress and black gum trees. The swamp is well known as a bald eagle roost. In spring, Ocean City and Pokomoke City become birder central for the Delmarva Birding Weekend, with guided trips to coastal bays, islands, forests and to some private farms not usually open to the public.

Make sure to allow time to explore towns like Berlin, a very hip, historic town with lots of galleries, boutiques and eateries. Snow Hill, just south of Berlin, on the banks of the Pocomoke River is home to the river's only outfitter for kayak and canoe rentals and trips.



Wetlands near Ocean City



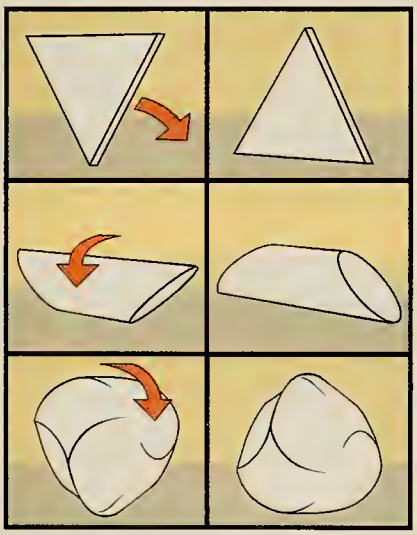
The Living Gömböc

Some turtle shells evolved the ideal shape for staying upright.

Illustrations by Joe Sharkey

There is something about a turtle on its back that twists your heart. With neck craning toward the ground and legs waving to no effect, it is the image of helplessness. But, malicious kids aside, turtles almost never end up upended. And it turns out that the apparent risk factor for that predicament—the turtle's rigid carapace—is less a liability than an asset, surprisingly well-suited to the turtle's goal of righting itself. The secret is in the mathematics of its shape.

Many a truly difficult mathematical problem can be stated in an approachable and deceptively simple way. Can you, for example, cut a convex shape from a uniform sheet of plywood that will only sit one way when balanced on edge? By "convex," I mean that there are no dents in the outline: a straight line drawn between any two points along the edge will stay inside the shape. A plywood square, for example, has four edges on which it will happily balance (if you ignore the third dimension and forget that it could flop over sideways). In addition, it has an unstable balance point on each corner—a point on which it can balance, but so precariously that even the smallest perturbation will send it tumbling. A triangle comes one step closer in the quest for a shape with only one balance point: it has three stable positions and three unstable ones [*see figures at left*]. An ellipse has two of each. It turns out that this is the very best you can do. No amount of trimming or trickery will get you a single stable equilibrium point in this essentially two-dimensional case.



Left: Illustrating the difference between an unstable and a stable equilibrium, a plywood triangle (top), regarded as a two-dimensional object, may balance precariously on one of its three points or come to rest on one of its three long sides. Similarly, a rod with both ends sliced off at oblique angles (middle) teeters on its short side—as it would if stood on either pointed end—but finds stability on its long side. Designed by mathematicians, the Gömböc (bottom) never rests for long on any point except its one and only stable surface. Below: Resembling the Gömböc, the shape of its shell gives an Indian star tortoise only one stable configuration: on its feet!

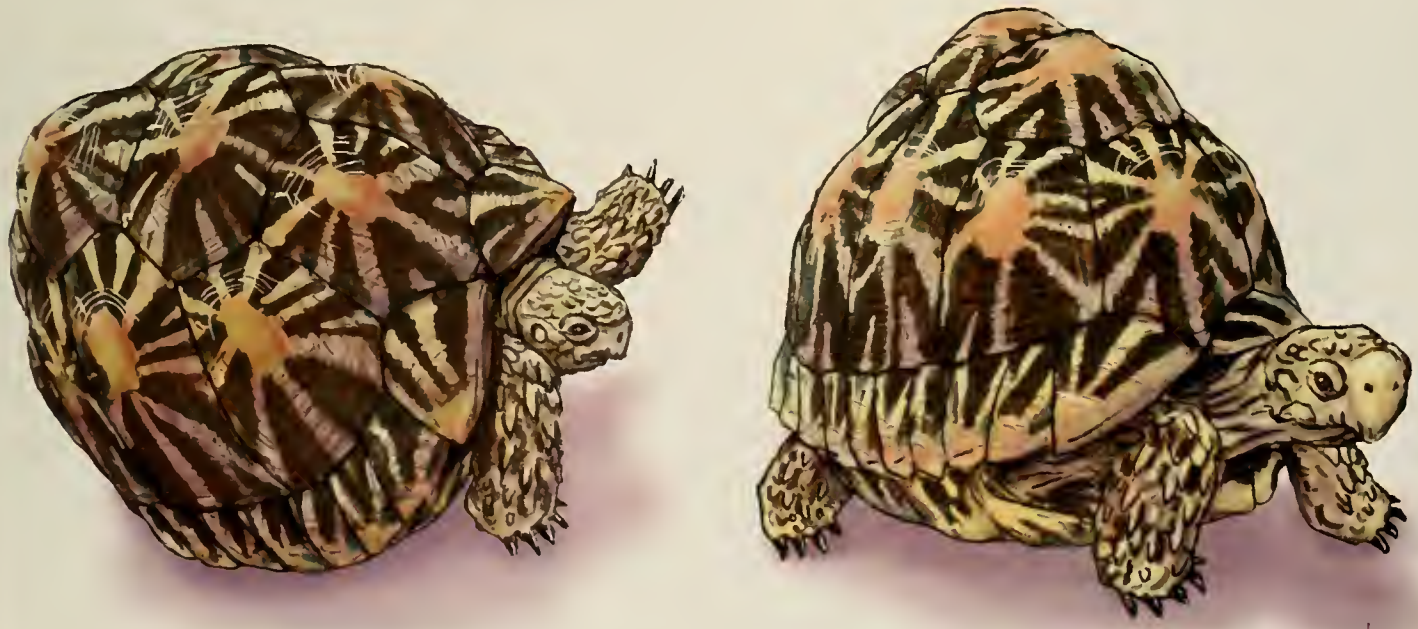
You might come to that conclusion based on trial and error; proving it mathematically, however, was not a trivial exercise. Gábor Domokos, of the Budapest University of Technology and Economics, successfully tackled that challenge. He then sought to extend the proof into three dimensions. It is tempting to believe that, as in the 2-D case, the best you can do is two stable equilibria and two unstable ones, but Domokos came up with a counterexample. Consider a rod with both ends cut off obliquely [*see figures on opposite page*]. It rolls around on the table and stops with the long side down every time. It has just one stable configuration. On the other hand, it has three unstable equilibria: balanced on either pointy end or with the shorter side down. Is that the best we can do? What about a shape that has just one stable equilibrium and a single unstable one—a mono-monostable object, in mathematicians' parlance? In the 3-D world we are all familiar with Weebles™, those cute plastic toys that wobble but don't fall down. They fit the bill, but they violate a key condition of the plywood problem: they have a little metal weight in the bottom. Is it possible to construct a Weeble that isn't weighted, one that rights itself just by virtue of its rotund little shape?

The trial-and-error answer is "no," but that seldom impresses a mathematician. Domokos, joined by his graduate student Péter Várkonyi (now also a professor at the Budapest University of Technology and Economics), began to work seriously on the problem. Using a spherical coordinate system, they constructed formulas that slightly squashed a sphere, added a pair of extra flattened planes on the surface (which they call "raceways"), and pressed one side into a sharp edge. For reasons that are clear only to native speakers of Hungarian, they called this sensuous shape a Gömböc (pronounced something like "gumboots"). Though it existed as a mathematical construct, Várkonyi and Domokos did not truly appreciate how interesting the shape was until they had a model made with a 3-D printer. With the Gömböc in hand, they were struck by the similarity of its shape to the highly domed shell of the Indian star tortoise (*Geochelone elegans*).

Domokos and Várkonyi turned their attention to the possibility that the Gömböc shape was a naturally occurring example of a mono-monostatic object. They looked at seventeen species of turtles, including high-domed tortoises and flatter pond turtles. By determining the curves that captured the 3-D shape of each turtle shell, they translated the animals into the same mathematical language as the Gömböc. It quickly became clear that tortoises are indeed quite close to being monostable: when placed on its back, a tortoise will roll right side up with just a little perturbation. But pond turtles are quite stable when placed on their backs and must use their necks and ninja-turtle footwork to lever themselves over. (In reality, that rarely becomes necessary, since they stay in or near water, where sudden inversion is not common.)

Of course, tortoises have an advantage over the Gömböc in that they have four legs to flail around, which moves their center of gravity enough so that they will wobble right side up without an outside influence. They are also not really of uniform density, and the placement of the lungs high in the dome certainly makes them more like a Weeble than a Gömböc. The similarities are striking enough, however, both for tortoises and for certain species of beetles, that it seems natural selection has been hard at work smoothing their form into a Hungarian tongue twister.

Adam Summers is an associate professor at the University of Washington's Friday Harbor Labs.



TO KILL A CORMORANT

Are double-crested cormorants overrunning their niche—or simply recovering from centuries of suppression?

By Richard J. King

I'VE BEEN OBSESSED with cormorants for several years now, ever since I wrote my interdisciplinary master's thesis on the seabirds. My studies took me all over North America, to four other continents, and almost to bankruptcy court trying to fund all the travel and research. Now, aside from the occasional boat trip to observe a local rookery, my involvement is limited to a Google news alert set to the keyword "cormorant." Nearly every morning I get a link to a newspaper or magazine article by or regarding someone, somewhere in North America, arguing bitterly about what to do with the bird.

