NATIONALGEOGRAPHIC.COM/MAGAZINE | MARCH 2010

NATIONAL GEOGRAPHIC

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UPHEAVAL IN THE OMO 96

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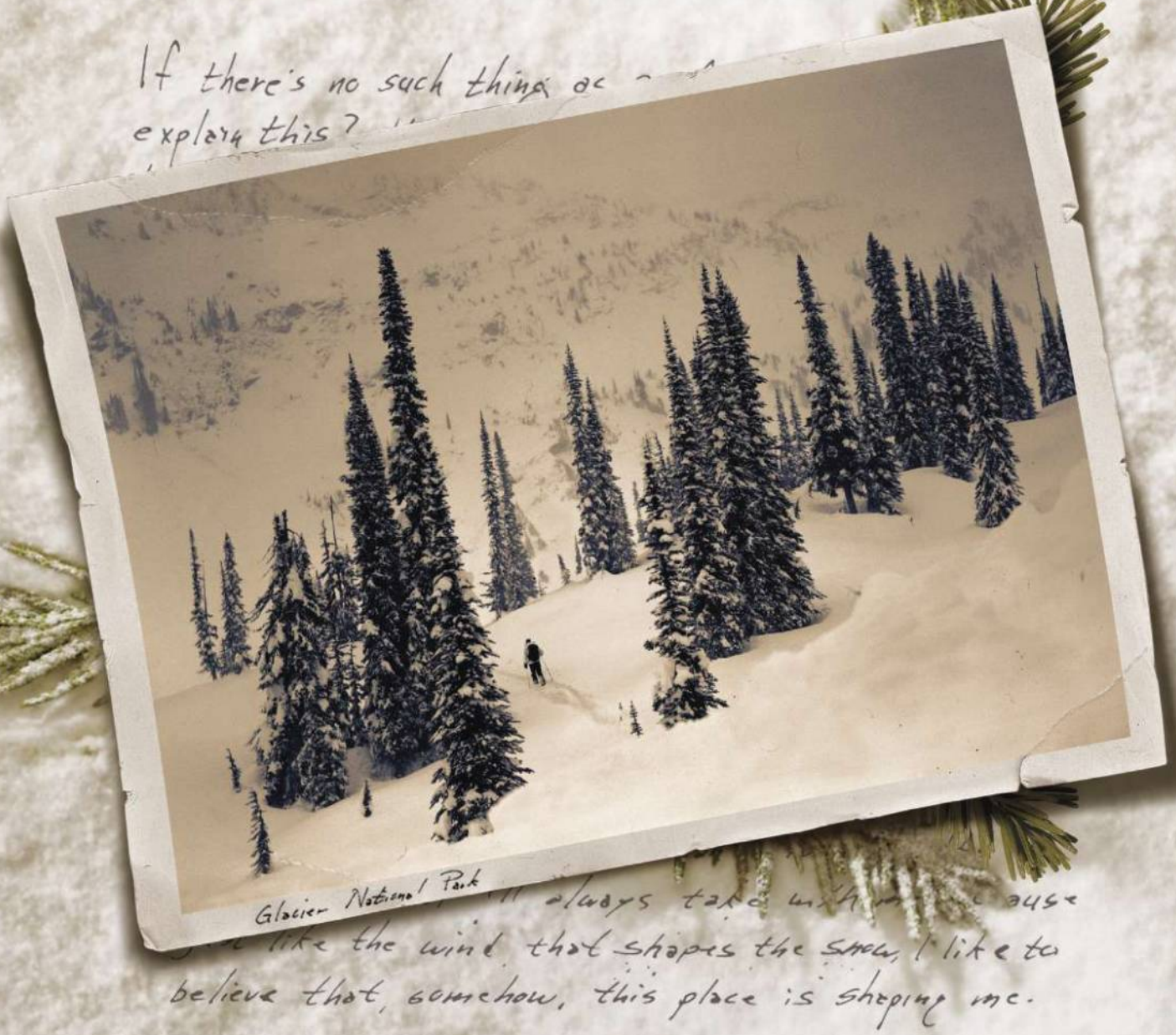
Wolf Wars

ONCE PROTECTED, NOW HUNTED

IT'S ONLY A TWO-DAY HIKE. BUT IT LASTS A LIFETIME.



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NATIONAL GEOGRAPHIC

MARCH 2010 • VOL. 217 • NO. 3

RANDY OLSON

Women from Ethiopia's Nyangatom tribe painted themselves with clay—no mirrors needed—then danced to mark a treaty with rivals. Story on page 96.

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY

NATIONAL GEOGRAPHIC

DEPARTMENTS

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When Wolves Fly
An airlift brought the animals back to their onetime hunting grounds in Idaho and Yellowstone National Park. Our interactive map traces their journey.

On the Cover
When a filmmaker and photographer arrived, this Wyoming male began to howl—calling his pups to come home.
Photo by Jess Lee

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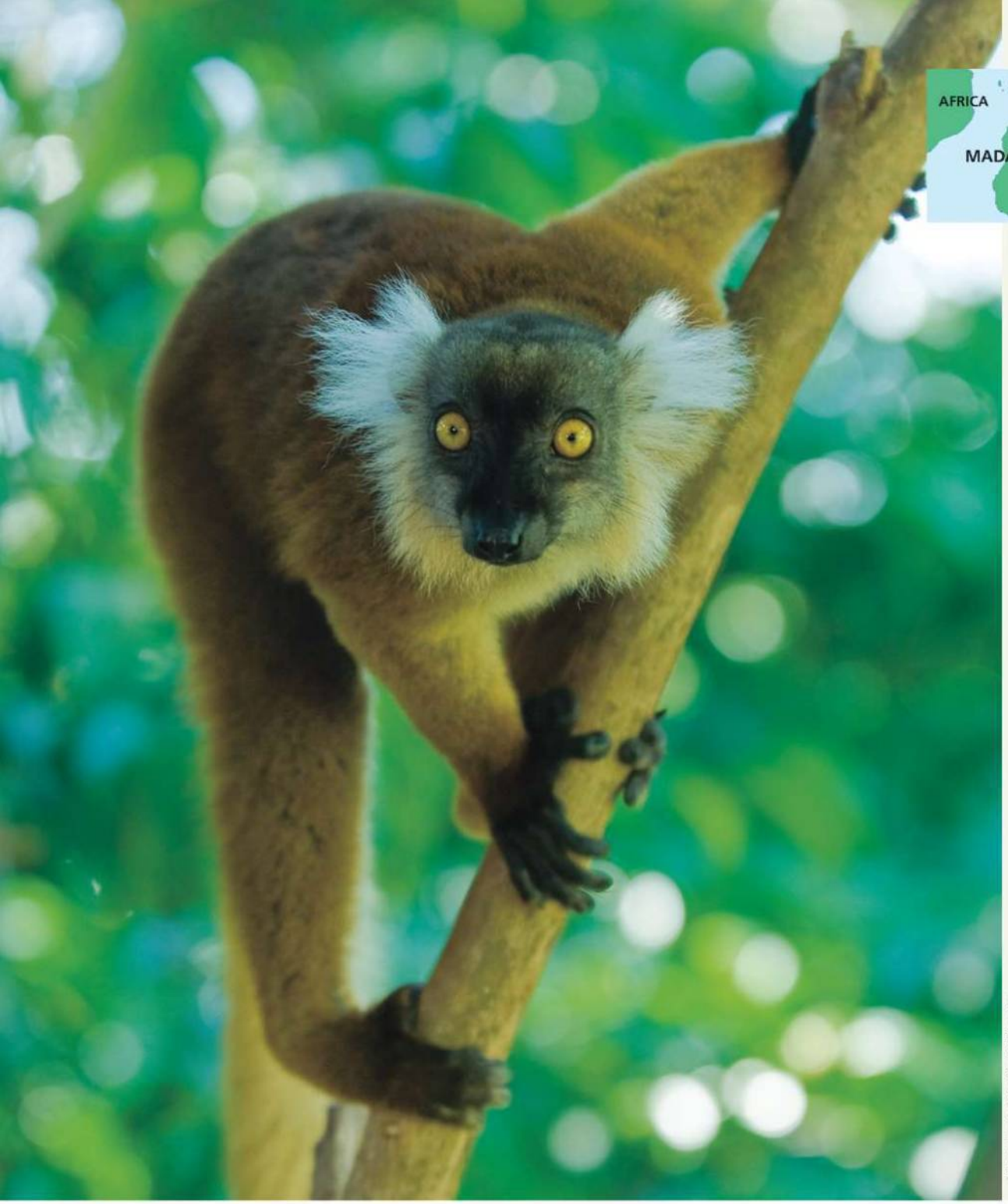

Black Lemur
(Eulemur macaco)
Size: Head and body length, 39 - 45 cm (15.4 - 17.7 inches); tail, 51-65 cm (20 - 26 inches) **Weight:** 2 - 2.9 kg (4.4 - 6.4 lbs) **Habitat:** Tropical moist lowland and montane forests **Surviving number:** Estimated at 10,000 - 15,000

Photographed by Iñaki Relanzón

WILDLIFE AS CANON SEES IT

Fantastically fruitful. The black lemur's fruit-centric diet is hugely beneficial to the growth and health of its forest home. One of the most frugivorous primates in the world, the lemur spreads the seeds of 38 species of trees, and acts as the sole seed disperser for all but four of them. It is also an important pollinating agent for certain trees. Small groups, generally led by dominant females, forage in the middle and upper canopy, constantly uttering guttural grunts to keep in contact with one another as they move through the trees. But both the lemur and the forest it nurtures are in danger as habitat loss and hunting threaten to upset their fruitful balance.

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

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EDITOR'S NOTE

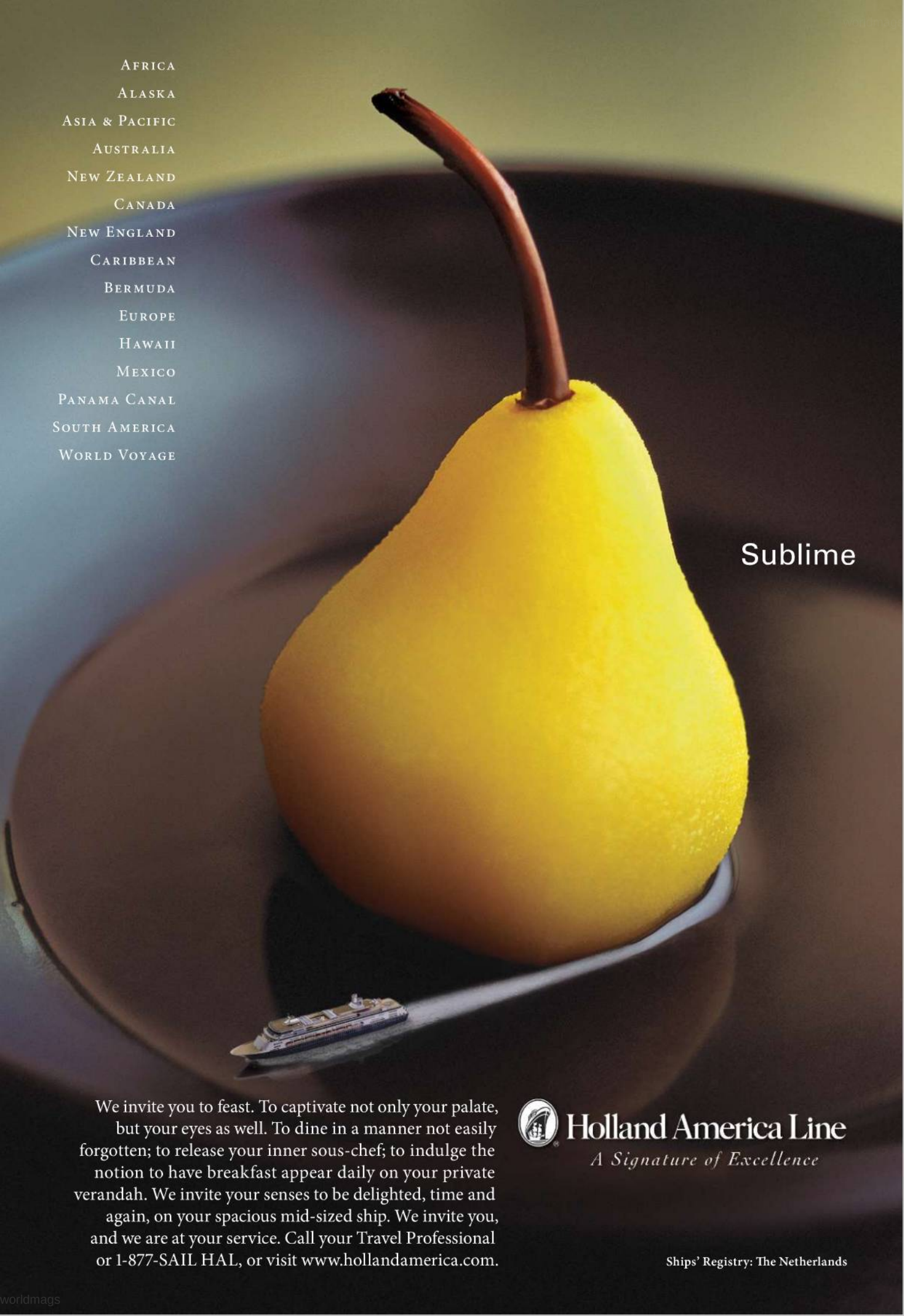
A lone male gray wolf patrols Wyoming's Blacktail Pond area of Yellowstone National Park.

I saw the damage on a crisp autumn morning when I checked the pasture where I was raising a dozen ewes for my Future Farmers of America project. Several lambs were down. Six were dazed and wounded, their faces chewed. I tried to save them, but two died in my arms. The others died the next day. I was sad, angry, and wanted answers. An animal control officer investigated and concluded that they had been attacked by dogs. I received compensation, but to a 16-year-old, it seemed woefully inadequate.

We have a complex relationship with canines. At worst it seems like an ugly divorce from an ancient, once fruitful relationship. All my life I've lived with dogs and loved them, but I guarantee that if I'd had the chance to shoot the dog that killed my sheep, I would have pulled the trigger without hesitation. I know the same is true for a shepherd who sees a wolf tear into his flock. How else to explain the extermination of wolves from the Rocky Mountains in the early 1900s? Now they've returned and reestablished themselves in our lives.

The debate over the return of wolves is emotional. There is confusion, anger, and misinformation, making it even more important to examine facts and listen carefully to those involved. To my mind, no one does this better than Doug Chadwick. He lives in Montana wolf country. In fact, a radio-collared wolf often visits his front yard. In our cover story, Doug examines the impact wolves are having on the West—with respect for the wolves and for their human neighbors.

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

John-Joseph van Haelewyn

John and Shirley Spinelli included National Geographic in their estate plans.

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"We believe in the work of National Geographic and wanted to be involved," says John Spinelli. He and his wife Shirley grew up reading *National Geographic* magazine and passed that love on to their children and grandchildren. Now retired, they enjoy in-line skating, tennis and bird watching.

The Spinellis set up a charitable gift annuity which provides them with steady income and tax savings while supporting the Society's efforts worldwide. "National Geographic is an important source for solutions to the challenges facing our planet," says John. "We want the world to be in good shape for our grandchildren."

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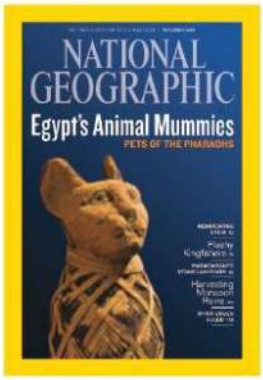

November 2009

Animal Mummies

As a quilter I was delighted and amazed to see the traditional "log cabin" pattern so exquisitely laid out on the cat mummy gracing the cover. The log cabin is a familiar quilt block here in America, and I felt an instant connection with those long-ago artisans who obviously found the same beauty in its textures and design.

JENNIFER KLEINE
Nashville, Tennessee

Reinventing Syria

Your article draws an unfairly bleak and inaccurate picture in stark contradiction to current objective reporting covering Syria. It is skewed to highlight solely negative aspects of an otherwise vibrant country undergoing tremendous transformations on the social, cultural, economic, and political levels. Syria is admittedly far from a perfect place. Although author Don Belt unfairly focuses on the *mukhabarat* [intelligence agency] legacy of Hafez Assad, he makes a point in depicting that President Bashar Assad had much reform to undertake. However, to show that Syria is still a tenebrous place—where people live in fear, where education is lagging and progress is stagnant, where everything is run by "Beverly Hillbillies" and mobsters—is an egregious fallacy.

IMAD MOUSTAPHA
Ambassador of Syria to the United States of America, Washington, D.C.

Congratulations to Don Belt for his excellent story about Syria. I knew little about this country's recent history, and he has brought it to life for me. I have a friend from Syria to whom I read this story, and he testifies to its accuracy, particularly since his own uncle served 25 years in prison on suspicion (never proved) of belonging to the Muslim Brotherhood.

SALLY WILTON
Bournemouth, England

When Crocs Ruled

I enjoyed your artist's beautiful impression of a crocodile ancestor battling a dinosaur 80 million years ago. However, in the picture I could not locate the wormhole that allowed seagulls to time travel to witness the scene, about 50 million years before they are known in the fossil record.

NICO VAN BELZEN
Steenbergen, Netherlands

The bird shown in the artwork is not a seagull. It's a ternlike bird of the genus Ichthyornis, *fossils of which have been reported at sites all over North America, in the Old World, and Antarctica.* Ichthyornis *was not quite like modern birds: Within its long beak lurked a row of sharp, rear-facing teeth.*

Kingfishers: Blaze of Blue

My wife grabbed the latest issue of *National Geographic* and, seeing the pictures of kingfishers, asked me if I had ever seen one. I replied, "I'll never forget where I saw the only one I have ever seen." It was midsummer, and I was fishing in a little stream next to the railway line between Fleet and Winchfield in Hampshire, England, when this wonderful blue-and-orange bird darted along the stretch where I was fishing. I was in awe. I couldn't believe my eyes when I read photographer Charlie Hamilton James's quote: "Everyone in England who has ever seen one will remember where they saw it." It was almost verbatim what I had said to my wife. I should add that my sighting occurred some 45 years ago.

JON FARADAY
Bogis-Bossey, Switzerland

Visions of Earth

I was so touched by the photograph of chimpanzees grieving over the passing of one of their own. I come from the central African region where that shot was taken and where chimpanzee meat is a delicacy for quite a few people. I hope that this photograph will move those chimpanzee eaters to feel compassion and greater respect for these closest relatives of humans. This advocacy also needs to be extended to other apes and monkeys.

BONGLACK NYANGANJI
Brooklyn Park, Minnesota

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Perfect imperfection, the natural raw 2 carat diamond

Ready for some rough stuff? We recently found a rare cache of extremely large uncut diamonds at an extraordinary price.

Sometimes it's impossible to improve on perfection. When the world's most desired stone is pulled from the ground, why not just brush off the earth and leave it alone? White cut diamonds may be nice for a polite kiss on the cheek, but extra large uncut diamonds can really ignite some raw passion. And isn't that what a great piece of jewelry is all about? These few rare 2 carat plus natural stones will certainly turn up your thermostat.

A real diamond in the rough

For centuries, large raw diamonds were treasured without a hint of facet or polish. We believe the early artisans were on to something. After a search through countries on four continents, we have found a cache of rare, very large, 2 carat plus uncut diamonds at a spectacular price from our Belgium dealer. Major gemstone experts across the globe have commented that rough diamonds will be the fastest growing trend on "the red carpet" this year and our long love affair with flawless cut white gemstones may have some competition. All one has to do is flip through the world's most exclusive catalog to find that "rough is all the rage." Our luxury retail friends in Texas recently featured a raw solitaire for $6,000, but they buy in such small quantities that they cannot compete with us on price. You see, Stauer is one of the largest gemstone buyers in the world and last year bought over 3 million carats of emeralds. No regular jewelry store can come anywhere close to that volume.

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LETTERS

Photo Journal

Regarding the bullfighting pictures from Portugal, does respect of another's culture include not speaking out against the barbarism that is part of that culture? It was especially heart wrenching to see the picture of the young children staring down a future foe. This teaches young people that it's appropriate to abuse an animal. How sad that these men are viewed as macho and even as heroes. Bullfighting is nothing more than animal abuse that some call sport.

CAROLE RITENOUR
Holland, Michigan

Your Shot

When I was a boy growing up in southern Arizona, family members often told me the story of the *campamocha* (Spanish for "praying mantis") that ate a hummingbird in my mother's zinnia patch. Someone from the biology department at Eastern Arizona College actually came over and photographed the event. Being too young to remember it, I went on faith and told the story through the years to many skeptical audiences. Finally, after 50 years, I have photographic vindication of my implausible claim. Thank you!