In case the hubbub has escaped your notice, let me sum it up for you. For the last thirty years or so, populations of double-crested cormorants (*Phalacrocorax auritus*) have been blossoming in many parts of North America. Although many people herald the cormorant boom as a success—an indicator of improving environmental health—all sorts of other folks are in a tizzy about it. For example, near my town of Mystic, Connecticut, otherwise nature-loving people want to kick cormorants off South Dumpling Island, a three-acre, uninhabited bump in eastern Long Island Sound. About 500 cormorants live there now, having only moved in (or perhaps back) less than ten years ago. Members of the Avalonia Land Conservancy, which owns South Dumpling, observe that the birds' feces are slowly killing the trees and ground cover, and they fear that soil erosion will soon follow. They're also worried that the cormorants are pushing other birds, such as the snowy egret, off the island. Anne H. Nalwalk, who recently stepped down as president after leading the Conservancy for twenty-two years, once said: "We'd rather see egrets than a bird that's destroying all the vegetation."

The conservancy works with a local marine-science educational group called Project Oceanology, which for the last four years or so has landed instructors and students on South Dumpling to test various cormorant deterrents. They've tried anti-erosion mats, snow fences, and nets draped over the trees. Their actions are backed, informally, by at least one local commercial fisherman, who

Ready, aim . . . a double-crested cormorant prepares to dive. Propelled by their large webbed feet, the birds are powerful and swift underwater swimmers.

approves of any measure to reduce the number of cormorants in Long Island Sound because he blames the birds for a drop in bluefish and flounder stocks.

Throughout the United States and Canada, pockets of citizens want to reduce cormorant populations they deem overabundant, for the same reasons: destruction of vegetation, unfair competition with more-valued species, and overindulgence in fish. Occasionally, there are claims that cormorants negatively affect water quality or public health, or just that their guano smells nasty. But the most vehement complaints are about fish—primarily from freshwater charter fishermen and fish farmers. In 1998, a bunch of charter fishermen turned vigilantes stormed onto Little Galloo Island in eastern Lake Ontario, trampling and shooting about 2,000 cormorants in violation of federal law. (It's a crime to kill migratory birds without a permit.) They were eventually brought to justice, but another group that killed more than 500 cormorants two years later on Little Charity Island in Saginaw Bay, Michigan, never was.

So great was the public outcry against the birds that the U.S. Fish and Wildlife Service (USFWS) felt compelled to draft a new cormorant management plan. During the grueling, multiyear analysis and public-comment period that followed, many voices pushed for stringent management to reduce cormorant numbers. Some wanted to establish hunting seasons—even though nobody eats cormorants. Others, including the National Audubon Society and the Humane Society of the United States, rallied to the cormorants' defense, citing a lack of scientific evidence that cormorants actually damage fish or wildlife populations. In 2003, the USFWS settled on expanding the rights of citizens and managers to deal with cormorants, handing over most of the decision making to selected local agencies. (The service took a similar route in 2006 to tighten management of burgeoning Canada geese, the only birds that provoke anywhere near as much irritation as cormorants for their fouling of lawns and parks.) Today, in thirteen states, aquaculture producers may shoot cormorants feeding on their private ponds, and they may call on government wildlife managers to shoot birds on nearby roosts. Local managers in twenty-four states can suffocate cormorant eggs with oil; destroy their nests; or kill cormorants that threaten public resources, such as wild fish, plants, and other birds' nesting areas.

Under the new rules, individuals and states are permitted to kill a total of 160,000 cormorants each year. An average of about 40,000 cormorants are reported killed each year—perhaps 2 percent of North America's population. That figure does not include tens of thousands of eggs oiled annually. Biologists cannot agree on the long-term ecological effect of the culling. Some have pointed out that managers who enter nesting grounds to cull or oil eggs often end up doing more damage to other bird species than the nesting cormorants do in the first place. Linda R. Wires, a conservation biologist and cormorant expert at the University of Minnesota in St. Paul, who has been deeply involved in the USFWS's investigations, told me: "At the heart of this issue is nearly a zero tolerance for cormorants. It's a witch hunt."

DEPENDING ON YOUR chosen taxonomy, there are between twenty-seven and thirty-eight extant species of cormorants, all closely related to pelicans, frigate birds, and anhingas. They live around the globe in colonies bordering salt- and freshwater.

There is the flightless cormorant of the Galápagos Islands and the pygmy cormorant of eastern Europe. The large and nearly flightless spectacled cormorant of the western Aleutian Islands was driven extinct in the mid-nineteenth century by natives and explorers, who ate the seabird's meat and harvested its eggs. A few cormorant species are called shags, lending themselves to all sorts of sexual puns. Then there is the great cormorant. Like the double-crested cormorant in North America, it has made a huge comeback in western Europe, spurring familiar outcries from fishermen and property owners who have nicknamed it "the black plague."

As a group, cormorants primarily eat fish, but will also eat crustaceans, mollusks, and small amphibians. Most species prefer to hunt in coastal shallows, but many can dive more than 100 feet underwater. (The Crozet shag of the Southern Ocean has been recorded at the impressive depth of 475 feet.) Using their beaks to gather sticks, seaweed, fishing line, ribbons, and other random items, cormorants build their nests in trees, or on

Sign, photographed in 2001, was posted in Henderson Harbor, New York, on Lake Ontario, where anti-cormorant sentiment runs high. Many anglers blame the birds for declining smallmouth bass numbers. In 1998, local charter fishermen illegally killed some 2,000 cormorants on nearby Little Galloo Island.

RICHARD J. KING

rocks, dirt, or sand. The adults have no song or call, only a hiss or a piggy grunt, something like the creak of an old door hinge. The young in the nest issue a shrill, high-pitched cry for food.

Today, six species of cormorants live in North America. By far the most prevalent in the U.S., and the only one found appreciably inland, is the double-crested cormorant, which gets its name from two tufts of feathers that appear on the heads of both sexes during breeding season. Double-crested cormorants nest in forty-three states, every Canadian province, Cuba, and the Bahamas. During migrations or winter roosting they spend time in every state except Hawaii. They travel as far north as Alaska and Labrador and as far south as the Yucatan Peninsula.

Double-crested cormorants have an inaccurate reputation as unusually voracious piscivores, perhaps because their fishing is conspicuous: they typically fish near shore and can eat large prey for their size.

ARCO IMAGES GMBH/ALAMY

SO WHAT DOES IT MEAN FOR a species as cosmopolitan as the double-crested cormorant to be "overabundant"? How many cormorants are "too many"? Much of the debate about managing the bird swirls around whether it's native to a particular region and how many once lived there—facts that have been difficult to pin down. Wires and Francesca J. Cuthbert, an avian biologist also at the University of Minnesota, made a recent attempt, examining archaeological records and naturalists' accounts, among other sources. Before Europeans became a major presence, Wires and Cuthbert conclude, double-crested cormorants lived throughout much of their current North American range, usually in populations far greater than today. For example, after birdwatching near Natchez, Mississippi, in December of 1820, John James Audubon reported: "We saw to day probably *Millions* of those . . . Cormorants, flying Southwest—they flew in Single Lines for several Hours extremely high." Numbers like that simply don't exist today.

To be sure, it is often impossible to tell whether a specific area was historically home to the birds. Cormorants might well have nested on South Dumpling Island at the time of European contact: explorers' accounts and archaeological records show nests within a hundred miles, and an 1847 nautical chart identifies a Cormorant Reef and a Cormorant Rock within five miles. Cormorant Cove lies twenty miles away. None of that proves they nested at South Dumpling—or at the other locations—but clearly cormorants are regional natives.

As with most animal species, the population history of double-crested cormorants in North America has been shaped by human activity. Native Americans on both coasts ate cormorants and their eggs. Early European settlers didn't seem to eat much cormorant, but they did use the bird's meat for fish bait. By the nineteenth century, most seabird populations in New England and Nova Scotia had plummeted. Settlement and industry had encroached on island nesting areas. People gathered eggs for food, and shot all kinds of seabirds for meat, hat feathers, sport, and to keep them from eating marketable fish. Men pegged cormorants, specifically, as fish stealers. Harrison Flint Lewis, author of the first North American doctoral thesis on cormorants, wrote in 1929: "The history of the Double-crested Cormorant during the latter part of the nineteenth century and the first quarter of the twentieth is largely a history of persecution and of the gradual abandonment of one breeding-place after another." By that time, cormorants no longer bred anywhere in New England.

Colony of double-crested cormorants nests on Washington's East Sand Island, in the mouth of the Columbia River. A recent study showed that the cormorants rely on migrating juvenile salmon and steelhead for just 9 percent of their diet, but they and the island's Caspian terns are numerous enough to dent several endangered salmonid stocks.

Cormorant populations made a brief recovery during the first half of the twentieth century as people moved off islands to seek better opportunities and built new seabird habitat—in the form of reservoirs, dock pilings, and bridges. But as cormorant numbers increased, so, again, did their persecution. John Steinbeck and Edward F. Ricketts, recounting a visit to the Baja Peninsula, facetiously summed up the prevailing attitude in their 1941 book, *The Sea of Cortez*:

> [T]here had been light gunfire on the cliffs, where several men were shooting at black cormorants; and it developed that everyone in Cape San Lucas hates cormorants. They are the flies in a perfect ecological ointment. . . . They dive and catch fish, but also they drive the schools away from the pier out of easy reach of the baitmen. They are considered interlopers, radicals, subversive forces against the perfect and God-set balance on Cape San Lucas. And they are rightly slaughtered, as all radicals should be.

DDT and other egg-thinning pesticides, introduced after World War II, intensified the devastation, and over the next two decades cormorant populations sharply declined again continent-wide. By 1969, the largest colony ever recorded in North America—perhaps a quarter million breeding pairs on an island off Baja California—had fallen to just 5,000 pairs. (It eventually hit zero and now probably numbers fewer than a thousand pairs.)

Then came 1972, one of the few good years in recent cormorant history. The National Audubon Society listed the double-crested cormorant as a species of special concern. The state of Wisconsin declared cormorants endangered and began building nesting structures to help them return. Lawmakers banned the use of DDT, and Congress signed a revised Migratory Bird Treaty Act that put cormorants under federal protection.

Cormorant populations have since rebounded, thanks in part to conservation measures and to people's inadvertent creation of ideal cormorant habitat near ample food supplies. For example, at the mouth of the Columbia River, the Army Corps of Engineers enlarged and stabilized an island with dredge spoil in the early 1980s. Today East Sand Island in Washington State hosts the continent's largest cormorant colony (albeit with fewer than 14,000 breeding pairs), surely because it is a protected, mammal-free nesting habitat near migrations of wild and farmed salmon and steelhead. The cormorants, along with Caspian terns, feed heavily on thirteen endangered salmonid stocks—a legitimate cause for concern, though it must be remembered that people both caused the salmon's problems and built the cormorants' base of operations. Now

managers are trying to lure the terns to artificial islands being built for them on distant lakes, and may attempt the same for the cormorants.

Meanwhile, catfish and baitfish aquaculture has been rapidly growing since the 1960s, particularly in the southeastern U.S., directly on the cormorants' migration route. Open aquaculture ponds provide winter or year-round homes with food aplenty. Many of the same cormorants breed and summer up north in the Great Lakes. That's the area with the greatest growth in cormorant populations, and the center of a good deal of the controversy. It's also the area where Wires and Cuthbert's evidence for cormorants' former abundance is the most anecdotal and inconclusive. The population growth in the Great Lakes—from approximately 90 breeding pairs in 1970 to nearly 115,000 in 2000—was fueled, ironically enough, by government managers stocking the region's waters for recreational angling, often using fish raised in the southeastern aquaculture ponds.

Nest building on East Sand Island

Great Lakes cormorant numbers seem to be holding steady today; indeed, recent nest counts suggest that cormorant populations nationwide are beginning to plateau, even to decrease in a few areas. If so, they've likely stopped far short of achieving numbers that existed throughout much of North America before European settlement.

IT IS RELEVANT that the National Audubon Society did not choose the double-crested cormorant for its logo: Anne Nalwalk is not alone in her preference for egrets. In my town you can buy a little wood sculpture of a gull, but not a tchotchke cormorant. Gulls have made a huge resurgence alongside cormorants, thanks to the everlasting food supply at landfills and littered beaches. They eat trash and plenty of people still love them.

Cormorants are black. The effect of color associations on an animal's popularity among Americans is debatable, but in Louisiana I've heard cormorants called "n— birds." Cormorants have no pretty song, no graceful step. There has been no movie or television show to anthropomorphize the bird, no cormorant Bambi or Flipper. There are a couple of positive small-press children's books, but the only major story featuring the bird is an award-winning novel by Stephen Gregory, called *The Cormorant*, in which the titular bird is literally satanic. It ruins a man's life, tearing off the face of his pet cat and causing the fiery death of his son. In fact, the bird has had a poor reputation in literature beginning with the Bible, where it is described as unclean and connected with death. In *Paradise Lost*, Milton portrays Satan himself breaking into Paradise and sitting on the Tree of Life "like a cormorant."

The adjective "cormorous" used to mean greedy, insatiable, ravenous. (Notice the raven here.) In four plays, Shakespeare used the word "cormorant" as a synonym for "voracious." Yet the charge that cormorants have an unusually large appetite is misplaced. Despite the notorious difficulty of determining exactly what seabirds eat, most studies show that on average, a double-crested cormorant eats at most one pound of fish per day. That's much less in absolute terms than a pelican eats and a similar percentage of body weight. Pelicans, though, remain generally beloved despite growing populations.

MICHAEL WILHELM

Dead trees on a Lake Champlain island testify to double-crested cormorants' effect on vegetation. The birds strip off foliage for nesting material, and plants are killed by the accumulation of guano, which is acidic. The cormorants moved onto the island in 1983, after managers chased them off a different, treeless island.

Cormorants may be easy scapegoats (another animal with an image problem) simply because their hunting is so visible to people. The birds often forage by docks and in bays, and they can eat memorably large fish for their size, slurping down eels and other species longer than two feet. Yes, cormorants eat fish, but their populations would crash naturally in a region that didn't have enough fish to eat.

Cormorants' effect on wild commercial stocks remains unclear. Admittedly, they could be eating fish that marketable species depend upon; and a very large population could conceivably put a dent in a commercial or sport fish stock. But most research shows that cormorants don't focus on the wild species that people like to eat. Instead, they opportunistically feed on small schooling fish, "trash fish," whatever is available. Cormorants' effect on the aquaculture industry, however, is painfully obvious: a dense flock can destroy a harvest, and cormorants are estimated to cost the catfish industry in Mississippi alone between $10 million and $25 million dollars annually.

THE CORMORANT SITUATION on my local South Dumpling Island is minor compared with that of the Great Lakes, the Mississippi Delta, and the mouth of the Columbia River, but it is representative of the issue's complexity. The popular view of how cormorants affect Long Island Sound's commercial fish is well put by Brae Rafferty, a senior instructor at Project Oceanology and a veteran of nearly three decades on the sound. He says: "When you're out on the water all the time and seeing the birds, you think, 'They've got to be feeding on something.' The winter flounder aren't coming back. I've seen cormorants eating flounder, so between them and the seals there's got to be some impact."

Anne Nalwalk isn't as concerned about the fish; it's the look of South Dumpling that bothers her. She's also aware that her objection to the cormorants is, as she says, "in the eye of the beholder." Her concern is not based on the local environment's true carrying capacity, but rather on what scientists call "wildlife acceptance capacity." Her opinion derives primarily from cultural factors: learned aesthetics, negative portrayals in the media, and a nostalgia for the way things used to look within her memory. And there's the rub with cormorants. Sure, their numbers are way up compared with what they were during the mid-twentieth-century DDT spree. But if their estimated populations before Europeans arrived are the baseline, they've simply paused partway on the long road to recovery.

People, not seabirds, have done the real damage to the fisheries and ecosystems of the coasts and the Great Lakes, through overfishing, introduced species, and pollution. The money spent trying to manage cormorants—which taxpayers will need to cough up indefinitely, unless we wipe the birds out forever—could be much better spent to reduce coastal pollution; to secure conservation land and marine preserves; and to help aquaculture producers develop new bird-smart practices and fishermen develop sustainable fisheries. Let's take the bird off the guano list. Maybe Disney could come out with a new film, something between *The Little Mermaid* and *The Ugly Duckling*. I'll be watching for it in a Google alert.

Richard J. King is Lecturer in Literature of the Sea at Williams–Mystic, the Maritime Studies Program of Williams College (Williamstown, Massachusetts) and Mystic Seaport (Mystic, Connecticut). He holds a doctorate from the University of St. Andrews in Scotland. He completed his master's thesis, an interdisciplinary study of cormorants, in 2003 at Wesleyan University. He has since published several articles on the birds and is working on a book titled *Curiosity and the Cormorant*. King writes a column about animals in maritime history for *Sea History*.

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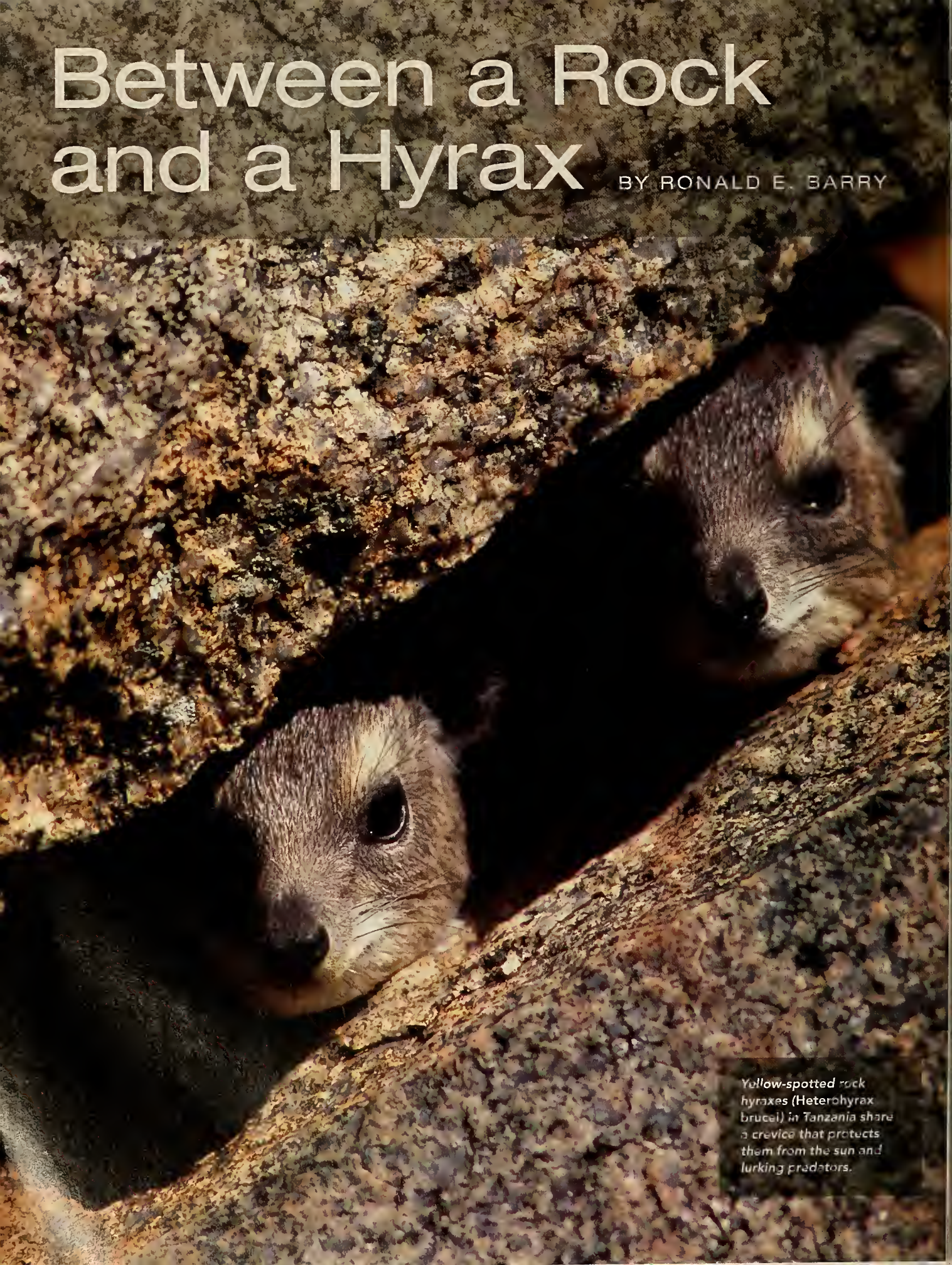
Between a Rock and a Hyrax

BY RONALD E. BARRY



Yellow-spotted rock hyraxes (Heterohyrax brucei) in Tanzania share a crevice that protects them from the sun and lurking predators.