FRED C. ROWLEY
Cedar City, Utah

I saw the chilling picture of a mantis on the hummingbird feeder. We have never had an accident near our feeders, but we have had to guard them constantly against mantises. This past summer we planted several basil plants near the feeders and, surprisingly, we didn't see a single mantis. I am almost certain that this was not a coincidence. As an additional benefit, the hummingbirds like the nectar of the basil flowers.

DENKA KUTZAROVA-FORD
Urbana, Illinois

Culture: Qat Goes Global

This brought memories of the years I spent on the staff of Amoud Teacher Training Center in northern Somalia from 1962 to 1964. The young men there received a monthly stipend. Many of them spent it immediately on qat. Fortunately, the price was too great for it to be of much influence. The expert quoted in your article left out one of the effects: constipation.

In those times much qat was smuggled in from Ethiopia. The areas from where it was smuggled are actually populated mostly by Somalis. Qat is forbidden to Muslims. The devout do not partake.

R. G. BLAIR
Paso Robles, California

"Soon you'll feel less hungry, more alert, a little euphoric." In light of skyrocketing levels of obesity, sleep deprivation, and depression, it seems that a little qat might do America some good.

NEL DE JONG
Durham, North Carolina

The Big Idea: Electric Cars

This article made interesting reading from a European perspective. In 43 years of driving, I've never owned a car that did less than an average of 30 mpg. My current diesel car does on average 45 mpg, but a gallon of fuel costs me £4.95 [$8.31], which equates to £0.11 [18 cents] a mile. The average American car, according to your figures, does 21 mpg at a cost of about £.07 [12 cents] a mile. If the American market were faced with European fuel costs, perhaps there'd be some incentive for manufacturers to develop a new generation of less polluting vehicles. I am not holding my breath.

BOB ENNION
Shropshire, England

Like many articles that deal with charging electric vehicles, "The Future of Filling Up" overlooks the American talent for promotion. If McDonald's offers free (or discounted) battery charging while you eat and Burger King doesn't, where do you think people will eat? If one shopping mall offers it and others do not, where do you think people will shop? If one motel chain lets you charge for free or cheaply overnight, where will people stay? If one cinema provides at their snack bar coupons for charging and its competitors don't…well, you get the idea. Not to mention all the other businesses looking for a way to keep one jump (pun intended) ahead of their competitors. I foresee not a dearth of places to charge one's car, but a glut. Say watt?

ALAN DEAN FOSTER
Prescott, Arizona

Up and Down Are your eyes drawn to the celestial or the terrestrial? There's plenty of beauty in both. Just find a sight you haven't seen before and capture it with your camera. Then send it to us; we might publish the result in *National Geographic*. Every month this page features two photographs: one chosen by our editors, one chosen by our readers via online voting. For more information, go to *ngm.com/yourshot*.

EDITORS' CHOICE

Amir Hossein Abolfath Tehran, Iran

An astrophotography teacher, Abolfath, 28, joined 200 other stargazers in April 2008 at Bahram Palace, an ancient site in Iran's Kavir National Park. His 6.5-hour exposure yielded this heavenly shot of stars moving across the night sky.

Christian Meyn Penedo, Brazil

"This is one of the most beautiful butterflies I've ever seen," says Meyn, 40, a software developer who noticed "perfect mimicry" in his parents' yard. "The textures and shades of its wings are amazingly similar to the leaf."

READERS' CHOICE

EARTHGRAINS® BREAD NOW HAS ECO-GRAIN™ WHEAT.

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There's a lot of "eco" this and "eco" that these days. "Save Energy," "Buy Green," "Drive Less," "Hug a Tree." Some of it is hard to do, but some of it is surprisingly easy. That's why we want to tell you about Eco-Grain™ wheat.

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Can your turkey sandwich help save the Earth?

Now, you're probably going to the store anyway, so why not do a good deed while you're at it? By simply buying our tasty and wholesome EarthGrains® bread, you're supporting a way of farming that needs all the support it can get. And you could do it the next time you run out to buy milk, trash bags or hummus.

WHERE CAN YOU GET SOME OF THIS ECO-GRAIN™ WHEAT? YOU ASK.

Idaho, an odd place for a revolution.

Today, there are just a handful of family farms in Idaho that grow Eco-Grain™ wheat. And there's just one bread company baking with Eco-Grain™ wheat – EarthGrains Baking Companies.

Eco-Grain™ wheat currently accounts for 20% of the flour in our line of 100% Natural 24 oz. whole-grain breads, but as our sales grow, so will this percentage.

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At EarthGrains Baking Companies, we're committed to making a real difference — one wheat field at a time. You can help, too — one sandwich at a time. The impact on the environment from Eco-Grain™ wheat so far has been small, but with lots of farmers growing it, the impact could be very big.

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VISIONS OF EARTH

Peru Forty miles southeast of Lima, against a winter tableau of wave, rock, and sky, four bottlenose dolphins vault in sync through the shallows. Fed by the nutrient-rich Peru Current, these coastal waters teem with marine life.

PHOTO: STEFAN AUSTERMÜHLE

Germany Upside-down thrill seekers ride the Top Spin at Munich's 176th Oktoberfest. Despite terrorist threats, the 16-day beer festival—the largest fair in the world—drew 5.7 million people last year.

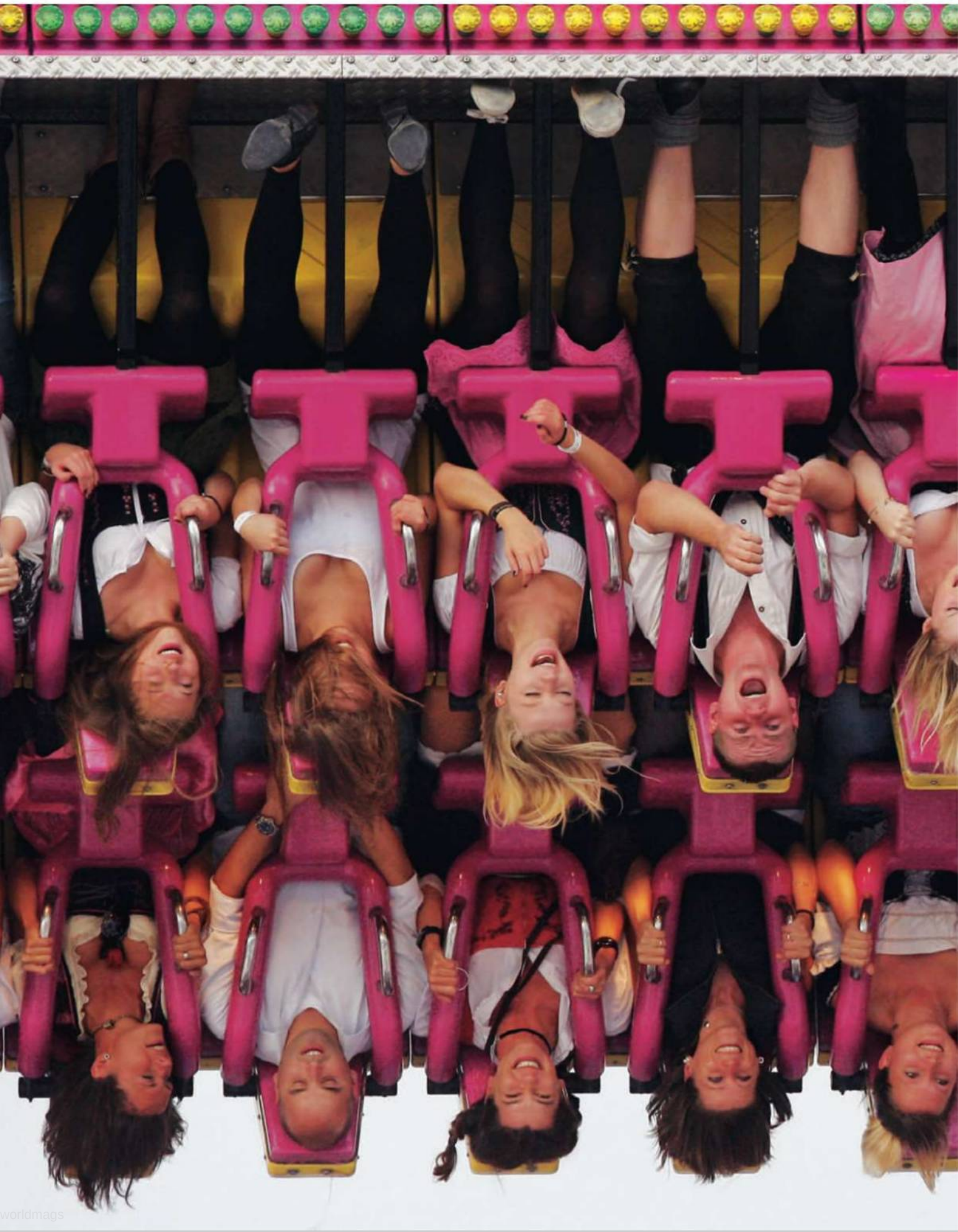


PHOTO: MIGUEL VILLAGRAN, GETTY IMAGES

China Like a gleaming egg adrift in ink, Beijing's glass-and-titanium National Center for the Performing Arts is reflected in the pool that surrounds it. The two-year-old, $336-million dome seats 5,452 people in three halls.

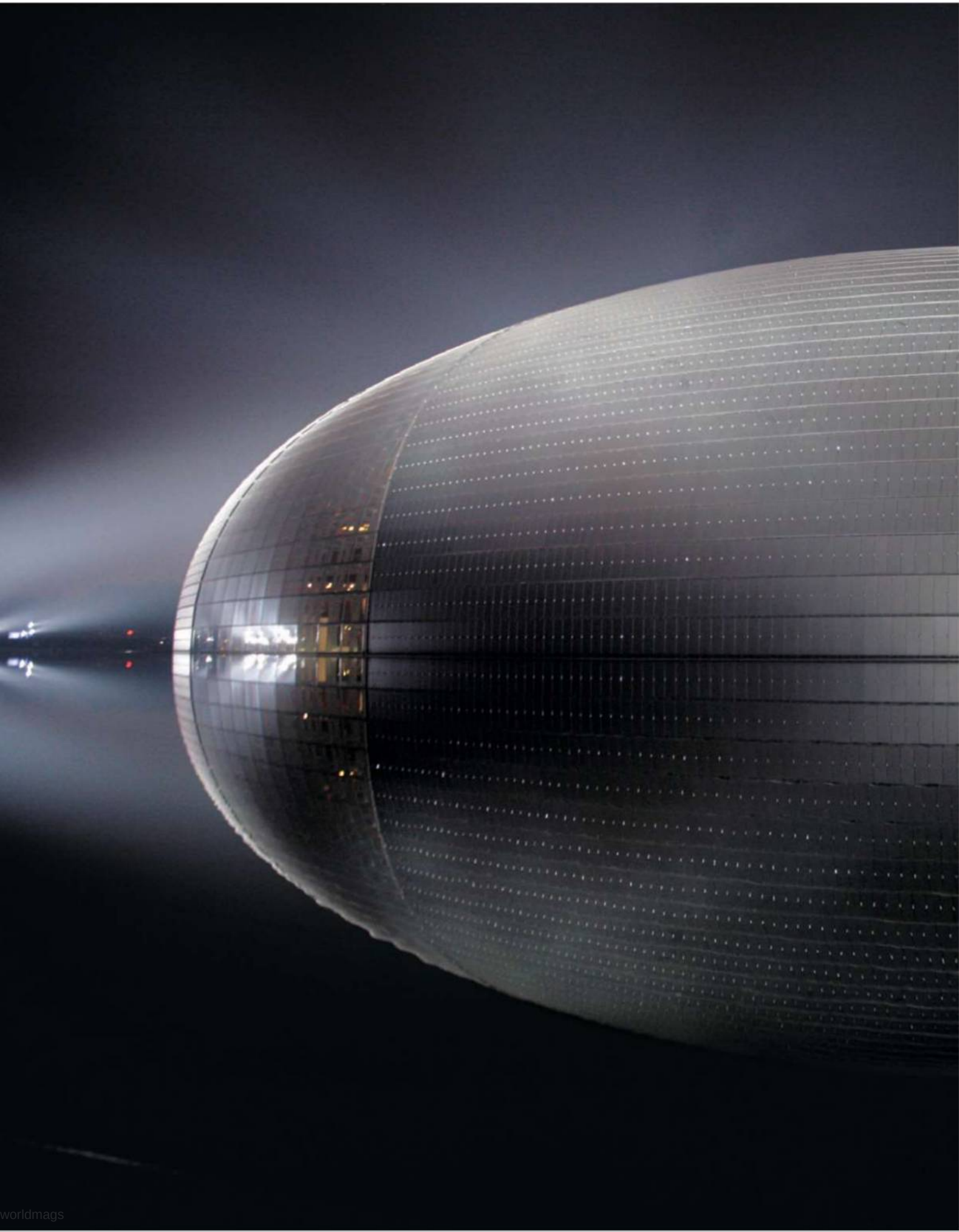
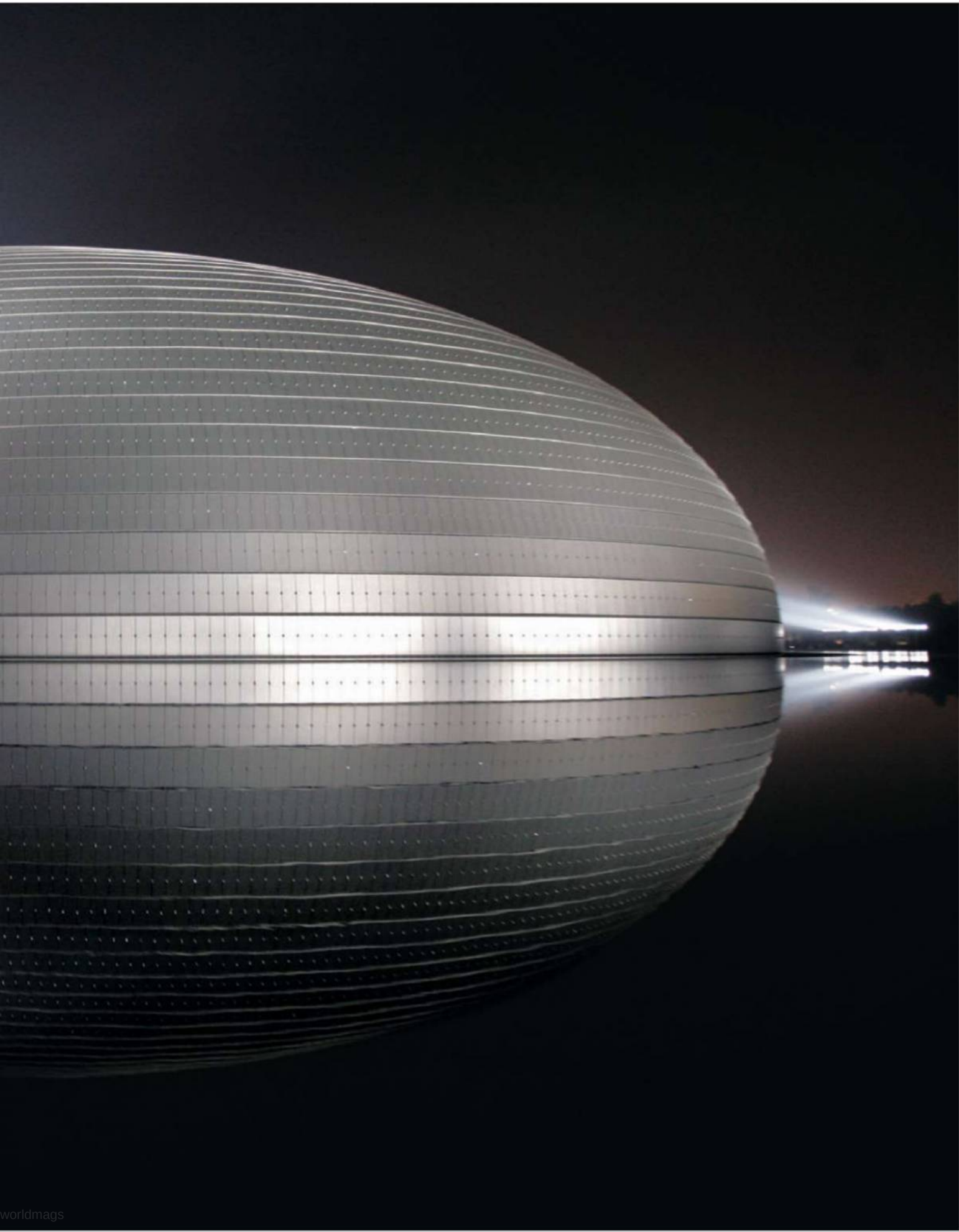
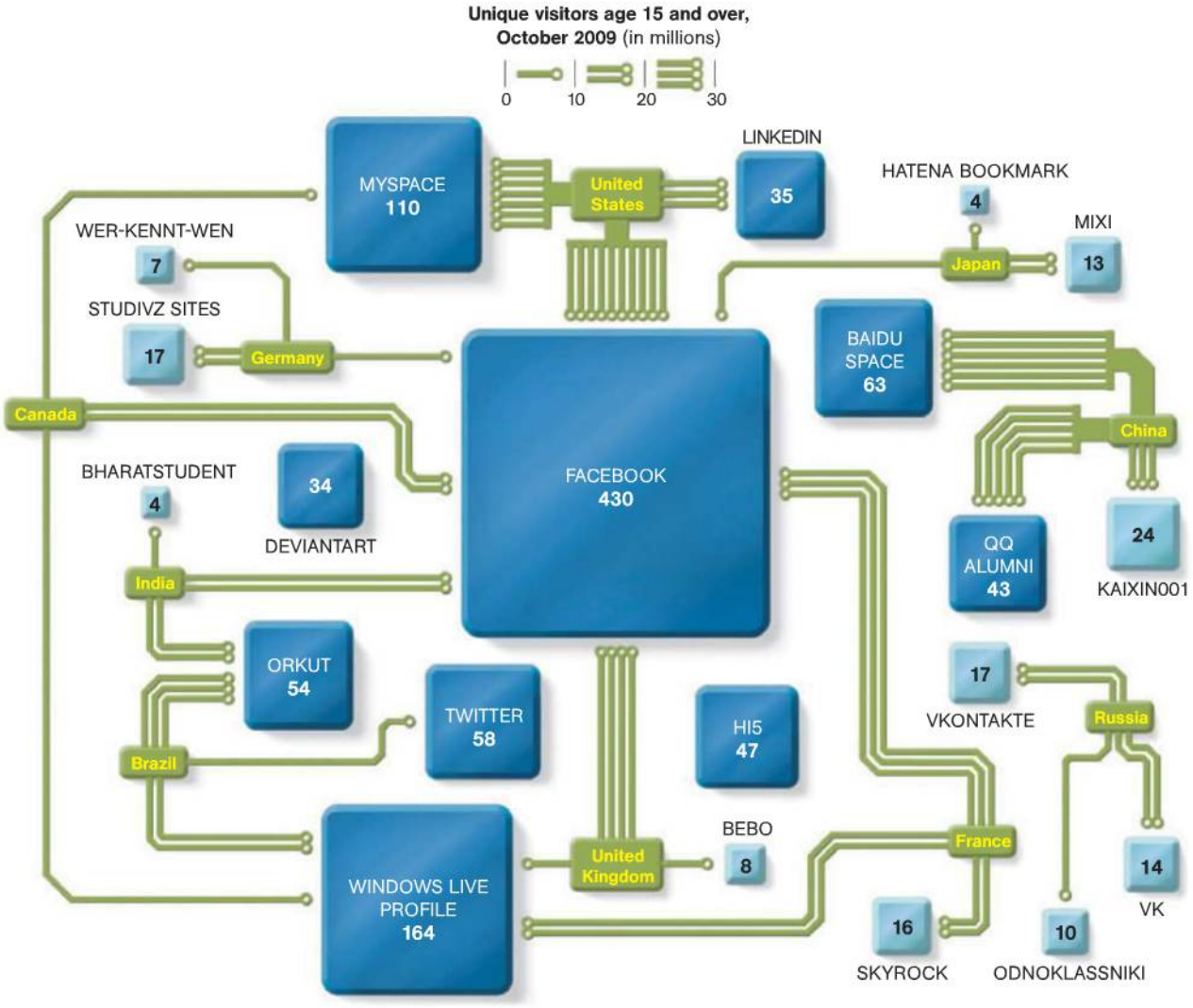


PHOTO: JASON LEE, REUTERS



World Wide Friends

In October 2009 more than 830 million users visited social networks via home and office computers. Ten sites (below in dark blue) had the most visitors. Green lines connect countries where networks are most popular to their three favorite sites.