Two closely related species find safety in numbers—except in the presence of people.

From my perch overlooking a rocky outcrop in Matobo National Park, in southwestern Zimbabwe, I keep watch over certain creatures that emerge from the cracks and crevices in the early morning and again in the late afternoon to recharge. Both times, they bask in the warming rays of the Sun, sometimes for several hours at a stretch, then forage briefly. In between these outings, they avoid the midday heat by retreating into the cavernous refuges of their craggy fortress. At nightfall they withdraw again to rest. Cold-blooded reptiles, you might guess? No, they are mammals—African hyraxes—whose low metabolic rate and varying body temperature belie their mammalian heritage. What especially fascinates me, however, is that they belong to two species of two different genera, the rock hyrax and the yellow-spotted rock hyrax. Their coexistence here, and in many regions of southern and eastern Africa, seems to challenge a long-standing principle, that similar species cannot occupy identical niches.

I was first introduced to the local hyrax populations in 1991 by Peter J. Mundy, then an ornithologist with Zimbabwe's Department of National Parks and Wildlife Management, and the late George Banfield, organizer of the Black Eagle Survey in Zimbabwe. I quickly began to collaborate with the parks department, initiating a study of the population biology of hyraxes in Matobo. In addition to Mundy, my primary colleagues were Moses Masiyandima, at the Natural History Museum in Bulawayo, and Ngoni Chiweshe and Edward Chabikwa, then with National Parks. In spite of ongoing political strife in the area, we were able to monitor the hyraxes over a period of fourteen years in the park, which covers approximately 170 square miles. Ultimately, the political and economic turmoil—which resulted in a lack of fuel, vehicles, and access to the park—forced us to close down the study.

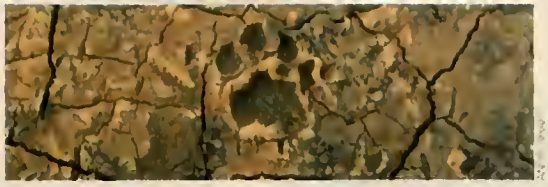
I had never seen a hyrax in the wild before setting foot on the *kopjes*, or rocky outcrops, of southern Africa; zoos had been my only immediate source of ref-

Outcroppings of rock, above, known as kopjes, offer prime real estate for rock hyraxes (Procavia capensis) and yellow-spotted rock hyraxes living together in Matobo National Park in Zimbabwe. There are plenty of crevices to spare, yet the hyraxes choose to stick together, possibly for protection. Right: Hyraxes even share nursery duties, as in the case of the two adult rock hyraxes watching over two juveniles.

erence for learning what the creatures actually looked like and how they behaved. My specialty was the spatial and temporal relationships among small mammals, such as the white-footed mouse (*Peromyscus leucopus*), North American deer mouse (*P. maniculatus*), and southern red-backed vole (*Myodes gapperi*), which coexist in eastern deciduous forests of the United States. But when I read about and saw pictures of two species of hyrax living side by side, I wondered if fieldwork on those African mammals might help me better understand my North American subjects. Gause's hypothesis, also known as the principle of competitive exclusion, insists that one of three fates awaits any two such overlapping species: one species can outcompete and displace the other; the two species can diverge biologically, with changes in one or both that permit a less competitive coexistence; or they can coexist by partitioning the available resources—food, space, and time (for example, when they sleep or eat). How, then, could two very similar hyrax species maintain such a cozy association? Could there be some hidden advantage to sharing the same area?

Known as "dassies" to the peoples of southern Africa, hyraxes are primarily herbivores, feeding on grass, bark, buds, leaves, flowers, and fruit. In general appearance they resemble marmots, but they are not closely related to such rodents. Instead, they are the only living representatives of the ancient mammalian order Hyracoidea.

Four hyrax species exist, and they fall within three genera—*Procavia*, *Heterohyrax*, and *Dendrohyrax*. The rock hyrax, *P. capensis*, ranges from southern and central sub-Saharan Africa to northeastern Africa, even into the Middle East. The yellow-spotted rock (or



Hyrax tracks

simply yellow-spotted, or bush) hyrax, *H. brucei*, has a more restricted distribution, especially in the north. Those are the two species that mingle in our study area. One can readily tell them apart, even at considerable distances: the yellow-spotted hyrax has a grayish coat with a white underside and bushy, brilliant white eyebrows, whereas the rock hyrax has a brown coat with a tawny underside. On average, too, an adult rock hyrax is about two feet long and weighs about seven and a half pounds, whereas the yellow-spotted hyrax is slightly smaller, reaching an adult weight of about six pounds and a length of just over a foot.

As it turns out, rock hyraxes prefer to graze at ground level—except in the dry season (May to September), when the grasses die out—while yellow-spotted hyraxes browse in shrubs and trees. That could be a way to lessen their competition. But both are diurnal rock-dwellers. Their agile movements in their rocky habitat suggest their other nickname, "rock rabbit." Rock hyraxes, incidentally, are thought to be the "coneys" of the Bible that "make their houses in the rocks."

The other two species—the southern tree hyrax, *D. arboreus*, and the western tree hyrax, *D. dorsalis*—are nocturnal and live mostly in trees. They generally do not share habitats with the rock hyraxes, and in fact neither is found in Zimbabwe. The two nocturnal species are renowned for their colorful vocal repertoires; the rock hyraxes, while less virtuosic, do emit a variety of sounds that include a twittering chirp, guttural growl, raspy bark, and high-pitched alarm squeal.

Molecular studies have shown that hyraxes, elephants, and sirenians (manatees and dugongs) are derived from a common ancestor. Those three groups, together with members of the extinct family Pliohyracidae, constitute the Paenungulata—"near ungulates." Some morphological similarities also reveal their relationship, such as digits with short nails; lack of a clavicle (collarbone); absence of a scrotum in males (the testes reside in the abdominal cavity); and absence of a baculum, or penis bone, in males.

An increase in body mass over evolutionary time—a trend known as Cope's Rule—is typical for mammalian lineages. Presumably a larger size confers such advantages as increased ability to capture prey or escape predation; efficiency in conserving body heat; and reproductive success. However, the lineage leading to hyraxes became smaller in body size. That may have been in response to competition from newly evolved antelopes, coupled (in the case of hyraxes) with the safety afforded by the narrow cracks and crevices of their rocky habitat. The earliest known member of the modern hyrax family, Procaviidae, is the late-Miocene *Heterohyrax auricampensis*, which lived in what is now Namibia. In size, and probably in many other ways, it was highly similar to the rock hyrax.

The rock hyrax and the yellow-spotted hyrax are critical players in the ecosystem of the Matobo Hills (encompassing Matobo National Park and surrounding communal lands), making them what are known as keystone species. They occur in great numbers (tens of thousands) and, as grazers and browsers of a variety of plants, mold the vegetative structure of their habitat. They are the principal prey of both the black eagle (also known as Verreaux's eagle) and the leopard, and important prey for a host of other vertebrate predators, including the crowned eagle, martial eagle, African hawk eagle, tawny eagle, rock python, black mamba, and chacma baboon.

Rock and yellow-spotted hyraxes possess a number of special adaptations to the kopjes. In addition to facial whiskers—a typical mammalian trait—they sprout stiff, sparsely distributed sensory hairs that protrude an inch or more above coat hairs on their back and sides, as well as along the abdomen and the fore- and hindlimbs. Those long hairs provide tactile feedback to help hyraxes navigate within their rocky refuges. Thick, rubbery pads on the soles of their feet, kept moist by secretions from numerous skin glands, enhance their grip for climbing among the rocks and even up and down tree trunks.

An unusual gland, located on the back of the hyrax, is surrounded by long, erectile hairs that form a black patch on the rock hyrax and an ivory or yellow patch on the yellow-spotted hyrax. My colleagues and I noticed that the hairs that make up those patches, particularly in the rock hyrax, are erected in the presence of other individuals. Apparently those hairs facilitate the wafting of an odor from the gland, an odor that appears to be important for mating, recognition of the

Black eagle swoops down with its talons bared, top; a leopard carries a hyrax, above. The two predators, and increasingly people, pose the greatest threats to hyraxes in the Matobo National Park.

mother by the young, and perhaps recognition of the presence of other individuals of the same species.

In some ways hyraxes seem more reptilian than mammalian. Although the physiological ecology of hyraxes has been little studied, more than thirty-five years ago the late evolutionary biologist George A. Bartholomew observed a metabolic rate for the yellow-spotted hyrax that was 20 percent lower than expected for a mammal of its size, and a body temperature that fluctuated by as much as 13 Fahrenheit degrees daily in response to changes in air temperature. Hyraxes rely considerably on behavior to thermoregulate. They bask on exposed rock in the early morning and late afternoon to raise their temperature, and so increase their metabolic rate and activity level, before they move a short distance to forage.

Hendrik Hoeck, a zoologist at the Max Planck Institute in Seewiesen, Germany, has studied rock hyraxes for more than thirty years on the Serengeti Plain of East Africa. Before undertaking my own fieldwork, I carefully read his publications. He described the two species as having a similar social unit: a single adult male, highly territorial, associating with as many as seventeen females—along with juveniles and subordinate males—on a single, isolated kopje. What struck me as most interesting, however, was his observation that the two species appear to live in the same rock crevices: they emerge from and retreat to the same spots between bouts of basking and foraging, and even occasionally lie next to each other during basking. Yet they do not interbreed. I found the same association in the Matobo Hills populations. Although members of the two species are more likely to associate with their own kind as they bask, they can frequently be found side by side, even in physical contact.

In searching for an explanation of why two potentially competing species would share the same habitat so intimately, my colleagues and I focused on the role of predation. Stowed away in the recesses of their kopjes, hyraxes are relatively safe—snakes may be the only predators that can make it inside. Out on basking rocks, though, the hyraxes are easy targets. Valerie Gargett, an avid birdwatcher who studied the black eagle in Matobo for more than twenty years, wrote in her 1990 book, *The Black Eagle,* that approximately 98 percent of that raptor's diet consisted of hyraxes, based on skeletal remains of prey at eagle nests.

The data that I collected with my colleagues suggest that half to three-quarters of all young hyraxes are lost to predators in their first year. Many of those deaths are at the talons of the black eagle. Adult hyraxes are also vulnerable, particularly the yellow-spotted hyraxes, whose lighter weight may make them the better choice for a nine-pound eagle. Not by coincidence, black eagles roost on or near the tops of kopjes occupied by hyraxes, and a nesting pair hunts them together. Hyraxes, in turn, spend much of their basking time transfixed—eyes trained on the sky for predators. In fact, hyraxes possess an umbraculum in the eye, a shield that extends from the iris into the pupil. That enables a basking individual to stare into the Sun as it watches for raptors, which often attack from that direction. "Basking," indeed, conveys a false sense of ease: our results show that adults spend about 90 percent of their time on guard.

Because of the need for vigilance against predation, we weren't surprised to find that a hyrax usually basks in the company of at least one other individual, with mixed-species groups averaging about five adults. At no time of the year did we observe more than about a fourth of the adults basking alone. There are several ways in which being part of a larger group could be advantageous for a hyrax. Their sheer numbers could confuse a predator, reducing its success rate. Moreover there is the "many-eyes effect": the more eyes, the more likely a predator will be detected by one individual, whose reaction will warn others nearby. The yellow-spotted hyraxes in par-

ticular act as sentinels for the group, making alarm calls understood by both species. Freed to devote less time and energy to vigilance, individuals can divert more attention to feeding, mating, and caring for young.

We were somewhat surprised to learn how the size and makeup of basking groups changed around birthing season—a time when protecting young is critical. We found that right before the birth season of mid- to late March, the size of single-species groups decreased as that of mixed-species groups increased. And once born, the young were collectively looked after in mixed-species nurseries. Talk about trusting—allowing your young to be with another species! Then, during the weaning season, four to five months after birth, the mixed-species groups began to disband.

Juvenile hyraxes climb on an adult.

There could be several reasons why they go their separate ways—at least to a certain extent—when the young are weaned. We suspect it might be because mating takes place in August, five months after the previous pulse of births, and males of both species become more territorial, aggressive, and vocal as the mating season approaches. The two species would only get in each other's way at that time. A separation period could also be needed because as the dry season progresses, the rock hyrax increasingly competes with the yellow-spotted hyrax in foraging. In any case, even in terms of safety there can be drawbacks to large group size. A large group may be easier for a predator to detect than a solitary individual, and not just visually: hyraxes also betray themselves with smelly communal latrines.

Although we may not be able to state with certainty yet why the two species share their space so intimately, we can discount a couple of explanations. For one, a scarcity of real estate is not the driving consideration. During a drought in the early 1990s, hyrax populations in Matobo sank dramatically to historical lows, and vast areas of kopje were unoccupied. Yet the two species still associated. We can also be reasonably certain that the hyraxes are not gathering for extra warmth, because it is in the coldest months of the year—June and July, several months after the birthing season—that the two species began to associate less.

We fear the political strife and economic collapse in Zimbabwe will have long-term effects on the hyraxes. In a 2007 article in the journal *Ostrich*, Ngoni Chiweshe, now a conservation officer for BirdLife Zimbabwe, discussed poaching for subsistence in and around Matobo and described finding a number of yellow-spotted hyrax carcasses in snares set in trees. He also found hyrax skins for sale at curio shops within the park and in nearby Bulawayo, Zimbabwe's second-largest city. Such exploitation of natural resources may be expected to intensify as economic conditions deteriorate. And, though I am in contact with those inside Zimbabwe who have been involved in the project, data collection has ceased and the current population cannot be reliably monitored.

Yet from video recordings of hyraxes collected in the 1990s, we are hoping to learn more about the species. Perhaps their somewhat different feeding strategies have led to complementary skills in detecting raptors, leopards, baboons, and snakes. If so, one or both species could benefit from an alliance, especially at a time of year when their young are most vulnerable. It may not take a mixed-species village to raise a hyrax, but having a neighborhood watch program may just help.

Mammalogist **Ronald E. Barry** has studied various aspects of the population, community, and behavioral ecology and the functional morphology of small mammals, from mice and voles to rabbits and hyraxes. Among his specific interests are the spatial and temporal associations of syntopic, or coexisting, species in eastern deciduous forests of the United States and the Matobo Hills of southwestern Zimbabwe. Barry is a visiting professor of biology at Bates College in Lewiston, Maine, and a professor emeritus at Frostburg State University in Maryland.

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

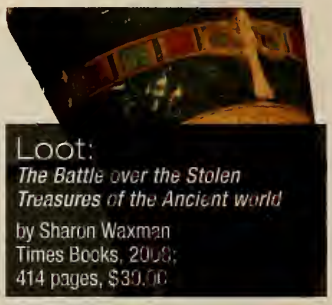
Margaret Mead, who remains America's best-known anthropologist thirty years after her death, belonged to a new breed of public intellectual that blossomed in the twentieth century—the celebrity scientist. Like Carl Sagan and Benjamin Spock, she was as recognizable as this month's Hollywood sensation, an icon whose appeal went far beyond her immediate professional community. Millions listened to her on radio talk shows and watched her TV documentaries; in her regular column in *Redbook* magazine, she voiced opinions on issues ranging from feminism to nuclear energy. The image of Mead, gray-haired, caped, and carrying a forked staff, became an archetype: she was a real-life Yoda, dispensing wisdom with the feisty assurance of a cultural critic whose keen eye and long experience could be counted on.

Nancy C. Lutkehaus, a professor of anthropology at the University of Southern California, worked for several years while in college and graduate school as an assistant to Mead. She's written an illuminating book—more a sociohistorical portrait than a birth-to-death biography—that examines how Margaret Mead became an American icon.

Part of it, of course, was being in the right place at the right time. Born in 1901, Mead came of age in the mid-1920s, the decade when women, newly enfranchised, were celebrating new freedoms. Mead's pioneering study of adolescence in Samoa understandably struck a responsive chord. Even before she had published anything on the subject, newspapers were reporting on the brave and brilliant young woman who was going native on a remote tropical island to find out whether young girls far from "civilization" grew up with the same problems and longings as the flappers of New York and Paris.

Chance, however, was only part of the story. Mead possessed boundless energy, a sharp mind, and a talent for evocative writing. Though she published many solid monographs in professional journals as an academic anthropologist, it was her popular writing, eloquent and accessible, that propelled her to superstardom. Her first book, *Coming of Age in Samoa*, published in 1928, was an immediate best seller. Coming as it did at a time when America's social mores were changing, its account of sexual freedom was received with delight by many who agreed with the notion that societal taboos and habits were conditioned by culture, not dictated by nature. Over the next half century, Mead became a leading voice for progressive cultural reform.

She never shunned controversy, and even after her death, Mead's Samoan study came under question. But by focusing on what made her a celebrity, Lutkehaus shows that Mead's work endures and that she was more than an empty tabloid phenomenon. The Mead of this book—by no means a puff piece—is thoughtful, enormously talented, and accomplished as both a writer and a scientist, if also opinionated, at times overbearing, and like most prodigious achievers, driven. Her genius lay not so much in revolutionizing academic anthropology as in making her science come alive as a transformative power in society. The American Museum of Natural History, where she worked for most of her career, lists Mead among its fifty greatest treasures, and rightly so—she was as remarkable as any mammoth bone, gemstone, or feather cloak the museum has on display.



They call it the British Museum. Why, then, does it count among its treasures a sizable portion of the frieze that adorned the Parthenon in Athens, Greece, for roughly two thousand years? And why does it hold the Rosetta Stone, the code-key of hieroglyphics, unearthed by French soldiers in the Nile Delta in 1799?

According to journalist Sharon Waxman, we should regard all these treasures as plunder. Some were, in fact, the direct spoils of war. Napoleon's armies were accompanied by a corps of savants who collected scientific and cultural artifacts—including the Rosetta Stone—as part of the Little Corporal's imperial vision. The precious Stone passed in turn to the British when they crushed Napoleon's army in 1801, and thus it made its way to London.

Other museum showpieces were spirited from their mother countries in times of civil turmoil. But most of the artifacts, especially small ones like pottery and jewelry, were simply looted by local treasure hunters, usually after a serendipitous discovery, to be sold through private middlemen, including prestigious dealers who were willing to ignore the niceties of provenance. As antiquities trader Robert Olson told a reporter, "If it wasn't for people illegally digging up stuff, there wouldn't be museums."

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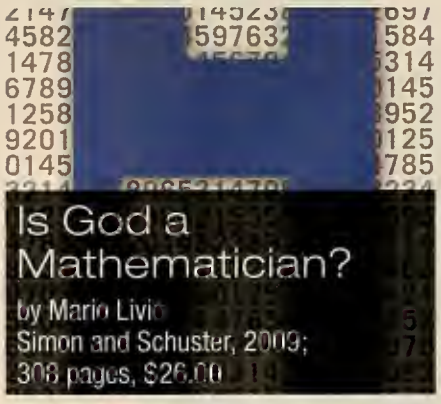
nineteenth century, the distinction between looting and collecting was hardly recognized. Great powers, intent on spreading Western civilization throughout the savage world, saw it as both a right and a duty to collect, salvage, and display the finest art and architecture of the ancients. Clearly the poor Turks and Greeks and Egyptians hadn't done much to preserve it over the ages.