The first social-network website, known as SixDegrees, launched 13 years ago. Its members could find and send messages to pals—and then communicate with each other's friends and family—online. The site went off-line in 2000, but the trend of social networking has surged. More and more people are joining sites that let them set up profiles and share photos and updates about anything from their lunch to their daydreams.

U.S.-based giants Facebook and Windows Live are popular just about everywhere. But why is Google's Orkut site number one in both Brazil and India, countries miles apart literally and culturally? Researcher Michael Thelwall credits that site's simplicity, which gives it an advantage in places with slow Internet access.

In many countries nuances of language and culture make homegrown networks such as China's Baidu Space and Russia's VKontakte stronger than imports. Japan's top site, Mixi, lists blood types as part of its member profiles, catering to the local belief that knowing that tidbit can predict compatibility. And in South Korea, Cyworld users create avatars, or alter egos, that express emotions and repair friendships on behalf of their real-life counterparts. *—Shelley Sperry*

GRAPHIC: OLIVER UBERTI, NG STAFF; HIRAM HENRIQUEZ. SOURCE: COMSCORE, INC.

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Not Beyond Compare

"That's like apples and oranges." The classic phrase sums up the impossibility of comparing dissimilar objects or ideas. But are the two foods that different? Each is a seeded fruit "you want to pick up and bite," notes Cornell University horticulturist Ian Merwin. Yet each grows in "profoundly different ways." That doesn't mean you can't compare them (below). But Merwin sees subtlety in the cliché: "Apples and oranges may seem the same, but they're not." To cite utterly unlike items, try Serbia's odd pair: "old ladies and frogs." *—Marc Silver*

57	Calories, raw fruit*	85
2.6 grams	Fiber*	4.3 grams
5 milligrams	Vitamin C*	96 milligrams
11.3 grams	Total sugars*	16.8 grams
Thin, with natural wax layer	Skin	Thick, with oil glands
Embedded in the core	Seed location	In the edible sections
Warm summer, cold winter	Prime growing conditions	Subtropical
Deciduous	Tree type	Evergreen

*PER CUP

PHOTOS: MARK THIESSEN, NG STAFF
SOURCES: USDA; IAN MERWIN AND CHRISTINA MAY STARK, CORNELL UNIVERSITY

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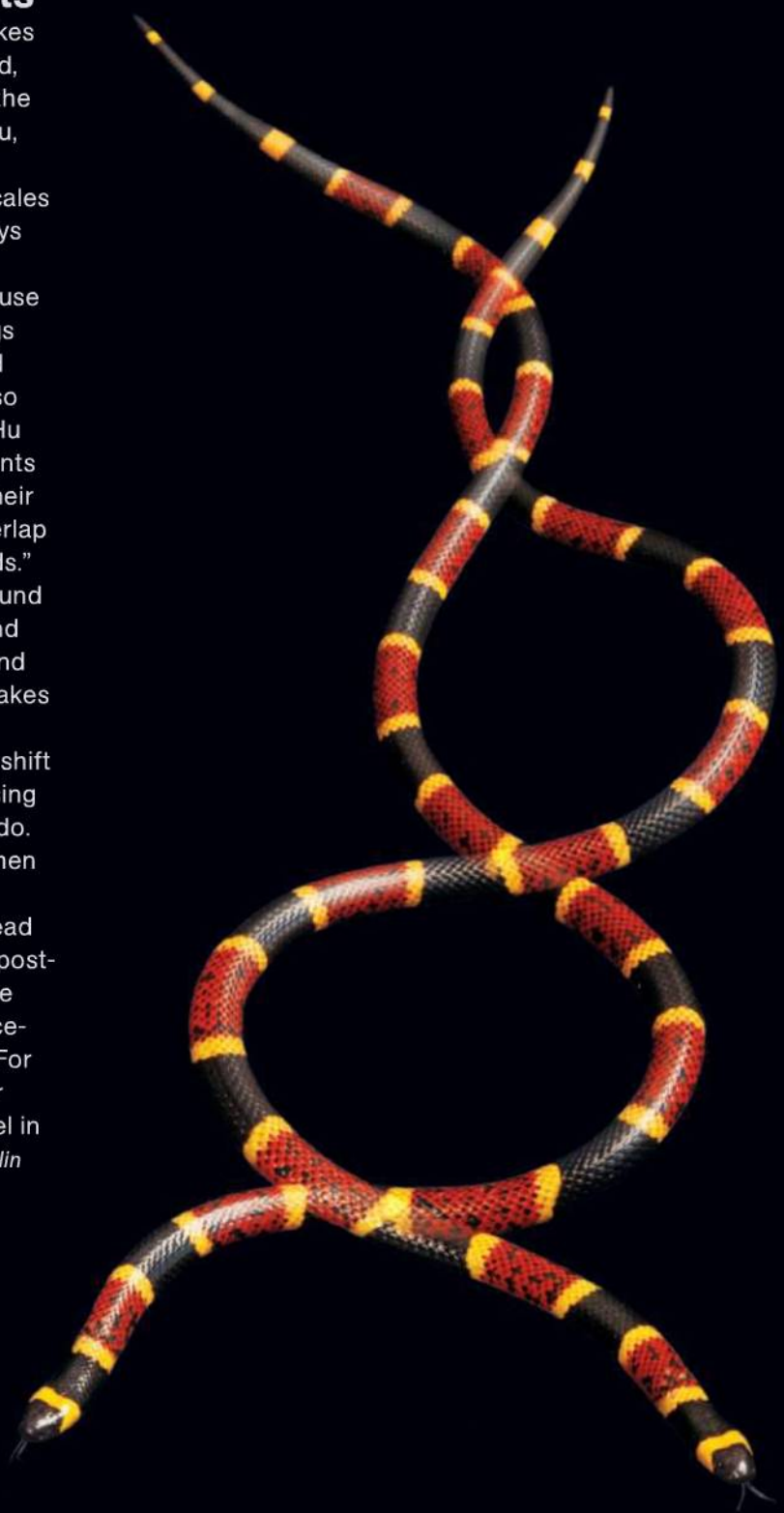
Slithering Secrets

No legs? No problem. Snakes get around just fine on land, thank you—only not quite the way we'd thought. David Hu, a mechanical engineer at Georgia Tech, says belly scales and body lifting are the keys to serpent locomotion.

Scientists knew snakes use their sides to push off twigs and rocks but were baffled by how they could slither so well on smooth surfaces. Hu investigated their movements and found the answer in their stomach scales, which overlap like "a spread deck of cards." These scales catch on ground features such as cracks and crevices, even tiny ones, and increase friction, which snakes use to propel themselves forward. To go faster, they shift their weight by slightly raising parts of their body, as we do. "We don't drag our legs when we run or walk," says Hu.

His findings may soon lead to better "snake-bots" for post-disaster search-and-rescue missions and medical procedures like colonoscopies. For now, they're simply further proof that snakes can travel in efficient style. *—Jeremy Berlin*

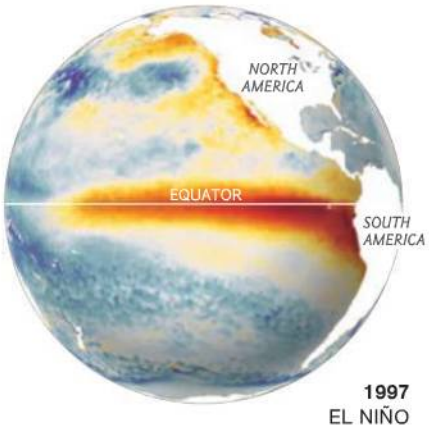


In this double exposure, a Texas coral snake struggles to move on featureless black velvet, where belly scales can't act as "friction hooks."

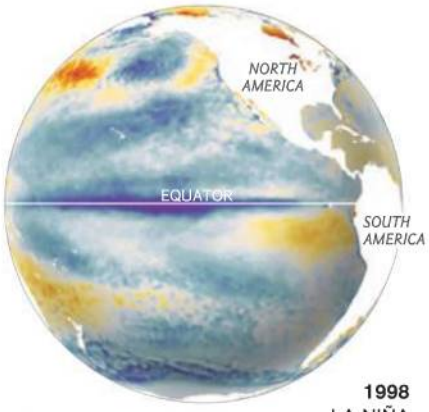
PHOTO: JOEL SARTORE WITH CHARLES RASH

A New El Niño It used to be simpler. Whenever the surface waters of the equatorial Pacific turned warmer than normal in summer, climatologists would expect an El Niño year, then forecast when and where droughts, floods, and hurricanes might occur. But that was before a study by Georgia Tech scientists, led by Hye-Mi Kim, deciphered the effects of another pattern in which high temperatures are confined to the central Pacific (below). Now the already difficult field of atmospheric forecasting has become even trickier.

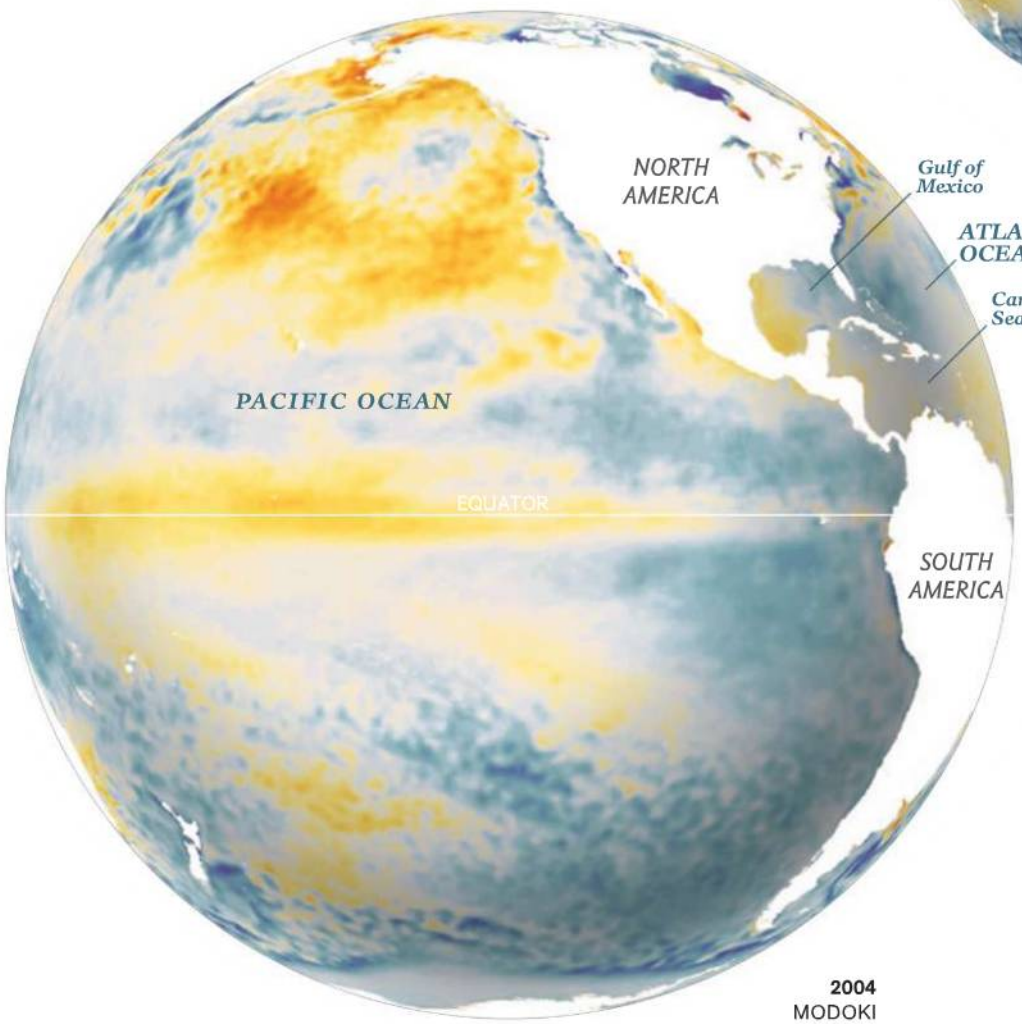
Called El Niño Modoki (Japanese for "similar but different"), it joins El Niño and La Niña, a cold-water phenomenon, as major climate swings that emerge every few years. A Modoki cycle triggers more landfalling storms in the Gulf of Mexico and the western Caribbean than normal, and more tropical storms and hurricanes in the Atlantic than El Niño does. Another difference: Modoki's precipitation patterns are the reverse of El Niño's—making the American West, for instance, drier rather than wetter. In 2009, despite early signs of a Modoki year, El Niño prevailed, producing the fewest named Atlantic storms since 1997. *—Tom O'Neill*



1997
EL NIÑO



1998
LA NIÑA



2004
MODOKI

Sea-surface temperature departure from average (in degrees Fahrenheit)
August-October

-6 -3 0 3 6 9

STORM CLUES
The busiest hurricane seasons in the Atlantic tend to occur during La Niña years, such as 1998. El Niño years, such as 1997, usually have fewer storms. Modoki is a hybrid of sorts: Its warm waters are like El Niño's, but its storm totals are closer to La Niña's. However, in most years none of the three cycles occurs.

MAPS: JEROME N. COOKSON, NG STAFF
SOURCES: HYE-MI KIM, GEORGIA INSTITUTE OF TECHNOLOGY; NATIONAL CLIMATIC DATA CENTER, NOAA

Monkey See The cure for color blindness may be within sight. Gene therapy has given adult male squirrel monkeys—which, like color-blind people, lack the pigment gene that lets them distinguish red and green—a glimpse of hues they've never seen before.

About 20 weeks after receiving retinal injections of the *L-opsin* gene, color-blind monkeys began spotting red and green dots on a computer screen, and their perception improved with time. Conventional wisdom had held that color vision relies on an inflexible nerve network hardwired early in development. But University of Washington neuroscientist Jay Neitz says this study shows that "the brain can adapt preexisting circuitry for a new purpose. It's extremely exciting." Someday the therapy could cure the estimated 200 million people, mostly men, who miss out on everything from autumn leaves to signs of sunburn to sight-oriented careers—and might spark fixes for other genetic blindnesses.

Meanwhile, says Neitz, at least one wise-eyed monkey has a new penchant for green M&M's. *—Jennifer S. Holland*

Food color suggests ripeness, a cue now clear to this male squirrel monkey.

PHOTO: KEVIN HORAN

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Small Town Nukes

They'd be carbon free, relatively cheap, and according to the industry, inherently safe. An underground mini-nuke could power a village.

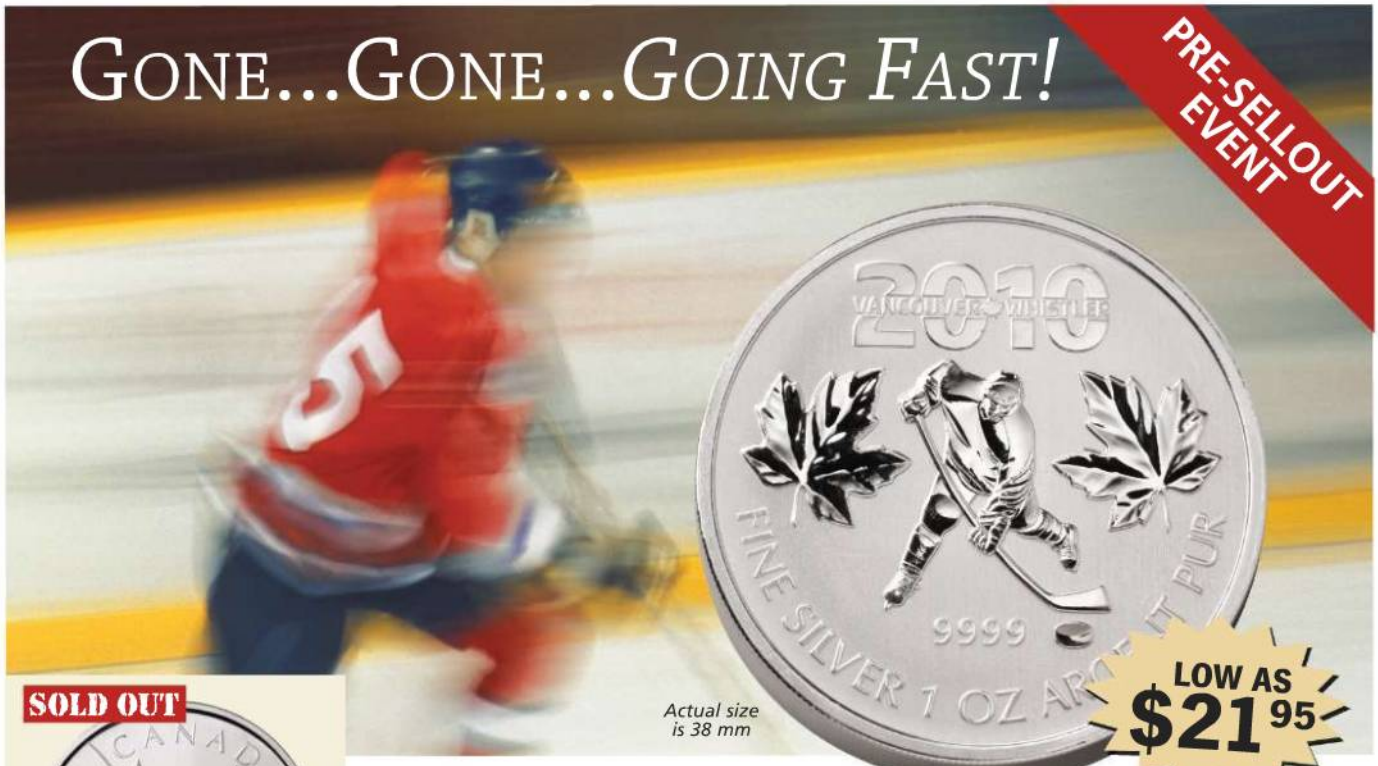
MOST NUCLEAR POWER PLANTS are behemoths, big enough to power a medium-size city. They are also behemoth investments, costing upwards of several billion dollars each to construct. Small wonder then that dozens of small-reactor prototypes are vying for attention in an industry newly energized by nuclear power's advantages as a low-emission alternative to fossil fuels.

"Small reactors can't address all the problems standing in the way of more nuclear investment, but they can address the biggest barriers—the economic ones," says Richard Lester, head of nuclear science and engineering at MIT. Building giant reactors, he points out, isn't the only way to achieve economies of scale; another way is to mass produce inexpensive mini-nukes. If they're designed as modules, a single unit might power a remote town or mine, while a dozen used in tandem could match the output of a traditional nuclear plant. In the developing world, small reactors would place less strain on fragile electrical grids. And the ability to start small and gradually add power modules could appeal to cash-strapped utilities everywhere.

None of the new small reactors have been deployed yet. Some, like the one designed by NuScale Power, *(Continued on next page)*

GONE...GONE...GOING FAST!

PRE-SELLOUT EVENT



Actual size is 38 mm

LOW AS $21.95

SOLD OUT

2008 GONE!

SOLD OUT

2009 GONE!

FINAL YEAR VANCOUVER 2010 OLYMPIC WINTER GAMES SILVER DOLLAR JUST RELEASED!

ACT FAST—EXPECTED TO SELL-OUT IN A FLASH!

To celebrate the return of the Olympic Games to North America, Canada is issuing a three-year silver dollar set. The 2008 issue, featuring the familiar Maple Leaf, quickly sold out. And then, this April, the mint cut off production of the 2009 Thunderbird issue. These are now sold out and unavailable. The 2010 silver dollar has just been released. There is no telling how long they will last, but *they could be gone in a heartbeat!*

HUGE DEMAND DEPLETED SUPPLY

These Official Vancouver 2010 Olympic Winter Games coins contain one full Troy ounce content of 99.99% fine silver and are sought by buyers worldwide. The 2010 issue features ice hockey, Canada's national sport, and could prove to be the hottest selling silver dollar of them all. We don't know when the mint will cut off production of this coin as they have done with the first two, but it could happen at any moment. So you must ACT NOW!

UNPRECEDENTED OPPORTUNITY!

The first Olympic Games Commemorative coin ever was issued by Finland in 1951 at a cost of about $13. Today that coin could cost as much as $674. Not only are Olympic Games coins sought after, Canadian Silver Dollars are HOT! You could have purchased a set of 1946, 1947 and 1948 silver dollars a few years ago for a few thousand dollars. Today, you could pay as much as $44,850 to obtain them in the same TOP QUALITY as these 2010 dollars. No one can predict the future, but for as little as $21.95 per coin, this is a HUGE buying opportunity!