But as former colonies have gained independence and economic power, they have begun to call for the return of what they see as pillaged patrimony. Greece has built a new museum at the foot of the Acropolis, with exhibit space specially built for the return of the Parthenon frieze, and Turkey successfully won the return of a large collection of looted Lydian artifacts in 1993. Yet significant holdings of the world's major museums remain in question, and, though UNESCO adopted a resolution in 1970 banning the illegal transfer of national treasures, there seems no quick practical resolution to the issue of what to do with those already displaced, or to the question of how to regulate future collecting.

Waxman has interviewed the principal figures on both sides of the debate to present a richly textured view of the problems facing the old imperial museums and the aggrieved nations. Waxman avoids the temptation to label bad guys and good guys. Great museums do indeed provide safe haven for artifacts that might otherwise be neglected or destroyed, and they clearly have the wealth, expertise, and location to display precious artifacts to a wide audience. What is needed, Waxman concludes, is a new ethos of forthrightness and collaboration on all sides. Museums must be up-front in acknowledging publicly the sources of their holdings, while countries seeking the restoration of treasures should establish clear procedures by which some artifacts can be offered for sale and loan, while others remain in their rightful homes.



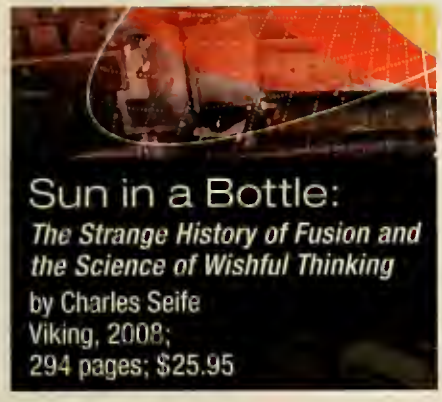
In *The Assayer*, an eloquent discourse on the scientific method published in 1623, Galileo Galilei observed that God's design for the universe "is written in the language of mathematics, and the characters are triangles, circles, and other geometrical figures, without which it is humanly impossible to comprehend a single word of it." Those sentiments may have been controversial in an era when most learned men venerated Aristotle, who had described the world quite cogently using neither formulas nor equations. But from the perspective of the twenty-first century, the unique explanatory power of mathematics seems self-evident. We know that mathematics is essential to the design of every device we use to augment our senses or control our environment, from iPods to self-defrosting refrigerators.

Why should this be? The effectiveness of mathematics in formulating the laws of nature is as puzzling the laws are themselves. If, as Galileo's comments imply, scientific laws exist independent of human consciousness, then scientists are, like explorers skirting the shores of an unknown continent, gradually mapping the preexisting contours of nature through observation, experiment, and reflection. It is a perspective that inspires scientific research to this day: "Our universe is not just described by mathematics," says cosmologist Max Tegmark of MIT, "it *is* mathematics."

There is much to commend this attitude, according to astrophysicist Mario Livio of the Space Telescope Science Institute in Baltimore, Maryland, whose latest book, despite the theological resonance of its title, is actually a well-crafted popular history of mathematical philosophy. Many theories that were originally thought to be pure abstractions, he notes, later turned out to describe aspects of the natural world. For instance, group theory, devised in the 1800s as a description of the relations between various mathematical operations, provided the key to understanding subatomic structure a century later.

Yet there are those who argue that the mathematical structure of the universe is mere appearance, a human invention that results from our brain's natural tendency to impose order on the raw experience of our senses. This point of view gained credence in the 1800s, when Euclid's geometry, long thought to be the only way to describe the world, was found to be only one among many axiomatic systems that did the job. Mathematics, to cognitive scientists George Lakoff and Rafael Nuñez, tells us more about the organizing principles of our minds than the underlying structure of nature.

So which is it? If you are impatient for answers, you might want to skip the various historical discourses on statistics, knot theory, symbolic logic, etc., and head straight for the final chapter, where Livio sets forth his own views on the matter. Avoid such temptation, however: the merit of this book is, as with much of mathematics, not so much with the "Q.E.D." at the bottom line, but with the steps taken to get there.



Sun in a Bottle:

The Strange History of Fusion and the Science of Wishful Thinking

by Charles Seife
Viking, 2008;
294 pages; $25.95

The recipe is enticingly simple. Take four hydrogen nuclei and push them together to form a single helium nucleus. Voilà—energy! We know this takes place in nature—inside the Sun—so why not harness the same reaction to power our furnaces, generators, and automobiles?

Unfortunately, it is nearly impossible to get hydrogen to behave. Bring positively charged hydrogen nuclei close to each other, and their mutual electric repulsion resists compression like a powerful spring, keeping them too far apart to form any helium. Inside the Sun, enormous pressures and high temperatures overcome that difficulty, but reproducing the same conditions in the laboratory has frustrated scientists for the past half century.

Science journalist Charles Seife details these efforts to harness the Sun, from the first donut-shaped magnetic device envisioned by Princeton astrophysicist Lyman Spitzer in the 1950s to the multibillion-dollar ITER (International Thermonuclear Experimental Reactor), a mammoth international collaboration that has been proceeding in fits and starts since the Reagan years. But like the proverbial skeptic who sees the hole, not the donut, Seife relishes writing about the egregious failures of fusion research, not its hard-won successes.

These stories run the gamut of human frailties, from hubris to fraud. In March 1951, Argentina's president Juan Perón announced that his country had solved the energy crisis: a scientist named Ronald Richter had achieved fusion in what amounted to little more than a stone furnace. Experts, however, found a light-show worthy of the Wizard of Oz and Richter was ultimately arrested.

Poor Richter was, as Seife notes, "the first casualty of the quest to put the sun in a bottle," but hardly the last. Hopefully, when the ultimate history of fusion energy is written, Seife's tragicomic tales of folly will appear as mere footnotes, rather than as poignant testimony to the futility of bottling the Sun.

Laurence A. Marschall is W.K.T. Salim Professor of Physics at Gettysburg College in Pennsylvania, and coauthor, with Stephen P. Maran, of Galileo's New Universe: The Revolution in Our Understanding of the Cosmos. *published by BenBella Books.*

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MISCELLANEOUS

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SKYLOG BY JOE RAO

Daylight saving time (DST) returns on the second Sunday of March for most of North America: clocks "spring forward" one hour at 2:00 A.M. local time. Daylight saving time trades a little sunshine in the morning for more in the evening, allowing people to do outdoor activities by natural light after office hours. Based on U.S. Department of Transportation statistics from the mid-1970s, supporters claim DST saves energy that would otherwise go for artificial lighting. Indeed, the number of weeks of DST was increased not long ago, in part based on that reasoning.

But does that argument hold? Not according to recent findings by Matthew J. Kotchen, a professor of economics, and Laura E. Grant, a doctoral student in environmental science and management, at the University of California, Santa Barbara. In a working paper for the National Bureau of Economic Research published this past October, they report data from Indiana, where most counties did not adopt DST until 2006. It turns out household energy consumption increased, probably because of greater demand for heating and air conditioning.

World War I–era poster celebrates the introduction of daylight saving time.

Also notable in March is Venus, which shines as an evening "star" most of the month, but then switches its appearances to the morning. Only once every eight years do viewers in the Northern Hemisphere get a brief window to glimpse Venus at both dawn *and* dusk on the same day. That occurs when two events coincide. Venus must undergo inferior conjunction with the Sun (swing past the near side of the Sun), which is when it shifts from evening to morning stardom. And Venus must be near the point in its orbit that is farthest north of the ecliptic, the plane of Earth's orbit around the Sun. (That provides enough separation between Venus and the Sun so we don't lose sight of the planet in the sunlight.) For several days this month around the 25th, both conditions are met.

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

MARCH NIGHTS OUT

4 The Moon waxes to first quarter at 2:46 A.M. eastern standard time.

8 Daylight saving time returns at 2:00 A.M. local time (see story above).

10 The Moon becomes full at 10:38 P.M. eastern daylight time (EDT).

18 The Moon wanes to last quarter at 1:47 P.M. EDT.

20 Moving north, the Sun appears to cross the celestial equator (Earth's equator projected onto the heavens) at 7:44 A.M. EDT. Spring begins in the Northern Hemisphere and autumn begins in the Southern Hemisphere.

22 An hour or so before sunrise, a thin crescent Moon sits in the southeast, about 5 degrees above and to the right of Jupiter.

23–27 Venus, a hairline crescent, may be spotted in both the morning and evening twilight (see story above). On the 25th it appears 5 degrees above the horizon at sunrise and again at sunset.

24 Mars, lost in the Sun's glare since October, may be visible as an orange-yellow apparition in the east-southeast, thirty to forty minutes before sunrise. Look for it about 3 degrees below and to the right of a very thin crescent Moon.

26 The Moon is new at 12:06 P.M. EDT.

EXPLORER GUIDE

Thinking Inside the Box

If you've ever spent hours reorganizing a sock drawer or searching for the ideal spice rack, you have just a hint of the work afoot on fossil storage floors of the Childs Frick Building at the American Museum of Natural History. There, under a grant from the National Science Foundation, a team of staff and volunteers painstakingly updates the storage of one of the Museum's most prized possessions: the fossil mammal type specimen collection, made up of some 2,000 specimens in all.

This tray containing the type specimen for *Osbornodon fricki*, an extinct dog, displays several safety solutions: cushioning cradles, teeth-up storage, and phalanges tied with tidy cotton bows.

A "type" is the original specimen used to describe a new genus or species, and having such a large collection in one place is a fundamental part of what makes the Museum "a repository of learning," says Ivy Rutzky, a painter and Master of Fine Arts who is the senior scientific assistant coordinating the project. Rutzky and volunteers Judy Kittay and Lori Francz are about halfway through a major project to rehouse the fossils of the mammal type collection.