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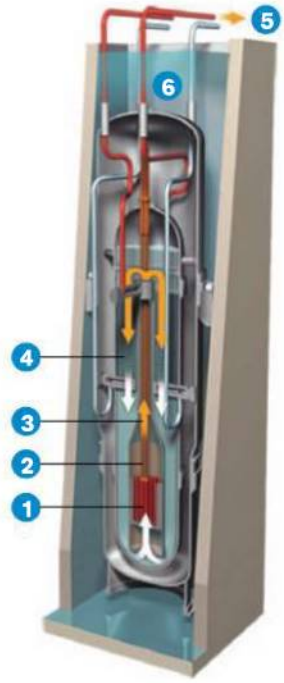
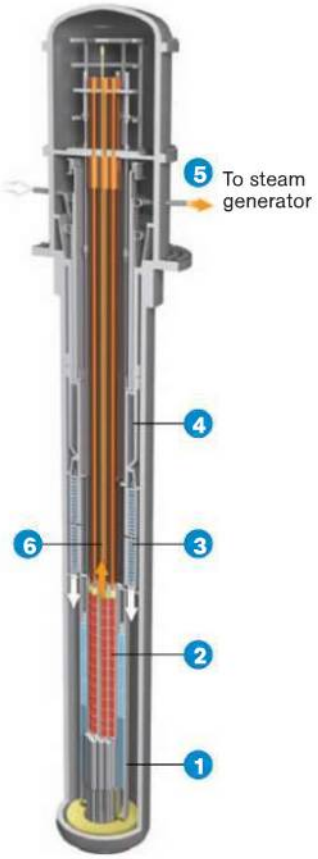


TWO LITTLE NUKES
Both installed underground, they maintain the nuclear reaction—and safety—in different ways.

NUSCALE
45 megawatts
A conventional water-cooled reactor, it's small enough to be cooled by convection, without pumps.

TOSHIBA
10 megawatts
A sodium-cooled reactor that runs 30 years without refueling, it has two ways of shutting down in an emergency.



How it works

The water is both coolant and "moderator": it slows neutrons emitted by the uranium fuel rods **1**, allowing them to split more uranium atoms. Control rods **2** temper the chain reaction. Water is heated as it rises through the core **3**. It then heats tubes **4** that generate steam, which leaves the reactor vessel **5** to drive a turbine. As a safeguard against meltdown, the whole system is immersed in water **6**.

How it works

A steel reflector **1** bounces neutrons back at the fuel **2** to maintain the chain reaction; it inches upward as fuel is consumed. Electromagnetic pumps **3** drive molten sodium through the core to a heat exchanger **4**, transferring its heat to a secondary sodium loop that runs **5** to a steam generator. To shut down fission, the reflector drops below the core, and a neutron-absorbing rod **6** drops into it.

are light-water reactors that resemble ones long used on warships. Others are more novel. Toshiba and the Japanese Central Research Institute of Electric Power Industry are working on a liquid-sodium-cooled "nuclear battery." Delivered partially assembled and installed underground, the reactor would generate ten megawatts for 30 years until it needed refueling. The isolated Alaska village of Galena is in discussions with Toshiba to become its first customer.

Besides costing less to build, some small reactors could be inherently safer, says Vladimir Kuznetsov of the International Atomic Energy Agency. NuScale's design requires no reactor cooling pumps, while Toshiba's pumps are electromagnetic, without moving parts; either approach diminishes the possibility of a disastrous failure. Chinese researchers, meanwhile, are developing a small reactor in which the nuclear reaction itself is self-limiting. In a dramatic 2004 demonstration, they turned off the cooling system; the reaction just burned itself out. With any of the new reactors, of course, there will still be radioactive waste to contend with.

There are 56 reactors under construction in the world today, 19 in China alone. But with energy demand soaring—and the threat of climate change looming—even that much construction will not greatly increase nuclear's share of the global electricity supply. Small reactors could help, Lester says. "The point is to scale up low-carbon energy sources rapidly. Nuclear has great potential to do this." If regulators go along, that is. In the U.S., officials say some designs may win certification within five years. More innovative ones may take longer. *—Chris Carroll*

ART: HIRAM HENRIQUEZ

Packs are making a comeback. That's a thrill for wildlife lovers. But wolves are still wolves, killing cattle and elk. Many Westerners are angry. And so, the age-old fight over land and food has begun anew.

Wolf Wars

By Douglas H. Chadwick

Wolves range far beyond Yellowstone's protected territory. This winter run took the Washakie pack across Wyoming's Absaroka Range in search of food.

JEFF VANUGA

ROBERT MILLAGE

Realtor Robert Millage's rifle lies across his trophy: the first wolf taken, in Clearwater National Forest, during Idaho's 2009-2010 season. The state set a quota of 220 in its first regulated wolf hunt.

Wolves, when you get down to it, are a lot like us.

They are powerful, aggressive, territorial, and predatory.

They are smart, curious, cooperative, loyal, and adaptable.

They exert a profound influence on the ecosystems they inhabit.

Nevertheless, we have problems with wolves, no doubt about it. Maybe we can't wrap our minds around both the big bad wolf and the close relative with the adoring gaze that follows us around the house. Or maybe it's because gray wolves are the planet's most widespread large land mammals after humans and their livestock and—in the Northern Hemisphere—have long been our most direct competitors for meat.

Whatever the reasons, humans are at war with wolves. It is an ancient dispute over territory and food between their clans and ours, and its battleground spreads across the northern Rocky Mountain states and right up to the door of my remote cabin near Montana's Glacier National Park. A young female named Diane marked the place by peeing on the front-porch mat.

There is a den not too far away atop a timbered knoll sheltered by overhanging boughs. Dug between tree roots, the opening gapes like a maw and extends underground for 18 feet—a manor by wolf standards. The ground around it is worn bare by generations of pawed feet. Paths lead to an open hillside overlooking a mile-long meadow fringed by autumn-colored aspen and willow, hushed except for the occasional call of a raven. The snowy peaks of the Continental Divide rise in the distance, and a wild river flows close by. Wolf tracks intersect with the prints of elk, deer, moose, and grizzly bears. Though the pups reared here are running with the adults now, the pack isn't far away, according to the radio signals of the alpha female.

MANY HAD THOUGHT the war was over. Relentlessly shot, trapped, and poisoned, even in nature reserves, gray wolves were gone from the West by the 1930s. In 1974, when *Canis lupus* was declared endangered in the lower 48 states, the gray wolf population was confined to a corner of northern Minnesota and Michigan's Isle Royale National Park out in Lake Superior.

Then, during the mid-1980s, a handful trotted down the Continental Divide from Canada. Two settled in the hidden meadow in Glacier and in 1986 reared five pups. Footsore biologists trying to keep track of the newcomers dubbed them the Magic pack for the way they seemed to vanish and reappear like wisps of ground fog.

The pack grew and soon split into two, then three, keeping mostly within the park. Some animals broke away and dispersed to neighboring national forests. Then all at once, a pair was denning on private ranchland 90 miles southwest of Glacier and less than 30 miles from the Idaho border. People began to report wolves in both Idaho and northern Wyoming. Still, there was no proof those wolves were anything but passing wanderers. Not yet.

In 1995 and 1996, the U.S. Fish and Wildlife Service captured wolves in Canada and released them into 2.2-million-acre Yellowstone National Park and central Idaho's wilderness areas. The unprecedented federal action triggered such an eruption of hope, fear, resentment, lawsuits, and headline news that most people assume the whole return of the wolf to the West began that way. It didn't, but those reintroductions worked like a rocket booster. Populations grew, and the war escalated.

During 2008, wildlife agents confirmed 569 cattle and sheep deaths from wolves throughout the West. That amounted to less than one percent of livestock deaths in the region, but the

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Wildlife biologist and longtime contributor Douglas Chadwick lives in Montana wolf country. His book The Wolverine Way *will be published this spring.*

Hunters protest federal management of wolf populations outside the Montana Department of Fish, Wildlife & Parks in Kalispell. In a region reeling from lumber-mill and factory closures, wolves are direct competitors for meat to stock the family freezer in winter.

damage is never distributed equally. The same year 264 wolves were killed for attacking livestock in Montana, Idaho, and Wyoming. That's a big number, but it was taken from a wolf population now grown to around 1,600, roaming the region in more than 200 packs. Today there are two new packs in northeastern Washington and, some whisper, a small enclave in Colorado as well. The West is getting wilder by the hour.

Wildlife enthusiasts and tourists couldn't be happier. In Yellowstone alone, tens of thousands come to watch wolves each year, adding an estimated $35 million to the area's economy. Scientists are documenting ecological changes tied to this top predator's return that may hold the potential to repair out-of-balance wildlands, making them more stable and biologically diverse.

On the other hand, some folks say they no longer feel as safe taking their families into the woods. Sportsmen complain too—bitterly. To many out West, where interior decorating tends to involve antlers and come fall, "Howdy" is replaced by "Get your elk yet?" wolves are depicted as four-legged killing machines—land piranhas—ravaging game populations. Guys mutter about taking matters into their own

MICHAEL GALLACHER, *MISSOULIAN*

hands and to hell with the Feds. Bumper stickers show a crossed-out wolf and the slogan "Smoke a Pack a Day."

In May 2009, the wildlife service declared the species recovered in the northern Rocky Mountains and handed over responsibility for them to Montana and Idaho. Both instantly labeled them game animals and set quotas for the first legal wolf hunts in either state's memory—75 in Montana, 220 in Idaho. "It's amazing—from a single, endangered pack to a huntable surplus across a whole region," says Jim Williams, the Montana Department of Fish, Wildlife & Parks wildlife program manager for northwest Montana. "This is the most striking Endangered Species Act success story I can think of." Maybe. In November 2009, Idaho extended its season to last until the quota is met, or until March 31, whichever is sooner. The change could open the door to hunters traveling by snowmobile and to the killing of pregnant females.

Guys mutter to hell with the Feds. Bumper stickers show a crossed-out wolf and the slogan "Smoke a Pack a Day."

After an earlier federal decision to delist Western wolves in 2008, Wyoming essentially defined the animals as varmints, or pests, allowing virtually unlimited shooting and trapping year-round. A resulting lawsuit forced the wildlife service to temporarily put wolves back on the endangered list. (Since then, the service has refused to take them off in Wyoming until that state comes up with a different plan.) Meanwhile, a coalition of 14 environmental and animal protection organizations led by Earthjustice is suing the federal government to relist all wolves until the Western states develop a regional conservation strategy that includes core protected areas and buffer zones where wolves can live in normal packs that won't get shot to pieces.

JOHN AND RAE HERMAN run 800 head of Angus cattle in western Montana's Hot Springs area. They grew up in America's golden age for pastoralists, in rolling valleys of bunchgrass and sage with forested mountainsides—with virtually all large native predators wiped off the landscape.

"We'd usually be missing three to five calves at roundup," John says. "Now it's closer to 25. This spring our calving grounds down near the house got hit. Seven calves were confirmed wolf kills, so we were reimbursed for them."

The trouble is if ranchers don't come across a carcass right away, scavengers may drag off or shred all the evidence. Many say in some areas the actual kills by wolves may average as high as seven for every one that can be proved, but no confirmation, no compensation. And dead and missing animals are only part of the toll. Cattle harassed by wolves over one season can lose 30 to 50 pounds each. On top of that, hormonal effects from stress kick in. "We had 85 pregnant heifers this spring, and 60 aborted," John says.

"The worst part," Rae says, "is that 23 of the cows that aborted were in our son's starter herd of 25. He's stuck with a $7,500 bank note and two calves to pay it off with. We'll end up selling some mother cows to offset our losses, so we'll be going backwards."

Stock with leg injuries from chases or infections from wounds become unmarketable. And after brushes with wolves, mother cows stay ornery and extra protective of calves. The Hermans aren't the only ranchers to say it is harder to wrangle such cattle in pens; who don't even think about using their dogs; who consider the fact that if you drive those cows onto prime range the next summer, they may not stay because the upland forests are where the wolves hang around.

THE BLACKFOOT CHALLENGE ranchers—a cooperative established in 1993 to conserve the rural setting in west-central Montana's Blackfoot River watershed—are trying a range rider program. I'm patrolling with the lone rider himself,

Friendly canine eyes watch Jason Simonsen from his pickup as the ranch hand turns from the remains of a dead calf near Cameron, Montana. A wildlife specialist found enough evidence of wolf predation for the owner to apply for compensation, around $600.

Peter Brown, who travels by pickup truck, motorcycle, or foot. He monitors the whereabouts of wolf packs in relation to cattle and reports daily to ranchers so they can move herds to safer grazing spots or keep a closer eye on them. Electric fencing now surrounds calving lots in many risky areas. To visually warn wolves away from other pastures, Brown sometimes turns to the old European technique called fladry, stringing wire with bright flags along its length.

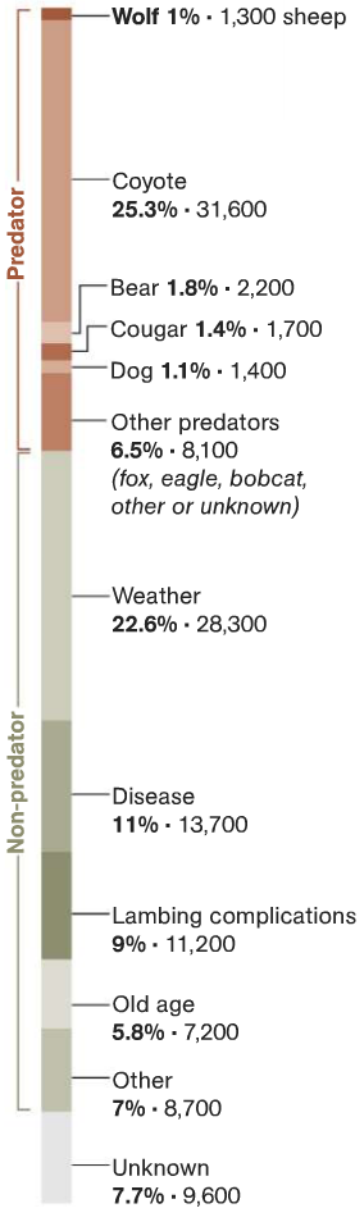
As we scan some bottomlands amid October snow flurries, Brown's gaze is drawn by ravens, among his surest guides, to a carcass. In this case the birds are merely scavenging elk guts left by a human hunter. So is a raven-black wolf from the Elevation Mountain pack. Yet four deer are grazing peacefully across a fence line, and scores of cattle are doing the same 200 yards beyond.

"A herd's behavior is our early warning system," Brown notes. "What I look for is cattle bunched up or running, or just looking around alertly and calling. I also keep an eye out for unhealthy stock, which can attract predators. I think that just by moving around the area, my presence deters wolves from killing livestock. The wolves are learning and adapting at least as

MATT MOYER

COUNTING SHEEP LOSS

Wolf predation reported by ranchers in Wyoming, Montana, and Idaho (2008 statistics below) accounts for a fraction of sheep deaths but is one more blow. Of the cases wildlife agents were called to investigate, 355 were confirmed as wolf kills, eligible for compensation.



125,000
Total reported sheep loss
Percentages exceed 100 because of rounding.

NG ART. SOURCE: USDA NATIONAL AGRICULTURAL STATISTICS SERVICE.

fast as we are. Besides that, we have good populations of natural prey here. I've seen wolves walk right through cattle herds to stalk deer."

Ranchers used to leave stock that died of disease, birthing problems, and accidents lying on the range or collected in heaps called bone piles. But "as predators began to recover, the carcasses kept luring them into trouble," explains Seth Wilson, a conservation biologist who coordinates the range rider program. "Now we collect carcasses right away and compost them at a distant site. It's one of the simplest and most effective ways to reduce conflicts with both bears and wolves. It just requires changing old habits."

The question is no longer how to get rid of wolves but how to coexist with them. Family rancher David Mannix says, "We have to realize that the general U.S. population wants wolves. That population is also our customers for beef. It's not a good idea to tell your customers they don't know what they're doing. So instead of taking a hard line and fighting to get everything back to where it was 50 years ago, we're trying things like the range rider."

"But if ranchers can't make a living," stockman and veterinarian Ron Skinner says, "the alternative these days is usually subdivision for real estate, and there goes an awful lot of the open space and prime wildlife habitat in the West."

WHEN THE NEW WOLVES in Yellowstone first came calling, the area's elk and moose stood their ground as though they were still dealing with coyotes. Bad plan. Today Yellowstone holds half the elk it did 15 years ago. Yet by most measures the population had swelled too high, and their range was deteriorating. Shortly after killing the last Yellowstone wolves in 1926, park officials were culling elk by the thousands. The elk kept rebounding and overgrazing key habitats, creating a perpetually unnatural situation for a park intended to preserve nature.

With a near-unlimited meat supply, Yellowstone's new wolves rapidly multiplied. But the count abruptly fell in 2005. It increased again, reaching 171 in 2007, then sank to 124 by the end of 2008, a 27 percent drop this time. Doug

Smith, leader of the Yellowstone Wolf Project, recorded the fewest breeding pairs since 2000. "We have a declining wolf population," he says. "Numbers never got as high as we expected based on the availability of prey. This suggests that once wolves reach a certain density, you start to get social regulation of their numbers."

Clashes with humans are by no means the only wolf wars under way.

Yellowstone's Druid Peak pack established its territory in 1996 and has held it ever since. In all probability they have been the most watched group of wolves in the world: The wide-open country they claim on both sides of Wyoming's Lamar River Valley is bisected by one of the park's main roads. On a late October morning the temperature is reading 4°F. Hoarfrost coats the noses of bison below one of the Druids' favorite rendezvous sites. Scattered elk graze the same slope, and two coyotes are picking over the remains of an elk calf on the river's shore. I spy no wolves, but Laurie Lyman, a former teacher who moved from California to be near Yellowstone's wolves and has watched them almost daily for several years, lowers her binoculars to tell me about the ones she saw yesterday.

Two Druids—a female labeled Number 571 and her younger brother, called Triangle Blaze, for his white chest patch—were traveling by the river when three invaders from the new Hurricane Mesa pack appeared. The groups exchanged howls and then ran at each other. Outnumbered, the Druid pair gave way first, but the Hurricanes caught up to 571. Four times they pulled her down onto her back. The final time two held her on either end while the third—and largest—bit into her chest, shaking and tearing with its teeth. "That's when Triangle Blaze jumped in," Lyman recalls. "He came to her rescue, fighting off the Hurricanes. They started chasing him, but not before 571 got in a bite on one's rear. She escaped across the river. When her brother finally rejoined her, he was limping, and she was bleeding from her wounds."

During 2008, Yellowstone saw twice as many wolves killed by other wolves as in any previous year. Distemper claimed a record share too, after hitting the population in 1999, 2000, and 2005 as well. Parvovirus, another deadly canine disease, has been detected in the area. And like many packs, the Druids are suffering serious hair loss from an epidemic of mange.

Loss of superabundant prey is another issue, Smith says. There are still close to 10,000 elk wintering in Yellowstone and perhaps double that number summering in the park. "But wolves are very selective hunters," Smith says. "What counts for them is the amount of vulnerable prey."

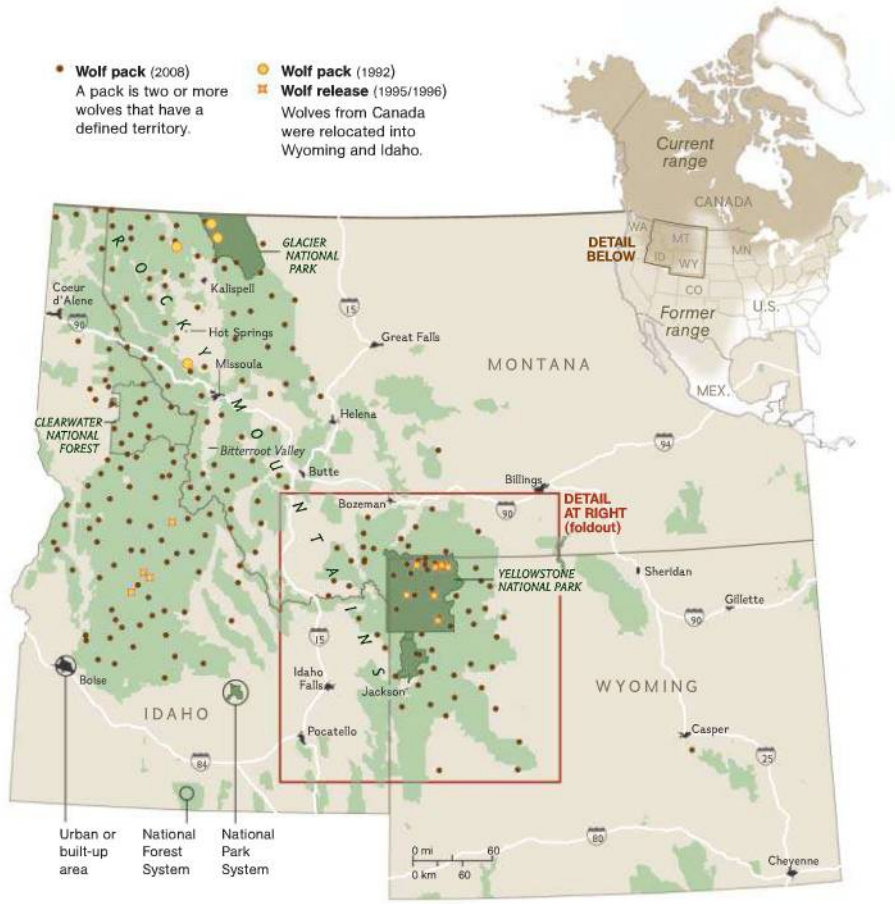
When the new wolves in Yellowstone first came calling, the area's elk and moose stood their ground. Bad plan.

Much as experience with wolves can transform cattle into not-so-domestic animals, pack-hunted elk turn into less vulnerable quarry. They become more vigilant and keep on the move more. In the wolfless era, herds practically camped at favorite winter dining spots, foraging on young aspen, willow, and cottonwood until the stems grew clubbed and stunted like bonsai plants. Released from such grazing pressure, saplings now shoot up to form lush young groves. More songbirds find nesting habitat within their leafy shade. Along waterways, vigorous willow and cottonwood growth helps stabilize stream banks. More insects fall from overhanging stems to feed fish and amphibians. Beavers find enough nutritious twigs and branches to support new colonies.

Surveying the huge northern range, where most of the park's elk winter, Doug Smith turned up just one beaver colony in 1996—the lowest tally in decades. By 2009, he recorded 12. Along Crystal Creek I find another recent beaver dam storing water, releasing a more constant flow for riparian *(Continued on page 54)*

Return of the Wolf

Exterminated as vermin, gray wolves vanished from the lower 48 (save for the far upper Midwest) by the 1930s. In 1995 and 1996, the U.S. Fish and Wildlife Service airlifted 66 wolves from Canada in an experiment to repopulate Yellowstone National Park and Idaho wilderness areas. A few wolves had already crossed the border into Montana by themselves and formed packs. By the end of 2008, the northern Rocky Mountain states held more than 1,645 wolves in 217 packs, 1,500 of them living outside national parks.



YELLOWSTONE WOLF PACKS
From the epicenter of Yellowstone National Park, reintroduced wolves quickly spread across the Greater Yellowstone Area (right). Most of the suitable wild habitat (green) is filled, and populations are probably close to saturation at about 450 wolves, 124 of them in Yellowstone Park. Packs pushing beyond these areas seldom survive.

8 *Pack name*
Established wolf pack
Circles mark the center of a pack's territory and show the number of wolves per pack. Data from the end of 2008, the most recent available.

Observed pack territory
Extent of wolf sightings for each pack where available

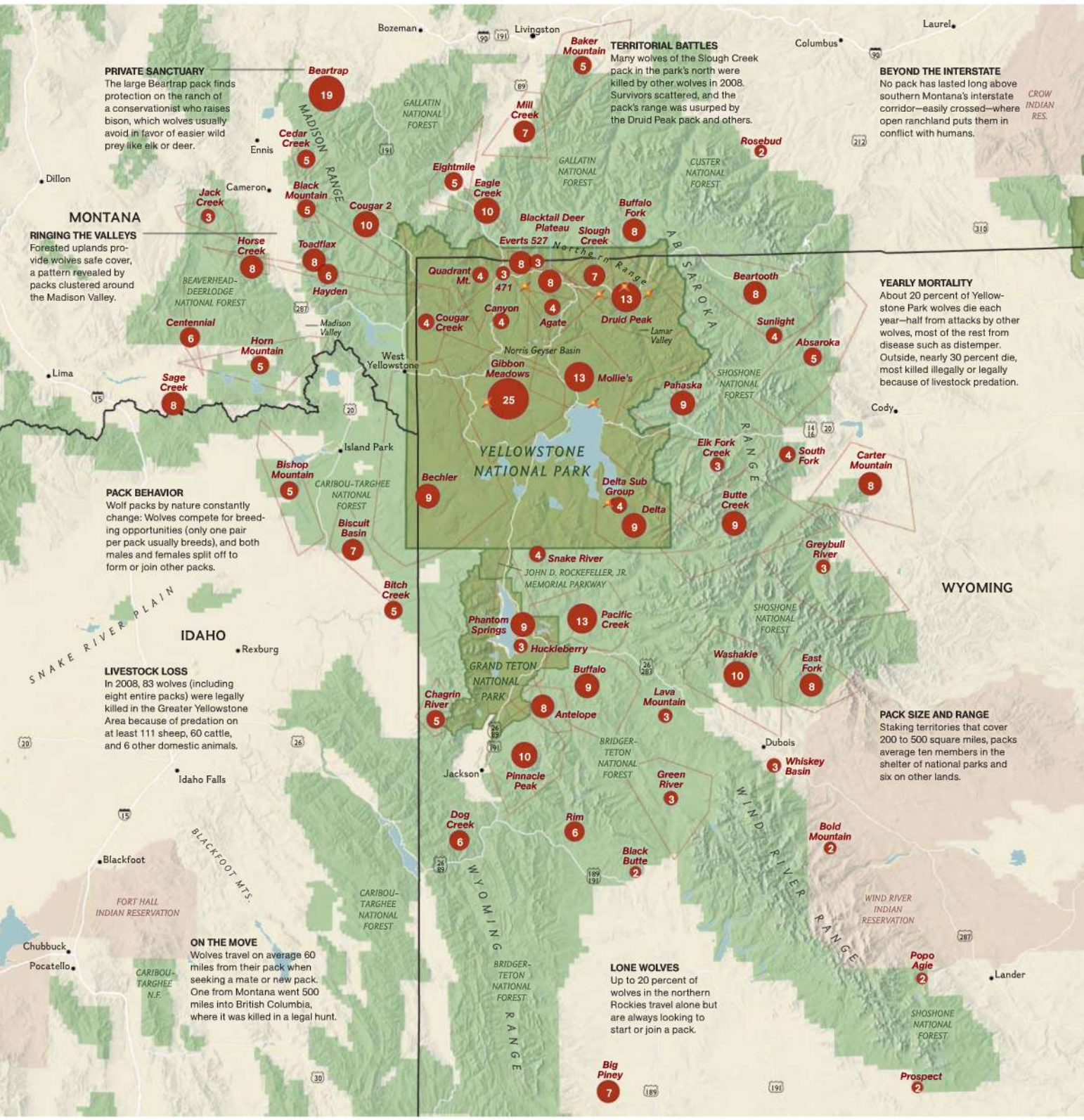
Reintroduction sites
Canadian wolves airlifted into Yellowstone in 1995 and 1996

Land ownership
- National Park System
- National Forest System or wilderness area
- Private or Bureau of Land Management

0 mi 20
0 km 20

WILLIAM E. MENULTY, NG STAFF; ALEX TAIT, INTERNATIONAL MAPPING

SOURCES: ED BANGS AND MIKE JIMENEZ, U.S. FISH AND WILDLIFE SERVICE; CAROLYN SIME AND ADAM MESSER, MONTANA FISH, WILDLIFE & PARKS; DOUGLAS W. SMITH, YELLOWSTONE NATIONAL PARK. DECEMBER 2008 DATA


PRIVATE SANCTUARY
The large Beartrap pack finds protection on the ranch of a conservationist who raises bison, which wolves usually avoid in favor of easier wild prey like elk or deer.
RINGING THE VALLEYS
Forested uplands provide wolves safe cover, a pattern revealed by packs clustered around the Madison Valley.
PACK BEHAVIOR
Wolf packs by nature constantly change: Wolves compete for breeding opportunities (only one pair per pack usually breeds), and both males and females split off to form or join other packs.
LIVESTOCK LOSS
In 2008, 83 wolves (including eight entire packs) were legally killed in the Greater Yellowstone Area because of predation on at least 111 sheep, 60 cattle, and 6 other domestic animals.
ON THE MOVE
Wolves travel on average 60 miles from their pack when seeking a mate or new pack. One from Montana went 500 miles into British Columbia, where it was killed in a legal hunt.
TERRITORIAL BATTLES
Many wolves of the Slough Creek pack in the park's north were killed by other wolves in 2008. Survivors scattered, and the pack's range was usurped by the Druid Peak pack and others.
LONE WOLVES
Up to 20 percent of wolves in the northern Rockies travel alone but are always looking to start or join a pack.
BEYOND THE INTERSTATE
No pack has lasted long above southern Montana's interstate corridor—easily crossed—where open ranchland puts them in conflict with humans.
YEARLY MORTALITY
About 20 percent of Yellowstone Park wolves die each year—half from attacks by other wolves, most of the rest from disease such as distemper. Outside, nearly 30 percent die, most killed illegally or legally because of livestock predation.
PACK SIZE AND RANGE
Staking territories that cover 200 to 500 square miles, packs average ten members in the shelter of national parks and six on other lands.
MONTANA
IDAHO
WYOMING
YELLOWSTONE NATIONAL PARK
Bozeman
Livingston
Laurel
Columbus
Dillon
Ennis
Cameron
Lima
Island Park
West Yellowstone
Rexburg
Idaho Falls
Blackfoot
Jackson
Dubois
Cody
Lander
Chubbuck
Pocatello
Beartrap 19
Baker Mountain 5
Mill Creek 7
Cedar Creek 5
Eightmile 5
Eagle Creek 10
Rosebud 2
Jack Creek 3
Black Mountain 5
Cougar 2 10
Buffalo Fork 8
Blacktail Deer Plateau
Slough Creek
Everts 527
Horse Creek 8
Toadflax 8
Hayden 6
Quadrant Mt. 4
3
471
8
3
7
13
Beartooth 8
Canyon 4
Cougar Creek 4
Agate 4
Druid Peak
Sunlight 4
Absaroka 5
Centennial 6
Horn Mountain 5
Sage Creek 8
Norris Geyser Basin
Gibbon Meadows 25
Mollie's 13
Pahaska 9
Elk Fork Creek 3
South Fork 4
Carter Mountain 8
Bishop Mountain 5
Bechler 9
Delta Sub Group 4
Delta 9
Butte Creek 9
Biscuit Basin 7
Snake River 4
Greybull River 3
Bitch Creek 5
Phantom Springs 9
Pacific Creek 13
Huckleberry 3
Washakie 10
East Fork 8
Buffalo 9
Chagrin River 5
Antelope 8
Lava Mountain 3
Pinnacle Peak 10
Whiskey Basin 3
Green River 3
Dog Creek 6
Rim 6
Bold Mountain 2
Black Butte 2
Popo Agie 2
Prospect 2
Big Piney 7
Madison Valley
Lamar Valley
GALLATIN NATIONAL FOREST
GRAND TETON NATIONAL PARK
JOHN D. ROCKEFELLER, JR. MEMORIAL PARKWAY
BRIDGER-TETON NATIONAL FOREST
CARIBOU-TARGHEE NATIONAL FOREST
SHOSHONE NATIONAL FOREST
CUSTER NATIONAL FOREST
BEAVERHEAD-DEERLODGE NATIONAL FOREST
FORT HALL INDIAN RESERVATION
WIND RIVER INDIAN RESERVATION
CROW INDIAN RES.
MADISON RANGE
ABSAROKA RANGE
Northern Range
WIND RIVER RANGE
WYOMING RANGE
BLACKFOOT MTS.
SNAKE RIVER PLAIN
CARIBOU-TARGHEE N.F.

The Slough Creek pack isolates a bison cow on a thin layer of snow atop a frozen creek. This bison made it back to the herd, but had it been ambushed in deeper snow, its size and weight would have put it at a disadvantage, and it might have been taken down.

DAN STAHLER, NATIONAL PARK SERVICE

Before & After Wolves

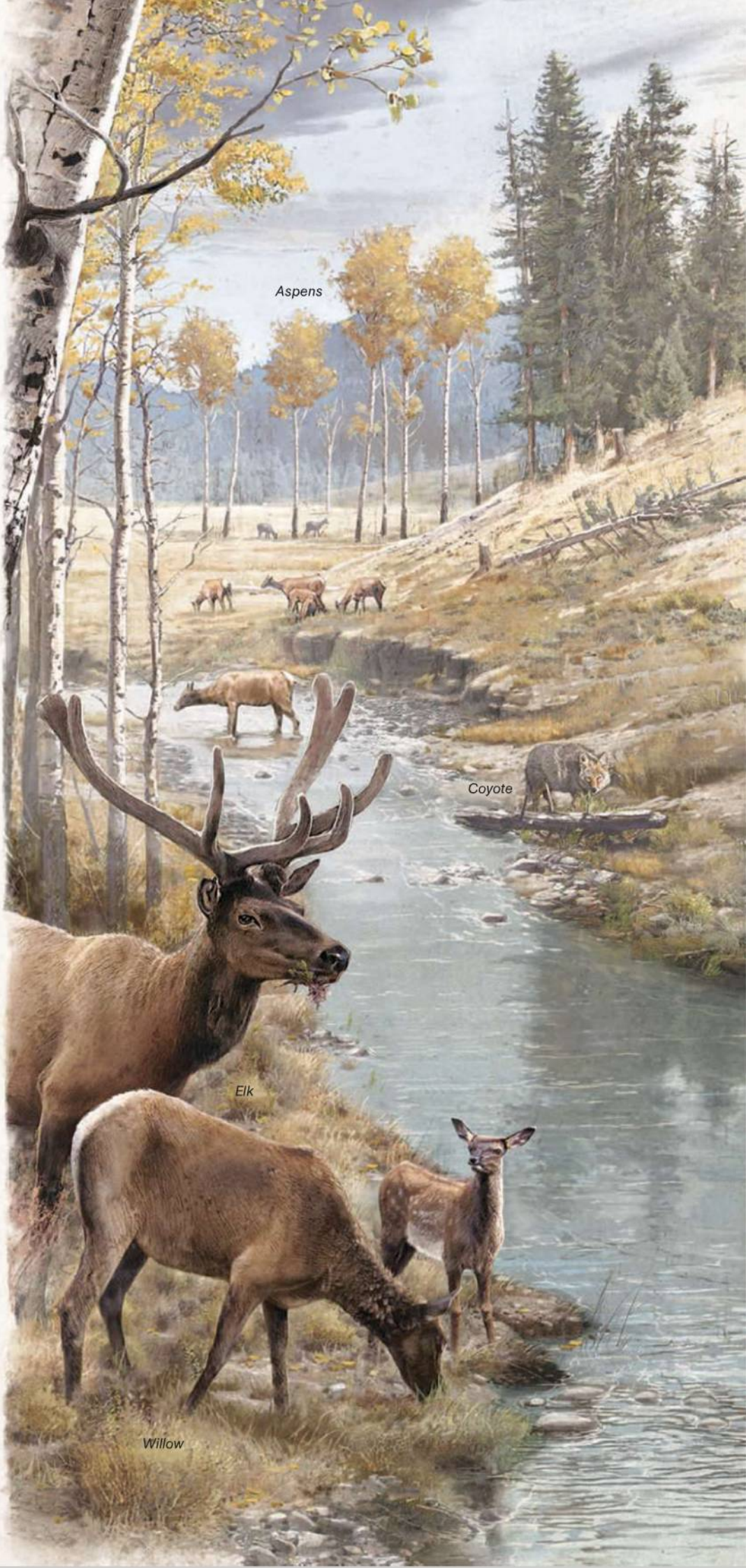
Restoring wolves to Yellowstone after a 70-year absence as a top predator—especially of elk—set off a cascade of changes that is restoring the park's habitat as well.

YELLOWSTONE WITHOUT WOLVES 1926-1995 ►

ELK overbrowsed the streamside willows, cottonwoods, and shrubs that prevent erosion. Birds lost nesting space. Habitat for fish and other aquatic species declined as waters became broader and shallower and, without shade from streamside vegetation, warmer.

ASPEN trees in Yellowstone's northern valleys, where elk winter, were seldom able to reach full height. Elk ate nearly all the new sprouts.

COYOTE numbers climbed. Though they often kill elk calves, they prey mainly on small mammals like ground squirrels and voles, reducing the food available for foxes, badgers, and raptors.



ART BY FERNANDO G. BAPTISTA, NG STAFF; AMANDA HOBBS, NG STAFF

SOURCES: ROBERT L. BESCHTA AND WILLIAM J. RIPPLE, OREGON STATE UNIVERSITY; DOUGLAS W. SMITH, YELLOWSTONE NATIONAL PARK

YELLOWSTONE WITH WOLVES 1995-PRESENT ►

ELK population has been halved. Severe winters early in the reintroduction and drought contributed to the decline. A healthy fear of wolves also keeps elk from lingering at streamsides, where it can be harder to escape attack.

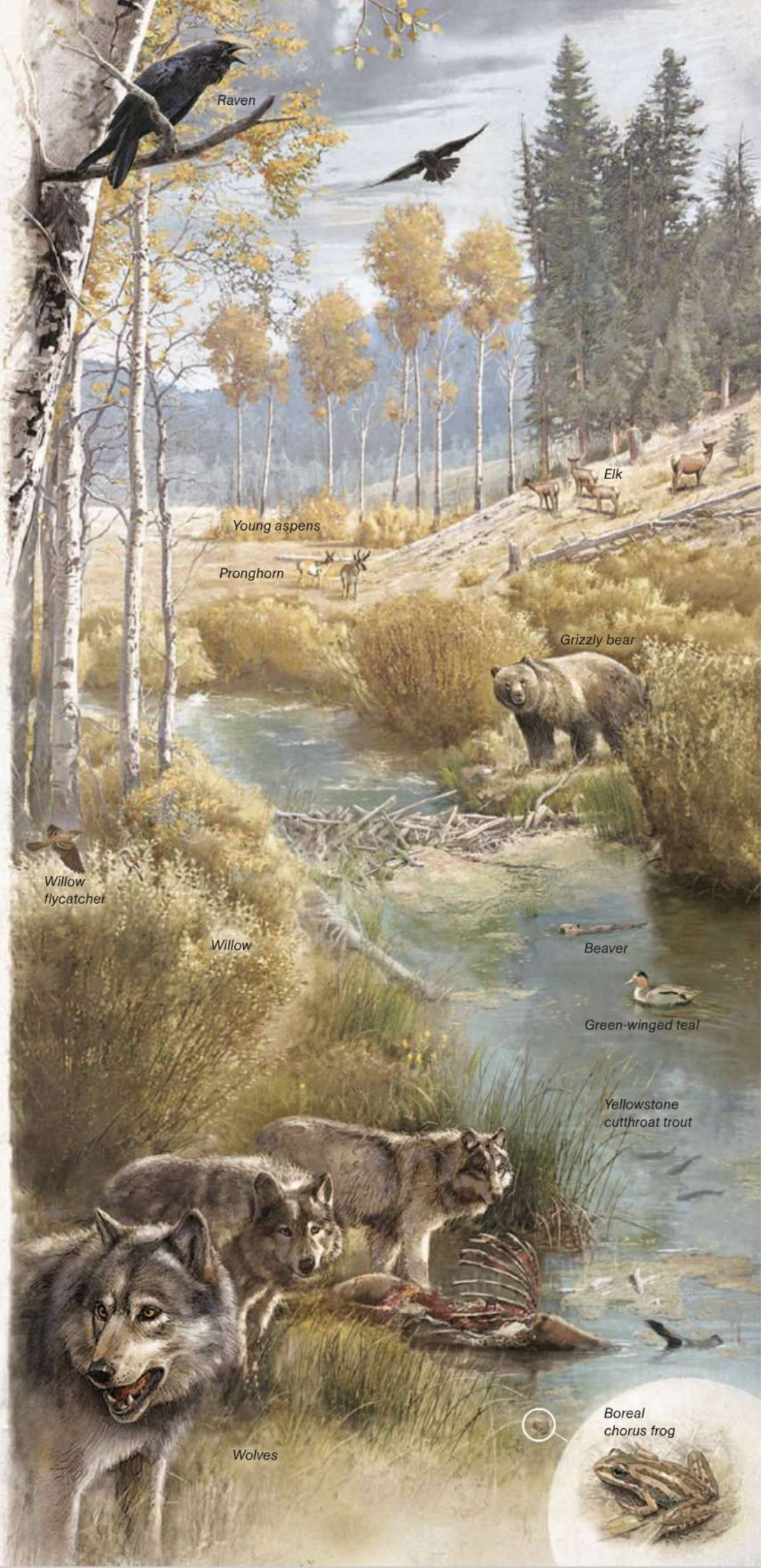
ASPENS The number of new sprouts eaten by elk has dropped dramatically. New groves in some areas now reach 10 to 15 feet tall.