One would think something that has already survived millions of years would be indestructible, but fossils are often extremely fragile, given their age, degree of mineralization, or general structure. The most common cause of damage to specimens? Humans. Mishandling, absent-minded misplacement, even the way one opens a cabinet or moves a tray can put a fossil at risk.

The Museum's collection—one of the largest of its kind—draws researchers from around the world. And it is those researchers whom Rutzky and her team keep in mind when designing proper storage. Rutzky tests each new housing by acting out the part of a weary researcher, rushing to finish in time to catch a flight and putting specimens willy-nilly into a box. One of the hallmarks of a good design is interchangeability: wherever possible, a fossil housing should accommodate its fossil backwards or forwards. "If you can't design it interchangeably," Rutzky says, "make it obvious which way the specimen must be put back." In other words, proper replacement should be intuitive. Storage solutions must also accommodate an astonishing range of sizes and weights, from huge skulls to the tiniest teeth. Because of space constraints, the team's motto is, "As large as necessary, as small as possible."

While such general principles are applied to all fossils, however, each rehousing is approached as a unique design problem. For example, skulls should always be stowed top side down, teeth up. "Teeth have some of the most diagnostic characteristics in mammals," explains Rutzky. "So if researchers don't have to turn over the skull to see them initially, we eliminate many sorry mishaps. Also, the weight of a skull can break the canines right off."

The materials used to rehouse fossils are of archival quality, from the triangular polyethylene rods cut to create custom bumpers to the fluted polypropylene sheets used for building boxes. Rutzky's team, through the creative process they pride themselves on, found that an ordinary nail file was perfect for sanding smooth the polypropylene's sharp edges. Similarly, soft, cotton library tape was found to be of special value in securing the phalanges of articulated feet, which are left unglued for research purposes.

Once rehoused, lucid labeling of every specimen is crucial. A clear envelope accompanies each specimen, containing every slip of paper ever associated with it, from the latest computer printout to beautifully scrawled notes on yellowed paper. "We need to communicate through the specimens, not each other," Rutzky explains. "And we communicate over time, perhaps 50 to 100 years, with researchers and collections staff in the past and for years to come."

AMNH Senior Scientific Assistant Ivy Rutzky

Milstein Science Series: World Water Day

Water is essential to life as we know it. A seemingly limitless resource, water sustains our bodies and shapes our planet. Yet only a fraction of a percent of the world's supply supports all life on Earth. Though water covers nearly three-quarters of Earth's surface, only 3 percent of Earth's water is fresh—and less than one-third of that is in a form or a place that makes it readily available for human consumption. As the human population continues to grow, we must protect this finite resource. Only careful stewardship—thoughtful, more efficient use of water and protection of its purity—will let us balance competing demands among all species.

On Saturday, March 21, the American Museum of Natural History hosts World Water Day, a fascinating look at all things water. Part of the new Milstein Science Series, the all-day event will feature live animals, interactive displays, and activity stations on conservation, smart consumer choices related to fresh water, and more. Families will delight in a spectacular performance by the Arm-of-the-Sea Puppet Theater in which larger-than-life puppets illuminate the relationship between man and nature. Museum scientists will be on hand to answer questions about their water-related research. Special guests include the NYC Department of Environmental Conservation, Riverkeeper, Scenic Hudson, and others.

World Water Day will be held in the Milstein Hall of Ocean Life from 11 am to 4 pm. Free with Museum admission. Visit amnh.org /worldwaterday for additional information.

Proudly sponsored by the Paul and Irma Milstein family.

Attention Documentary Filmmakers: Mead Festival Seeks Submissions

African thumb-piano players, Laotian bomb technicians, primate scientists in Abkhazia, prostitutes in Phnom Penh, Manhattan pre-schoolers—these are just a few of the unusual subjects explored in the most recent annual Margaret Mead Film & Video Festival at the American Museum of Natural History. Submissions are now open for this year's festival, to be held November 12–15, 2009.

The Mead was begun in 1976 as an exhibition of anthropologists' recordings and has evolved into a world-renowned exploration of the art of documentary, encompassing a broad range of styles: documentary feature films, indigenous community media, animation, and experimental nonfiction. The 2008 festival opened with the New York premiere of the newly restored *In the Land of the Head Hunters*, a silent melodrama produced in 1914 by Edward S. Curtis and accompanied by a live orchestra. Many of the innovative films featured in the Museum's three-day fall festival continue on to venues throughout the United States and abroad as part of the traveling program.

To become a part of this premiere showcase, visit amnh.org/mead to learn more about submitting a film. Information on the annual Festival and its year-round screening series is also available. The early deadline for 2009 submissions is April 13, and the final deadline is May 29.

At the Museum

AMERICAN MUSEUM & NATURAL HISTORY

www.amnh.org

EXHIBITIONS

Climate Change: The Threat to Life and A New Energy Future
Through August 16, 2009
This timely exhibition explores the science, history, and impact of climate change on a global scale, providing a context for today's most urgent headlines. The exhibition lays the groundwork for potential solutions, empowering and inspiring visitors of all ages.

Climate Change is organized by the American Museum of Natural History, New York (www.amnh.org), in collaboration with the Abu Dhabi Authority for Culture & Heritage, United Arab Emirates; The Cleveland Museum of Natural History; The Field Museum, Chicago; Instituto Sangari, São Paulo, Brazil; Junta de Castilla y León, Spain; Korea Green Foundation, Seoul; Natural History Museum of Denmark, Copenhagen; Papalote Museo del Niño, Mexico City, Mexico; and Saint Louis Science Center.

Climate Change is proudly presented by **Bank of America**.

Major support has been provided by **The Rockefeller Foundation**.
Additional support for *Climate Change* and its related educational programming has been provided by Mary and David Solomon, the Betsy and Jesse Fink Foundation, the Linden Trust for Conservation, and the Red Crane Foundation.

The Butterfly Conservatory
Through May 25, 2009
Mingle with up to 500 live, free-flying tropical butterflies in an enclosed habitat that approximates their natural environment.

Saturn: Images from the Cassini-Huygens Mission
Through March 29, 2009
This stunning exhibition reveals details of Saturn's rings, moons, and atmosphere with images sent over half a billion miles by the Cassini spacecraft.

The support of the National Aeronautics and Space Administration is appreciated. Special thanks to the Cassini imaging team, especially those scientists at Cornell University's Department of Astronomy, along with the staff of Cornell University photography. The Eastman Kodak Company of Rochester, New York, printed the images.

On Feathered Wings
Through May 25, 2009
This exhibition brings together the work of renowned wildlife photographers whose artistry showcases the majesty of birds in flight.

The presentation of both *Saturn* and *On Feathered Wings* at the American Museum of Natural History is made possible by the generosity of the Arthur Ross Foundation.

GLOBAL WEEKENDS

Spring Equinox
Sunday, 3/29, 1–5 pm
On tour in the United States for three months in 2009, the KODO drummers from Sado Island, Japan, bring their performance to New York exclusively for the Museum.

MILSTEIN SCIENCE SERIES

World Water Day
Saturday, 3/21, 11 am–4 pm
This family-friendly event includes interactive displays, activities, talks, and a special performance by *Arm-of-the-Sea Puppet Theater*, all to inform visitors about water conservation and smart consumer choices. Participants include the NYC Department of Environmental Conservation, Riverkeeper, Scenic Hudson, and others.

Proudly sponsored by Paul and Irma Milstein.

LECTURES

All in the Bones: A Biography of Benjamin Waterhouse Hawkins
Tuesday, 3/31, 6:30 pm
Robert M. Peck, Senior Fellow, Academy of Natural Sciences, Philadelphia, will discuss the legacy of artist Benjamin Waterhouse Hawkins, famous for his dinosaur reconstructions.


FR. ENERGY

Horse Hollow Wind Farm

SCIENCE & SOCIETY

Our Energy Future
Thursday, 3/12, 6:30 pm
Michael Oppenheimer, Albert G. Milbank Professor of Geosciences and International Affairs, Woodrow Wilson School and the Department of Geosciences, Princeton University, and co-curator of Climate Change, moderates a discussion with Joseph Romm, Senior Fellow, Center for American Progress, and executive director and founder of the Center for Energy and Climate Solutions; Ashok Gupta, Air and Energy Program Director, Natural Resources Defense Council (NRDC); and Rohit Aggarwala, Director, New York City Mayor's Office of Long-Term Planning and Sustainability.

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

FAMILY AND CHILDREN'S PROGRAMS

Dr. Nebula's Super Cold Adventure
Saturday, 3/28, 2–3 pm
Earth may be warming, but the big freeze is happening in Dr. Nebula's Lab! Explore the properties of cold and learn how temperature affects different states of matter.

Robots in Space I (Beginner)
Tuesday–Thursday, 3/24–3/26, 4–5:30 pm
In this class, you will design and build robots using the Lego Mindstorms design system. (Ages 8 – 10)

Climate Change Sundays
11 am–12:30 pm (4th and 5th graders), 1:30–3 pm (6th and 7th graders)

What Is the Difference between Climate and Weather?
Sunday, 3/15

What Is Climate Change?
Sunday, 3/22

What Can We Do about Climate Change?
Sunday, 3/29
In conjunction with the exhibition *Climate Change*, these hands-on workshops introduce young audiences to the science of climate change and potential solutions. Take all three sessions and earn a certificate.

MEMBERS' PROGRAMS

Animal Drawing
Eight Thursdays, 3/5–4/23, 7–9 pm
Learn about the gifted artists of AMNH's world-class dioramas as you sketch subjects in their "natural" environments with Stephen C. Quinn, Department of Exhibition, AMNH.

BEHIND THE SCENES TOURS

Behind the Scenes in the Archaeology Lab
Thursday, 3/12, 6:30 pm, 7 pm, and 7:30 pm
Join Curator David Hurst Thomas and Lab Director Lorann Pendleton for this rare look inside The Nels Nelson Laboratory for North American Archaeology at AMNH.