COYOTES Wolf predation has reduced their numbers. Fewer coyote attacks may be a factor in the resurgence of the park's pronghorn.

WILLOWS, cottonwoods, and other riparian vegetation have begun to stabilize stream banks, helping restore natural water flow. Overhanging branches again shade the water and welcome birds.

BEAVER colonies in north Yellowstone have risen from one to 12, now that some stream banks are lush with vegetation, especially willows (a key beaver food). Beaver dams create ponds and marshes, supporting fish, amphibians, birds, small mammals, and a rich insect population to feed them.

CARRION Wolves don't cover their kill, so they've boosted the food supply for scavengers, notably bald and golden eagles, coyotes, ravens, magpies, and bears.



A Yellowstone wolf feeds on an elk carcass. A pack of wolves typically kills an elk every two to three days. Because wolves can consume more than ten pounds of meat at once, they can go for more than a week without eating.

ROBERT WESELMANN

(Continued from page 43) species downstream through the dry months. Ponds and marshes that form behind the dams create habitat for moose, muskrat, mink, waterfowl, wading birds, and an array of other wildlife. After wolves moved in, cougars that had begun hunting the valleys retreated to the steep, rocky terrain they normally inhabit. The big canines killed nearly half the coyote population. They may have rebounded a bit, but the coyotes now live in groups with shrunk territories or as vagabond "floaters." With less competition from elk for grasses, bison may be doing better than ever.

Large mammals are learning and changing their behavior all the time: deer, elk, bears, wolves, and yes, humans too.

From a single new predatory force on the landscape, a rebalancing effect ripples all the way to microbes in the soil. Biologists define the series of top-down changes as a trophic cascade. In a nod to the behavioral factors at play, others speak of the "ecology of fear."

CRISTINA EISENBERG is a five-foot-two-inch, hundred-pound answer to the question of how dangerous wolves are to people. Over the past four years she has studied wolves, elk, and aspen in Glacier Park, often on its west side among two large wolf packs, one with 20-plus members. They sometimes watch as she and an assistant measure habitat features. Then the wolves pull out her marker stakes. During a blinding snowstorm, they silently took down an elk a stone's throw from Eisenberg.

Our afternoon survey leads to a trampled-down rendezvous site. The Dutch pack has dragged in ceramic shards, cans, pots, pieces of iron tools from abandoned homesteads in the park. Canine junk collectors. Who knew?

But what Eisenberg wants to show me is an aspen stand. Its upper tier consists of towering trees that arose between 1840 and the 1920s, before wolves were eliminated. The bottom row, 15 feet high, is of saplings that shot up after wolves returned. There are no aspens in between. None got past the elk's mouths. By contrast with Yellowstone, elk numbers haven't changed much here. As far as Eisenberg can tell, the recent aspen growth is almost all due to wolf-inspired changes in elk behavior.

The wolves' diet here is mostly white-tailed deer. Northwestern Montana has at least twice as many cougars as wolves and twice as many grizzly bears. Together they kill more adult deer and fawns than wolves do. Coyotes and black bears take a share as well. On top of that, the area has had two tough winters in a row. Deer totals dropped even where few predators prowl. Yet overall deer numbers remain within the historical average. For that matter, both elk and deer are doing well across the West. As game manager Jim Williams puts it, "With wolves back in the picture along with cougars and bears, we'll have places where elk and deer may never be as abundant again as people remember, and we'll have other places where they'll do fine. There are bigger drivers than wolves in these systems." Studies have shown that winter weather and the quality of wintering habitat are really what control deer and elk populations over time. That and human hunting.

Craig Jourdonnais is the state game department's wildlife biologist for Montana's Bitterroot Valley, near the Idaho border. Until recently, he says, most gripes about wildlife concerned elk raiding haystacks and deer damaging crops and gardens and being a danger on highways.

"Now we have 10 to 12 wolf packs for a minimum of 45 to 60 wolves. We also have 14,000 hunters coming through the Bitterroot check station in a given year." The main complaints he hears these days are about wolves overrunning the place and wiping out elk and deer. "I've been on the job 30 years, and I've never worked with any critter that raised so much emotion."

Somehow, Jourdonnais is supposed to make a

This juvenile eyed the camera curiously as the Canyon pack ranged along a power-line corridor near Yellowstone's Norris Geyser Basin. The wolf has been demonized, defeated, and defended by humans. It must now renegotiate its place in a changed habitat.

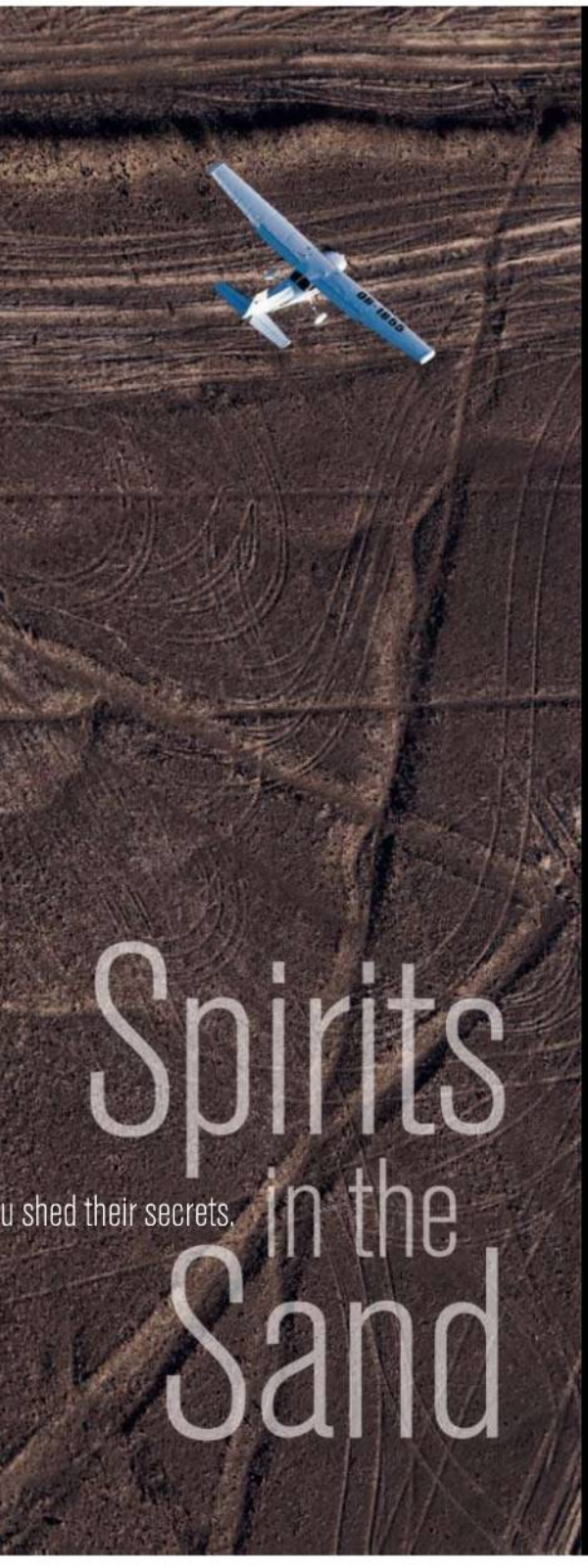
place for wolves where recreation and livelihood intermingle. He understands that big-game hunting in Ravalli County is worth $11.2 million annually. He also sees game losing critical winter range to subdivisions up and down the valley but knows that the one topic as hot as wolves out West is planning and zoning.

Bottom line? Survival rates for young game animals are lower the past couple years. Wolves may be partly responsible, but winter may be too. Overall, Bitterroot deer numbers are still fairly good. Whereas the elk total stood below 3,000 in the 1970s because sportsmen were allowed a generous take of females, it's currently above 6,000. A thousand of those animals have learned to retreat before the hunting season to a private ranch where only limited shooting is allowed.

Large mammals are learning and changing their behavior all the time: deer, elk, bears, wolves, and yes, humans too. For our part it seems we need to formulate better answers to the questions posed by the return of wolves—not the wolves in our minds but the real wolves watching from the mountainsides. When we say we want to conserve wildlife communities in America, does that mean including the wolf, or not? □

TOM LEESON

The ancient Nasca lines of Per



Spirits in the Sand

u shed their secrets.

In the coastal desert of southern Peru, sprawling figures etched on the land—a spider, a monkey, a strange flying animal, and more—have inspired wonder in air travelers since first spotted in the 1920s. Now scientists believe they know why ancient people created the designs, beginning more than 2,000 years ago.

For the Nasca, the gods who brought rain
asked a terrible price in return.

SEVERED HEAD COMPOSED OF THREE IMAGES

Likely a token of fertility, a severed head from Cahuachi hung from a rope of vegetable fiber. The victim may have been a local man sacrificed at a time of drought. A skull from Carrizales (above) shows a typical form of deliberate shaping, perhaps a sign of elite social status. Many buried corpses, including that of a man found at Ullujaya (left), were mummified naturally by the region's arid climate.

By Stephen S. Hall | Photographs by Robert Clark

From the air, the lines etched in the floor of the desert were hard to see, like drawings left in the sun too long. As our pilot cut tight turns over a desert plateau in southern Peru, north of the town of Nasca, I could just make out a succession of beautifully crafted figures.

"Orca!" shouted Johny Isla, a Peruvian archaeologist, over the roar of the engine. He pointed down at the form of a killer whale. *"¡Mono!"* he said moments later, when the famous Nasca monkey came into view. *"¡Colibrí!"* The hummingbird.

Since they became widely known in the late 1920s, when commercial air travel was introduced between Lima and the southern Peruvian city of Arequipa, the mysterious desert drawings known as the Nasca lines have puzzled archaeologists, anthropologists, and anyone fascinated by ancient cultures in the Americas. For just as long, waves of scientists—and amateurs—have inflicted various interpretations on the lines, as if they were the world's largest set of Rorschach inkblots. At one time or another, they have been explained as Inca roads, irrigation plans, images to be appreciated from primitive hot-air balloons, and, most laughably, landing strips for alien spacecraft.

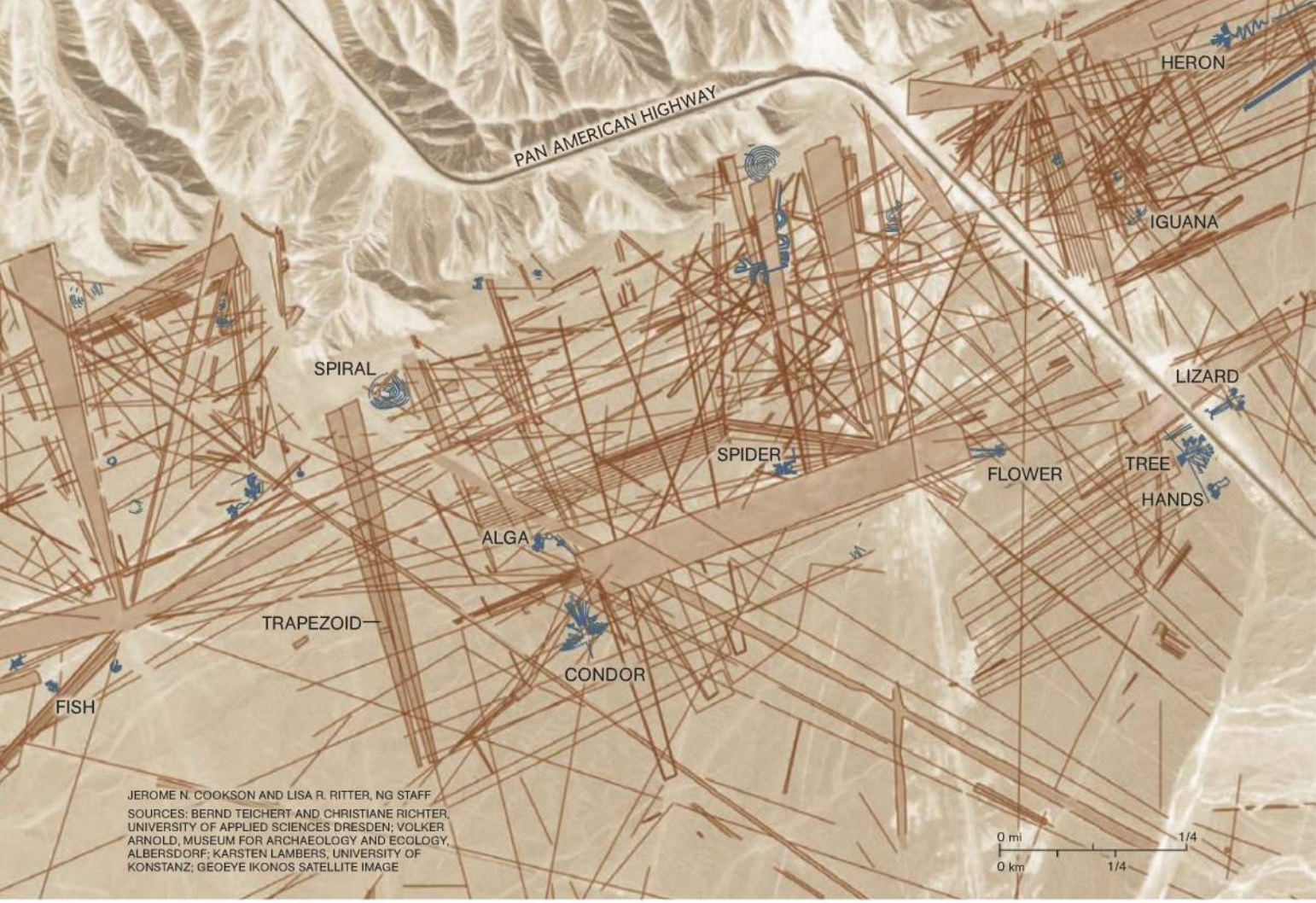
After World War II a German-born teacher named Maria Reiche made the first formal surveys of the lines and figures—called geoglyphs—outside Nasca and the nearby town of Palpa. For half a century, until her death in 1998, Reiche played a critically important role in conserving the geoglyphs. But her own preferred theory—that the lines represented settings on an astronomical calendar—has also been largely discredited. The ferocity with which she protected the lines from outsiders has been adopted by their caretakers today, so that even scientists have a hard time gaining access to the most famous animal figures on the plain, or pampa, immediately northwest of Nasca.

Since 1997, however, a large Peruvian-German research collaboration has been under way near the town of Palpa, farther to the north. Directed by Isla and Markus Reindel of the German Archaeological Institute, the Nasca-Palpa Project has mounted a systematic, multidisciplinary study of the ancient people of the region, starting with where and how the Nasca lived, why they disappeared, and what was the meaning of the strange designs they left behind in the desert sand.

As our plane banked into another turn, Isla, a native of the highlands who works at the Andean Institute of Archaeological Studies, kept his broad, high-cheeked face pressed to the window. "Trapezoid!" he shouted, pointing out a huge geometrical clearing looming into sight. "Platform!" he added, gesturing with his finger. "Platform!"

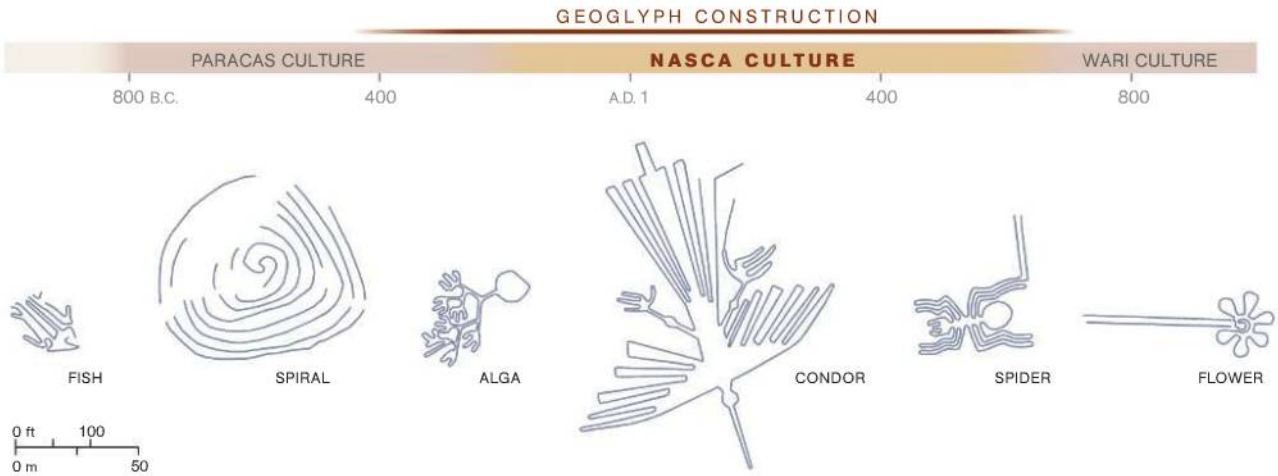
Platform? He was pointing at a small heap of stones at one end of the trapezoid. If Isla and his colleagues are right, such unprepossessing structures

This depiction of a giant bird, with a long, pointed beak and wings spanning 220 feet, may evoke tiny hummingbirds that flitted through irrigated fields.



Desert Mystery

Thousands of designs adorn some 1,500 square miles of desert in southern Peru (right). Created over more than a millennium (time line, below), they include dozens of naturalistic figures like those pictured at bottom. Lines and trapezoids were added later (above). No one knows for sure what the designs meant or why they changed over time, but they likely played a crucial part in the rituals of people who prayed for rain to fall in the Andes, to the east, and flow down to their fields.



may hold a key to understanding the true purpose of the Nasca lines. The story begins, and ends, with water.

THE COASTAL REGION of southern Peru and northern Chile is one of the driest places on Earth. In the small, protected basin where the Nasca culture arose, ten rivers descend from the Andes, to the east, most of them dry at least part of the year. These ten fragile ribbons of green, surrounded by a thousand shades of brown, offered a fertile hot spot for the emergence of an early civilization, much as the Nile Delta or the rivers of Mesopotamia did. "It was the perfect place for human settlement, because it had water," says geographer Bernhard Eitel, a member of the Nasca-Palpa Project. "But it was a high-risk environment—a very high-risk environment."

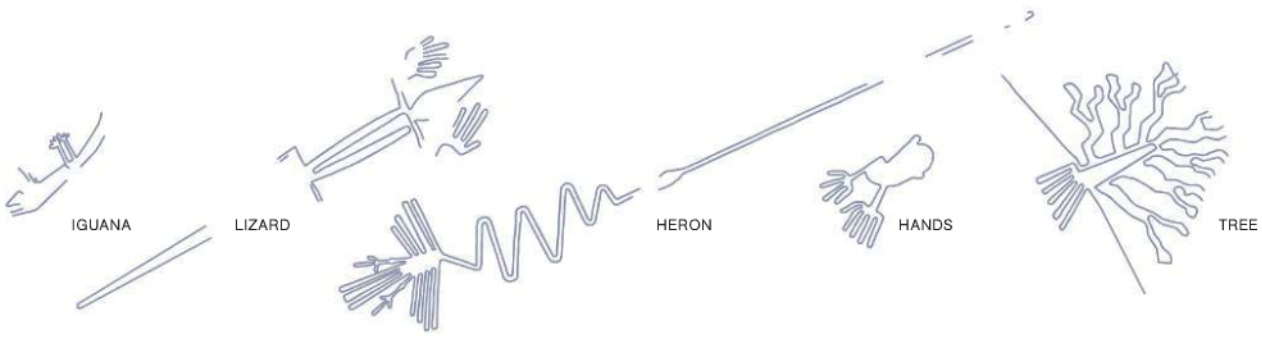
According to Eitel and his University of Heidelberg colleague Bertil Mächtle, the microclimate in the Nasca region has oscillated dramatically over the past 5,000 years. When a high-pressure system over central South America called the Bolivian High moves to the north, more rain falls on the western slopes of the Andes. When the high shifts southward, precipitation decreases, and the rivers in the Nasca valleys run dry.

Despite the risky conditions, the Nasca flourished for eight centuries. Around 200 B.C., the Nasca people emerged out of a previous culture known as the Paracas, settling along the river valleys and cultivating crops such as cotton, beans, tubers, lucuma (a fruit), and a short-eared form of corn. Renowned for their distinctive pottery, they invented a new technique of mixing about a dozen different mineral pigments in a thin wash of clay so that colors could be baked into the pottery. A famous ceramic tableau known as the Tello plaque—showing several Nasca strolling while blowing their panpipes, surrounded by dancing dogs—has been viewed as an iconic snapshot of a peaceful people whose rituals embraced music, dance, and sacred walks.

The theocratic capital of early Nasca times was a sand-swept mecca called Cahuachi. The site, first excavated in the 1950s by Columbia University archaeologist William Duncan Strong, is a vast, 370-acre complex featuring an imposing adobe pyramid, several large temples, broad plazas and platforms, and an intricate network of connecting staircases and corridors. In their 2003 book on Nasca irrigation systems, archaeologist Katharina Schreiber of the University of California, Santa Barbara, and Josué Lancho Rojas, a local schoolmaster and historian, point out that the Nasca River, which goes underground about nine miles to the east, resurfaces like a spring on the doorstep of Cahuachi. "The emergence of water at this point," they write, "was almost certainly regarded as sacred in prehistoric times."

"Cahuachi was a ceremonial center," says Giuseppe Orefici, an Italian archaeologist who has led the excavation for many years. "People came here from the mountains and from the coast, bringing offerings." Among the artifacts unearthed were dozens of severed heads, typically with a braided rope strung through a hole drilled in the forehead, perhaps to allow the skull to be worn around the waist.

Elsewhere in the Nasca realm, people moved east or west along the river valleys as rainfall patterns shifted. The Peru-German archaeological initiative has explored the region from the



Beneath the guiding hand of archaeologist Alberto Urbano, a snaking path traces an enigmatic figure that was meant to be walked on, as apparently were all the Nasca lines. At a distance (top right) Urbano paces the width of a trapezoid that cuts through the continuous swirls.

Pacific coast to altitudes of nearly 15,000 feet in the Andean highlands. Almost everywhere they have looked they have found evidence of Nasca villages—"like pearls in the valley margins," says Reindel. "And near every settlement we find geoglyphs."

THE PARCHED DESERT and hillsides made an inviting canvas: By simply removing a layer of dark stones cluttering the ground, exposing the lighter sand beneath, the Nasca created markings that have endured for centuries in the dry climate. Archaeologists believe both the construction and maintenance of the lines were communal activities—"like building a cathedral," says Reindel.

In the hyperarid southern valleys, early Nasca engineers may have also devised a more practical way of coping with the scarcity of water. An ingenious system of horizontal wells, tapping into the sloping water table as it descends from the Andean foothills, allowed settlements to bring subterranean water to the surface. Known as *puquios,* these irrigation systems still water the southern valleys.

Perhaps because of the adversity they faced, the Nasca people seem to have been remarkably "green." The creation of the puquios displayed a sophisticated sense of water conservation, since the underground aqueducts minimized evaporation. The farmers planted seeds by making a single hole in the ground rather than plowing, thus preserving the substructure of the soil. During a visit to a Nasca site called La Muña, Isla pointed out layers of vegetative matter in the walls of buildings and terraces that marked the rocky hillside settlement. The Nasca, he said, recycled their garbage as building material. "It's a society that managed its resources very well," he said. "This is what Nasca is all about."

Constructing the Geoglyphs

LINEAR (Based on evidence from unfinished geoglyphs)

1 The design is marked off with large stones. The surface layer of dark rock is removed to define the border.

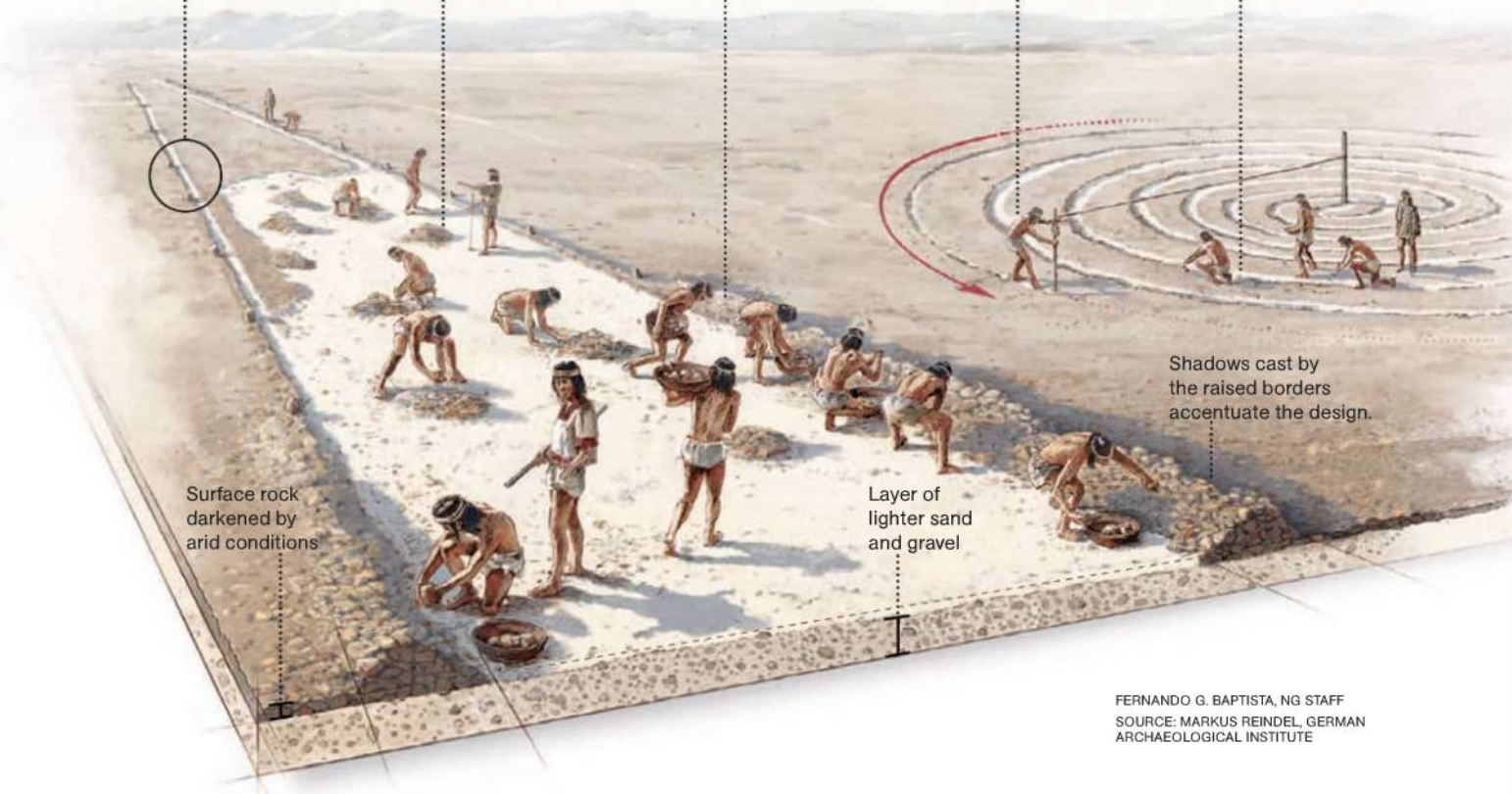
2 The interior is cleared of dark rocks, which are collected in mounds.

3 The mounds of surface rocks are distributed along the border to form an elevated edge.

SPIRAL (Archaeologists' theory)

1 A rope wrapped around a handheld stick and tied to a center pole is incrementally let out to etch a widening spiral.

2 A second spiral is traced within the first. Rocks on the edge of each track are cleared to reveal lighter ground.



FERNANDO G. BAPTISTA, NG STAFF

SOURCE: MARKUS REINDEL, GERMAN ARCHAEOLOGICAL INSTITUTE

Staring out from a hillside, a hundred-foot-tall, owl-eyed figure may have been made by the Paracas people, who occupied the region before the Nasca. Floodwater from monsoonal rains later scoured away the rust-colored rock of the surrounding terrain and carved channels in the underlying sand.

A revered *huarango* tree sprouts above a human face on this jar from La Tiza. Found in a tomb beside a decapitated body, the vessel may have served as a proxy for a head severed in a sacrifice. Near Cerro Blanco a desiccated huarango (right) stands as a reminder of the groves that once offered cooling shade. Some scientists now believe the Nasca made the land drier by clearing it for farming.

TO MOST PEOPLE TODAY, Nasca is all about the lines. But although the Nasca were certainly the most prolific makers of geoglyphs, they were not the first. On a hillside abutting a plateau south of Palpa sprawl three stylized human figures, with buggy eyes and bizarre rays of hair, that date to at least 2,400 years ago—earlier than almost any textbook date for the start of the Nasca civilization. Reindel's group has attributed no fewer than 75 groups of geoglyphs in the Palpa area to the earlier Paracas culture. These Paracas geoglyphs, which often depict stylized humanlike figures, in turn share distinct visual motifs with even earlier images carved in stone, known as petroglyphs. During a recent foot survey of a suspected Paracas site high in the Palpa River Valley, Isla came across a petroglyph of a monkey—a surprising, earlier incarnation of the famous Nasca geoglyph he had pointed out to me on the pampa below our plane.

Stephen Hall's latest book, Wisdom: From Philosophy to Neuroscience, *is due out this month from Knopf. Robert Clark is a frequent contributor.*

These new findings make an important point about the Nasca lines: They were not made at one time, in one place, for one purpose. Many have been superimposed on older ones, with erasures and overwritings complicating their interpretation; archaeologist Helaine Silverman once likened them to the scribbling on a blackboard at the end of a busy day at school. The popular notion that they can be seen only from the air is a modern myth. The early Paracas-era geoglyphs were placed on hillsides where they could be seen from the pampa. By early Nasca times the images—less anthropomorphic, more naturalistic—had migrated from the nearby slopes to the floor of the pampa. Almost all of these iconic animal figures, such as the spider and the hummingbird, were single-line drawings; a person could step into them at one point and exit at another without ever crossing a line, suggesting to archaeologists that at some point in early Nasca times the lines evolved from mere images to pathways for ceremonial processions. Later, possibly in response to explosive population growth documented by the German-Peruvian

team, more people may have participated in these rituals, and the geoglyphs took on open, geometrical patterns, with some trapezoids stretching more than 2,000 feet. "Our idea," Reindel says, "is that they weren't meant as images to be seen anymore, but stages to be walked upon, to be used for religious ceremonies."

Those ancient acts of worship have left their traces in the ground itself. Between 2003 and 2007 Tomasz Gorka and Jörg Fassbinder, geophysicists at the Bavarian State Department of Monuments and Sites, took measurements of the Earth's magnetic field on a trapezoid near Yunama, a village outside Palpa, and on other lines nearby. Subtle perturbations in the magnetic signal indicated that the soil had been compacted by human activity, especially around the platforms. Karsten Lambers, another member of the Nasca-Palpa Project, had meanwhile collected positional data and precise measurements of sight lines across hundreds of geoglyphs. The data showed that the trapezoids and other geometric shapes were constructed where they would be visible from a number of vantage points. The team concluded that they were places where "social groups acted and interacted, and spectators in the valleys and on other geoglyph sites were able to watch and observe."

CERRO BLANCO, among the tallest sand dunes in the world, rises pale and stark out of the surrounding bowl of sere Andean foothills, dominating the physical and spiritual landscape of the southern Nasca valleys. For centuries the Andean people have worshipped deities embodied in mountains such as Cerro Blanco. According to Johan Reinhard, a National Geographic explorer-in-residence, the mountains have traditionally been associated—mythologically, if not geologically—with water sources. The Nasca potsherds littering the path to the summit of Cerro Blanco would suggest the connection runs deep into the past.

In 1986 Reinhard reported finding ruins of a ceremonial stone circle at the summit of Illakata, at over 14,000 feet one of the tallest mountains feeding runoff to the Nasca drainage system. Along with other traces of ritual activity

The Faith of Farmers

The Nasca lines once framed solemn rituals celebrated to secure a good harvest. In this artist's interpretation, participants have left offerings at stone platforms at one end of a trapezoid and are moving in procession toward a platform at the other end. Musicians playing clay panpipes and flutes accompany the ceremony, while one worshipper appeals to the heavens

ART: JON FOSTER

by smashing a pot on the trapezoid's stone border. Offerings might include beans, golden-fleshed lucuma fruits, and other gifts for the gods. Most precious are the distinctive spiky shells of *Spondylus.* This warm-water mollusk would have appeared as far south as Peru only during El Niño weather patterns, which delivered an abundance of desperately needed rain.

at the top of Nasca watersheds, the discovery led him to propose that one of the main purposes of the Nasca lines was related to the worship of mountain deities, including Cerro Blanco, because of their connection to water.

Recent research has bolstered the hypothesis. In the highlands farther north, where wild vicuñas wander near the headwaters of the Palpa River, I joined Reindel and his team on a scramble to the top of a sacred mountain known locally as Apu Llamoca. (In the indigenous language, *apu* is the word for "deity.") At the summit of this dark volcanic dike, Reindel showed me a worship circle with ceramic potsherds the team had found in 2008 and nearby, a semicircular structure almost exactly like the one Reinhard had reported finding on Illakata.

For the Nasca-Palpa Project researchers, however, the real epiphany connecting Nasca sacred rituals to water worship occurred in 2000, on the trapezoid that dominates the desolate plateau near the village of Yunama. The archaeologists had frequently noticed large, man-made mounds of stones at the end of such trapezoids, which they suspected were ceremonial altars. As Reindel excavated his way through one mound, uncovering smashed potsherds, crayfish shells, vegetable remains, and other relics that clearly represented ritual offerings, he came upon fragments of a large seashell of the genus *Spondylus,* distinctive for its creamy, coral-like hues and spiky outer surface. It appears in the coastal waters off northern Peru only during El Niño events and is thus associated with the arrival of rainfall and agricultural fertility.

"The *Spondylus* shell is one of the few items of Andean archaeology that has been well studied," Reindel says. "It's a very important religious symbol for water and fertility. Like incense in the Old World, it was brought from far away and is found in specific contexts, such as funerary objects and on these platforms. It was connected in certain activities to praying for water. And it's clear," he adds, "in this area, water was the key issue."

Society Grant Some of this research was funded by your National Geographic Society membership.

Stones found in a ceremonial site at Cahuachi (above) were used to grind pigments for painting the great pyramid. After this religious center fell, for reasons still debated by experts, the Nasca began to build wells (left) to tap deep aquifers flush with mountain rainwater.

ULTIMATELY, ALL THOSE offerings and prayers went unanswered.

In 2004, at a site called La Tiza in the southern Nasca region, overlooking the dry Aja River, archaeologist Christina Conlee made a grim discovery while excavating a Nasca tomb. The first part of the skeleton to emerge from the dirt was not the skull, but the neck bones. "We could see the vertebrae sitting on top," Conlee told me. "The person was seated, with arms crossed and legs crossed, and no head."

Cut marks on the protruding neck bones probably indicate the head had been severed by a sharp obsidian knife. Underscoring the point, a ceramic pot known as a head jar rested against the elbow of the skeleton; it depicted a typically decapitated "trophy head," out of which grew an eerie, Halloween-like tree trunk with eyes. According to Donald Proulx, an expert on Nasca pottery and professor emeritus at the University of Massachusetts Amherst, the style of the jar suggests a tentative date of A.D. 325 to 450.

Everything about the burial—the posture of the skeleton, the head jar, and the posture of the body—indicates a deliberate, respectful interment. "You're not going to do that with your enemy," said Conlee, a researcher at Texas State University. Isotope analysis of the young man's bones make clear that he had lived in the immediate vicinity and was thus a local person rather than a foreign enemy captured in war. Conlee suspects the skeleton represents a ritual sacrifice. "Although we find trophy heads spread throughout the Nasca period," she said, "there are some indications that they became more common in the middle and late period, and also at times of great environmental stress, perhaps drought. If this was a sacrifice, it was made to appease the gods,

Ripped from its tomb, a skull bears witness to the damage looters did to a cemetery at Tunga while searching for gold, textiles, and intact pottery. Such illegal excavations, rampant in Peru, destroy evidence that could help explain lingering mysteries about the Nasca culture.

perhaps because of a drought or crop failure."

There is little question that water—or more precisely, its absence—had assumed paramount importance by the endgame of the Nasca culture, roughly between A.D. 500 and 600. In the Palpa area, geophysicists have traced the creep of the eastern margin of the desert about 12 miles up the valleys between 200 B.C. and A.D. 600, reaching an altitude of some 6,500 feet. Similarly, the population centers in the river oases around Palpa moved farther up the valleys, as if they were trying to outrun the arid conditions. "At the end of the sixth century A.D.," Eitel and Mächtle conclude in a recent paper, "the aridity culminated and the Nasca society collapsed." By A.D. 650, the more militaristic Wari (Huari) Empire, which expanded from its base in the central highlands, had supplanted the Nasca in the southern desert region.

"It wasn't just climate conditions that caused the collapse of the early Nasca culture at Cahuachi, and we can say the same thing for the end of Nasca culture in general," Johny Isla told me. "A state of crisis was provoked because water was more prevalent in some valleys than in others, and the leaders of different valleys may have been in conflict."

THE LEGACY OF THE NASCA lives on in the lines, of course, and although most people come to admire them from the air, what I'd seen and heard convinced me that you can't truly understand the geoglyphs unless you experience them at ground level. In one conversation, Isla had described to me the sensation of walking upon those sacred paths. "You can *feel* it," he said. Curious about that feeling, I asked him if we could walk several lines on the Cresta de Sacramento, a small ridge north of the town of Palpa.

We met at dawn on a winter morning in August, with fog streaming through the valley below us and the sun still trapped behind the Andean foothills to the east. As we picked our way across a large trapezoid on the floor of the desert plateau, Isla cautioned me to walk carefully and tended to the sacred landscape like a groundskeeper, tamping disturbed stones back into place as if they were golf divots. After several

The sacred symbols of the Nasca reverberate through their material culture. Adorning the border of a ceremonial shawl from Cahuachi, long-haired heads mimic real sacrificial heads. Spiders on a pot, echoed in the geoglyph on page 56, may have been symbols of agricultural bounty. Emerging before a rain, such creatures would have been welcome harbingers of an event that was crucial to survival.

minutes of an odd tiptoeing hike, we found ourselves standing in the lanes of an ancient spiral—another common form of Nasca geoglyph.

As we walked around the path of the spiral, my feet naturally drew me face-to-face with every point in the compass of the surroundings: the Palpa Valley to the south, the coastal mountains to the west, the local "sacred mountain" (Cerro Pinchango) to the north, and to the east, the foothills of the Andes, with their godlike power to feed the fragile rivers that curl through the Nasca drainage, watering the seeds of civilization sown in this otherwise arid environment. If I had stepped into the vortex of this curving itinerary in ancient times, I would also have been compelled to face my fellow worshippers walking the same path. Such a Nasca prayer walk, I realized, would have reinforced both sacred and social relationships.

"Look!" Isla suddenly exclaimed. The sun had risen above the foothills, and the slanting morning light was projecting our long shadows across the geoglyph. The spiral fairly hovered above the landscape, its boundaries of piled rock etched in sharp relief.