FIELD TRIPS

A Day with the Wolves
Saturday, 3/14, 9 am–6 pm
Visit the Wolf Conservation Center to meet wild wolves and discover why the preservation of these amazing animals is essential.

WALKING TOURS

The Landscape of Old New Amsterdam
Saturday, 3/28, 10 am–12 pm and 1–3 pm
Join geologist Sid Horenstein for a walk through old New Amsterdam.

HAYDEN PLANETARIUM PROGRAMS

TUESDAYS IN THE DOME

Virtual Universe
Messier Tour
Tuesday, 3/3, 6:30 pm

Celestial Highlights
Planets in Springtime
Tuesday, 3/31, 6:30 pm.

These programs are supported, in part, by Val and Min-Myn Schaffner

ISAAC ASIMOV MEMORIAL DEBATE

From Planets to Plutoids: The New Solar System
Tuesday, 3/10, 7:30 pm
Moderator Neil deGrasse Tyson, Director of the Hayden Planetarium, and an expert panel discuss our understanding of the solar system.

The late Dr. Isaac Asimov, one of the most prolific and influential authors of our time, was a dear friend and supporter of the American Museum of Natural History. In his memory, the Hayden Planetarium is honored to host the annual Isaac Asimov Memorial Debate—generously endowed by relatives, friends, and admirers of Isaac Asimov and his work—bringing the finest minds in the world to the Museum each year to debate pressing questions on the frontier of scientific discovery. Proceeds from ticket sales of the Isaac Asimov Memorial Debates benefit the scientific and educational programs of the Hayden Planetarium

Cosmic Collisions
Journey into space to explore the impacts that formed our universe. Narrated by Robert Redford.

Cosmic Collisions was developed in collaboration with the Denver Museum of Nature & Science; GOTO, Inc., Tokyo, Japan; and the Shanghai Science and Technology Museum.
Made possible through the generous support of CIT.

Cosmic Collisions was created by the American Museum of Natural History with the major support and partnership of the National Aeronautics and Space Administration's Science Mission Directorate, Heliophysics Division.

IMAX MOVIES

Wild Ocean
Experience the massive annual feeding frenzy off South Africa as billions of fish migrate up the KwaZulu-Natal Wild Coast.

Dinosaurs Alive!
Great dinosaur finds by AMNH scientists past and present come to life with archival and contemporary footage and scientifically accurate, computer-generated images.

LATE NIGHT DANCE PARTY

One Step Beyond
Friday, March 13
Visit amnh.org/onestepbeyond for details.

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!

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A Taste of the Wild

Wild nutmeg (left) and a raffia palm fruit (right)

Story and Photographs by Aaron French

While there are tens of thousands of edible plants in the world, people in the United States typically consume fewer than fifty. That held true for me, too, until I moved to the jungles of southern Cameroon for my master's-degree research on how birds, squirrels, and primates help to disperse seeds. My investigation was part of a larger project on rainforest dynamics. For nearly two years I lived in a camp with a number of Baka—"pygmy" hunter-gatherers native to the central African rainforest—whom I relied upon as guides. The camp was a twenty-mile walk into the forest from the nearest village, itself a full day's drive from the capital city of Yaounde. Under the circumstances, my colleagues and I limited our infrequent shopping to staples like rice, pasta, flour, and some canned goods. The surrounding forest compensated with an amazing treasure trove of things to eat.

As I walked our nearly twenty-mile network of forest trails, observing the frugivorous wildlife for my research, my Baka guides would collect wild fruits, harvest wild tubers and roots, search for wild honey in the rainforest canopy, and capture flying termites to roast over the fire. Luckily for me, I had become a professional cook to support myself through my undergraduate education, and I was open to experimentation with new ingredients. For cooking we used a two-burner propane stove and an "outback oven" that could be placed on top of the stove to bake breads and cakes.

Baka man eats a wild mango.

I loved all the exotic fare, but the fruits quickly became my favorites. My research subjects, such as the large hornbills, chimpanzees, and gray-cheeked mangabeys, sought out some of the same bounty. During the two rainy seasons, from March through May and again in August through October, the noise of feeding birds and monkeys echoed for miles around fruiting trees of wild nutmeg—*Staudtia kamerunensis, Pycnanthus angolensis,* and others. The Baka relish the waxy seed covering (called an *aril*) as a flavoring for sauces, and use the pungent oils from the seed itself as a disinfectant and painkiller.

One of the most popular delicacies in the Congo basin is the large green fruit of the moabi tree (*Baillonella toxisperma*). Its pulpy, yellow flesh has a creamy taste. The large, dark nuts inside the fruit can be pressed for high-quality oil. Unfortunately, moabi trees—with their ramrod-straight, towering trunks and dense wood—are a prized source of lumber in African forests. Even immature ones get cut down, a particular problem because a moabi tree doesn't begin to reproduce until it is almost a century old.

When I first started eating the wild forest fruits, I was amazed at how deeply they tasted. A small tree the Baka call *ngoyo* (*Trichoscypha acuminata*) produces golf-ball-size red fruits that grow directly off the trunk in what are known as cauliflorous bunches. Those juicy fruits seem like a vitamin-C bomb in the mouth, and their flavor lasts longer than anything promised in a gum commercial. The fruit and nuts of the wild mango (*Irvingia gabonensis*) have a complexity of flavor that leaves true mangoes (*Mangifera* sp.) flat by comparison. Wild mango is less sweet and more nutty; the flesh is eaten raw, while the seeds are hulled, cooked, and used for a rich, creamy sauce.

Living with the Baka and learning to appreciate their foods forever changed my perception of how to eat. As one of the last surviving hunter-gatherer groups in the world, they are true seasonal eaters. They enjoy every bite, not knowing what might be gathered tomorrow.

In addition, I saw how quickly indigenous knowledge could be lost. With the influx of cash from logging and bushmeat sales, the Baka were obtaining foreign goods—packaged candy, sodas, and other processed foods. Those quickly became the sweets of choice among the younger Baka, as they spent less time in the forest. I fear that in another generation much of what I was taught will become as scarce as the majestic moabi.

Aaron French, who has a master's in ecology, is the chef at The Sunny Side Café in Albany, California, and is the EcoChef columnist for ten Bay Area newspapers. See www.eco-chef.com *for more information.*

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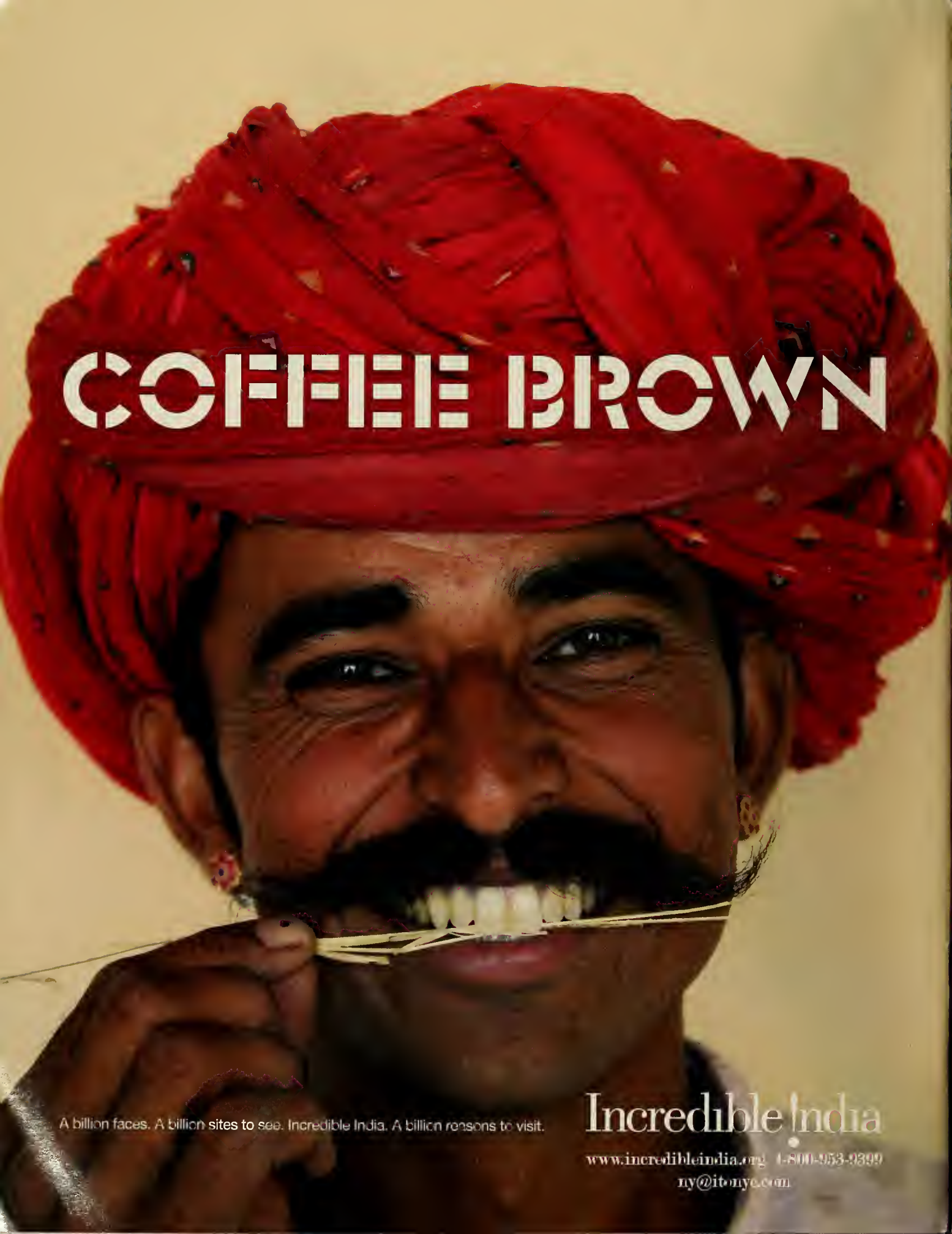
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