As my footsteps continued around the curves of the spiral, it occurred to me that one of the most important functions of the "mysterious" Nasca lines is no mystery at all. The geoglyphs surely provided a kinetic, ritualistic reminder to the Nasca people that their fate was tied to their environment—its natural beauty, its ephemeral abundance, and its life-threatening austerity. You can read their reverence for nature, in times of plenty and in times of desperate want, in every line and curve they scratched onto the desert floor. When your feet inhabit their sacred space, even for a brief and humbling moment, you *can* feel it. ☐

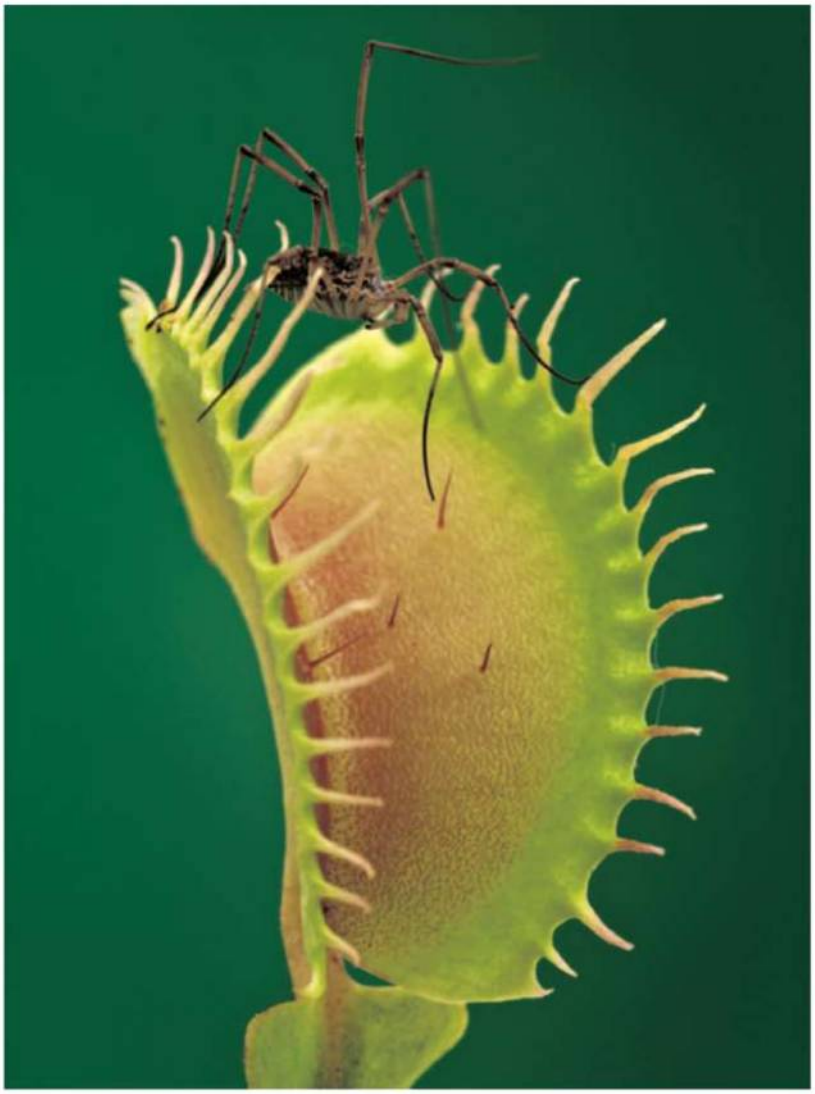
SOLVING THE ENIGMA

Severed human heads. Mysterious figures etched in the desert sand. Follow archaeologists as they probe the connection on the **National Geographic Channel, February 21 at 8 p.m. ET in the U.S.**

Bring the lines to life in an interactive map at **ngm.com/nasca.**

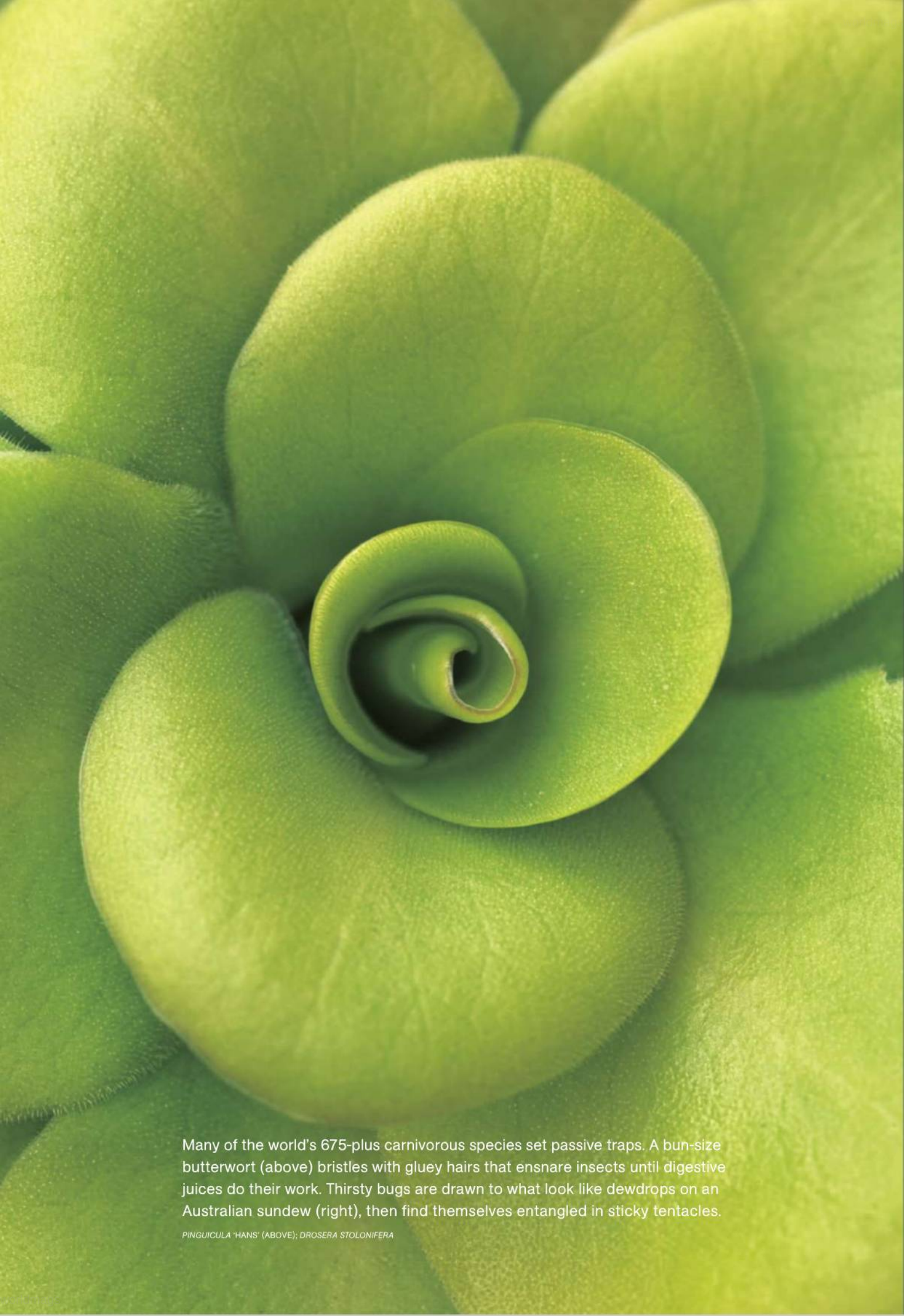
FATAL ATTRACTION

They lure insects into death traps, then gorge on their flesh. Is that any way for a plant to behave?



Carnivorous plants deceive, then kill. A Venus flytrap (above) snaps shut if its tiny hairs are brushed twice. A tropical pitcher plant (right) smells sweet to bugs, but its slippery surfaces tumble victims into its open maw.

 DIONAEA MUSCIPULA (ABOVE); *NEPENTHES LOWII*



Many of the world's 675-plus carnivorous species set passive traps. A bun-size butterwort (above) bristles with gluey hairs that ensnare insects until digestive juices do their work. Thirsty bugs are drawn to what look like dewdrops on an Australian sundew (right), then find themselves entangled in sticky tentacles.

PINGUICULA 'HANS' (ABOVE); *DROSERA STOLONIFERA*

By Carl Zimmer

Photographs by Helene Schmitz

A hungry fly darts through the pines in North Carolina. Drawn by what seems like the scent of nectar from a flowerlike patch of scarlet on the ground, the fly lands on the fleshy pad of a ruddy leaf. It takes a sip of the sweet liquid oozing from the leaf, brushing a leg against one tiny hair on its surface, then another. Suddenly the fly's world has walls around it. The two sides of the leaf are closing against each other, spines along its edges interlocking like the teeth of a jaw trap. As the fly struggles to escape, the trap squeezes shut. Now, instead of offering sweet nectar, the leaf unleashes enzymes that eat away at the fly's innards, gradually turning them into goo. The fly has suffered the ultimate indignity for an animal: It has been killed by a plant.

THE SWAMPY PINE savanna within a 90-mile radius of Wilmington, North Carolina, is the one place on the planet where Venus flytraps are native. It is also home to a number of other species of carnivorous plants, less famous and more widespread but no less bizarre. You can find pitcher plants with leaves like champagne flutes, into which insects (and sometimes larger animals) lose themselves and die. Sundews envelop their victims in an embrace of sticky tentacles. In ponds and streams grow bladderworts, which slurp up their prey like underwater vacuum cleaners.

There is something wonderfully unsettling about a plant that feasts on animals. Perhaps it is the way it shatters all expectation. Carl Linnaeus, the great 18th-century Swedish naturalist who devised our system for ordering life, rebelled at the idea. For Venus flytraps to actually eat insects, he declared, would go "against the order of nature as willed by God." The plants only catch insects by accident, he reasoned, and once a hapless bug stopped struggling, the plant would surely open its leaves and let it go free.

Charles Darwin knew better, and the topsy-turvy ways of carnivorous plants enthralled him. In 1860, soon after he encountered his first carnivorous plant—the sundew *Drosera*—on an English heath, the author of *Origin of Species* wrote, "I care more about Drosera than the origin of all the species in the world." He spent months running experiments on the plants. He dropped flies on their leaves and watched them slowly fold their sticky tentacles over their prey. He excited them with bits of raw meat and egg yolk. He marveled how the weight of just a human hair was enough to initiate a response. "It appears to me that hardly any more remarkable fact than this has been observed in the vegetable kingdom," he wrote. Yet sundews ignored water drops, even those falling from a great height. To react to the false alarm of a rain shower, he reasoned, would obviously be a "great evil" to the plant. This was no accident. This was adaptation.

Darwin expanded his studies from sundews to other species, eventually recording his observations and experiments in 1875 in a book, *Insectivorous Plants.* He marveled at the exquisite quickness and power of the Venus flytrap, a plant he called "one of the most wonderful in the world." He showed that when a leaf snapped shut, it formed itself into "a temporary cup or stomach," secreting enzymes that could dissolve the prey. He noted that a leaf took more than a week to reopen after closing and reasoned that the interlocking spines along the margin of the leaf allowed undersized insects to escape, saving the plant the expense of digesting an insufficient meal. Darwin likened the hair-trigger speed of the Venus trap's movement—it snaps shut in about a tenth of a second—to the muscle contraction of animals. But plants don't

PLANTS AND INSECTS ARRANGED AND PHOTOGRAPHED AT PALMENGARTEN FRANKFURT; BOTANIC GARDENS, UNIVERSITY OF BONN; AND GÖTEBORG BOTANICAL GARDEN, SWEDEN

Like figures in a shadow theater, silhouettes of prey show through a Philippine pitcher plant. The waxy surface in the red tube stops bugs from climbing free. Below, enzymes leach nutrients from trapped insects.

NEPENTHES ALATA

have muscles and nerves. So how could they react like animals?

Today biologists using 21st-century tools to study cells and DNA are beginning to understand how these plants hunt, eat, and digest—and how these bizarre adaptations arose in the first place. After years of study, Alexander Volkov, a plant physiologist at Oakwood University in Alabama, believes he has figured out the Venus flytrap's secret. "This," Volkov declares, "is an electrical plant."

When an insect brushes against a hair on the leaf of a Venus flytrap, the bending triggers a tiny electric charge. The charge builds up inside the tissue of the leaf but is not enough to stimulate the snap, which keeps the Venus flytrap from reacting to false alarms like raindrops. A moving insect, however, is likely to brush a second hair, adding enough charge to trigger the leaf to close.

Volkov's experiments reveal that the charge travels down fluid-filled tunnels in a leaf, which opens up pores in cell membranes. Water surges from the cells on the inside of the leaf to those on the outside, causing the leaf to rapidly flip in shape from convex to concave, like a soft contact lens. As the leaves flip, they snap together, trapping an insect inside.

The bladderwort has an equally sophisticated way of setting its underwater trap. It pumps water out of tiny bladders, lowering the pressure inside. When a water flea or some other small creature swims past, it bends trigger hairs on the bladder, causing a flap to open. The low pressure sucks water in, carrying the animal along with it. In one five-hundredth of a second, the door swings shut again. The cells in the bladder then begin to pump water out again, creating a new vacuum.

Many other species of carnivorous plants act like living flypaper, snagging animals on sticky tentacles. Pitcher plants use yet another strategy, growing long tube-shaped leaves into which insects fall. Some of the largest have pitchers up

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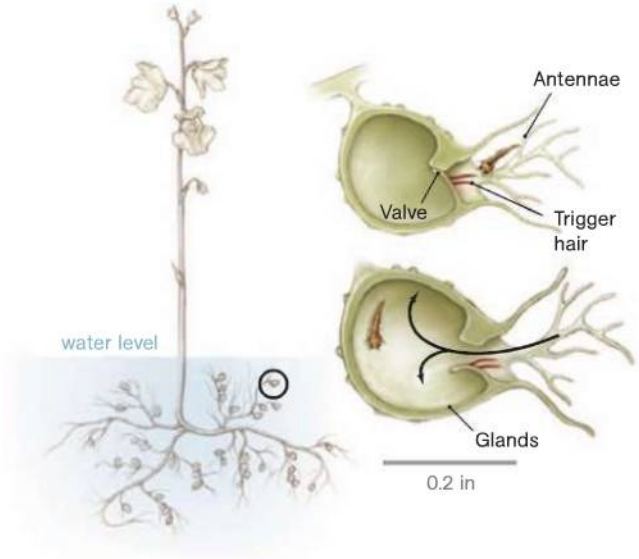
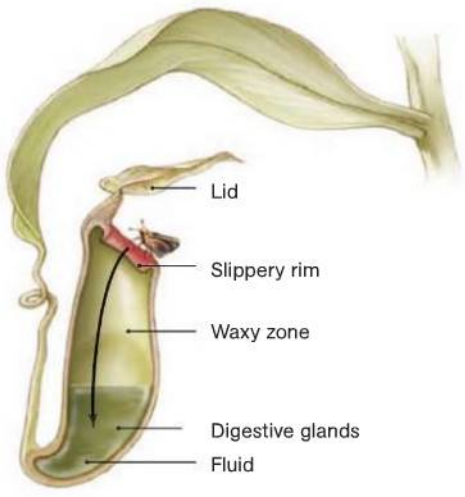
Carl Zimmer's most recent book is The Tangled Bank: An Introduction to Evolution. *Swedish photographer Helene Schmitz shot less assertive plants for a* National Geographic *story on Carl Linnaeus in June 2007.*



Suction Traps Bladderwort *(Utricularia)*

Antennae on the bladders of the aquatic plant guide tiny prey toward the trap. Touching the trigger hairs springs open a valve—and lower water pressure inside sucks in prey. Glands absorb nutrients and expel water.



Pitfall Traps Tropical pitcher plant *(Nepenthes)*

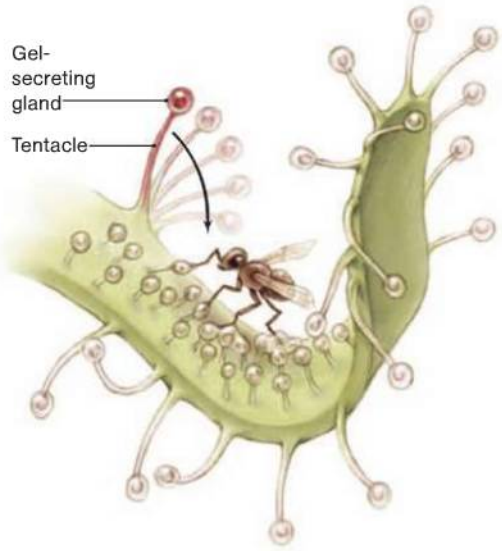
Nectar secreted on the lid and slippery rim draws insects and spiders. Losing their foothold, prey find no traction in the waxy zone and drown in a pool of digestive juices.

ART: JENNY WANG

to a foot deep and can consume a whole frog or even a rat unlucky enough to fall into them. Sophisticated chemistry helps make the pitcher a death trap. *Nepenthes rafflesiana,* a pitcher plant that grows in jungles on Borneo, produces nectar that both lures insects and forms a slick surface on which they can't get a grip. Insects that land on the rim of the pitcher hydroplane on the liquid and tumble in. The digestive fluid in which they fall has very different properties. Rather than being slippery, it's gooey. If a fly tries to lift its leg up into the air to escape, the fluid holds on tenaciously, like a rubber band.

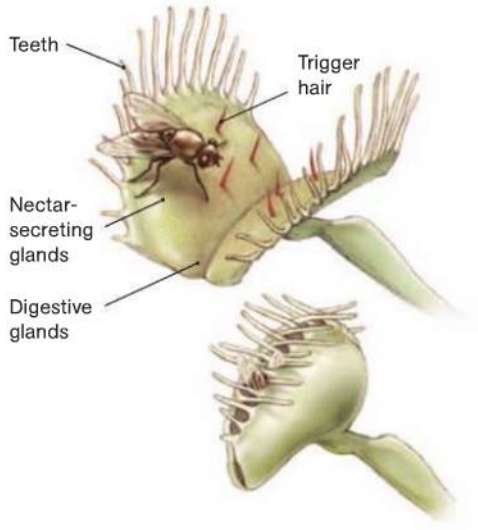
Many carnivorous plants have special glands that secrete enzymes powerful enough to penetrate the hard exoskeleton of insects so they can absorb nutrients from inside their prey. But the purple pitcher plant, which lives in bogs and infertile sandy soils in much of North America, enlists other organisms to digest its food. It is home to an intricate food web of mosquito larvae, midges, protozoans, and bacteria, many of which can survive only in this unique habitat. The animals shred the prey that fall into the pitcher, and the smaller organisms feed on the debris. Finally, the pitcher plant absorbs the nutrients released by the feeding frenzy. "Having the animals creates a processing chain that speeds up all the reactions," says Nicholas Gotelli of the University of Vermont. "And then the plant dumps oxygen back into the pitcher for the insects. It's a tight feedback loop."

PITCHER PLANTS GROW by the thousands in the bogs at the Harvard Forest in central Massachusetts. One late spring day Aaron Ellison took me on a tour, stopping from time to time to watch patiently as I pulled a sinking leg out of the muck. "You haven't had a real bog experience till you're up to your crotch in it," said Ellison, a senior ecologist at the forest. Little orange flags fluttered across the bogs. Each one marked a pitcher plant impressed into the service of science. In the distance a student was feeding flies to the flagged plants. The researchers raise these insects on food spiked with unusual forms of carbon and nitrogen so they can later harvest the pitcher plants and measure how much of



Sticky Traps Sundew *(Drosera)*

Tentacles sparkling with sticky gel arm more than 180 sundew species. The struggle of stuck prey stimulates other tentacles to bend toward the captive, coating it with enzymes that digest it.



Snap Traps Venus flytrap *(Dionaea)*

The trap closes in a tenth of a second when prey hit at least two trigger hairs—or one hair twice. Teeth form a cage to block escape. The trap slowly tightens, releases digestive fluids, then reopens in about ten days.

each element from the flies has been absorbed into the plants. Because pitcher plants grow slowly (they can live for decades), the experiments can take years to yield results.

Ellison and Gotelli are trying to figure out what evolutionary forces pushed these plants toward a taste for meat. Carnivorous plants clearly benefit from eating animals; when the scientists feed pitcher plants extra bugs, the plants get bigger. But the benefits of eating flesh are not the ones you might expect. Carnivorous animals like ourselves use the carbon in protein and the fat in meat to build muscles and store energy. Carnivorous plants instead draw nitrogen, phosphorus, and other critical nutrients from their prey in order to build light-harvesting enzymes. Eating animals, in other words, lets carnivorous plants do what all plants do: grow by grabbing energy directly from the sun.

Alas, they do a lousy job of it. Carnivorous plants turn out to be very inefficient at converting sunlight into tissue. That's because they have to use a lot of energy to make the equipment they need to catch animals—the enzymes, the pumps, the sticky tentacles, and so on. A pitcher or a flytrap cannot carry out much photosynthesis because, unlike plants with ordinary leaves, they do not have flat solar panels that can grab lots of sunlight. Ellison and Gotelli suspect that only under special conditions do the benefits of carnivory outweigh the costs. The poor soil of bogs, for example, offers little nitrogen and phosphorus, so carnivorous plants enjoy an advantage there over plants that obtain these nutrients by more conventional means. Bogs are also flooded with sunshine, so even an inefficient carnivorous plant can carry out enough photosynthesis to survive. "They're stuck, and they're making the best of it," says Ellison.

Evolution has repeatedly made this trade-off. By comparing the DNA of carnivorous plants with other species, scientists have found that they evolved independently on at least six separate occasions. Some carnivorous plants that look nearly identical turn out to be distantly related. Both kinds of pitcher plants—the tropical genus *Nepenthes* and the North American *Sarracenia*—grow deep pitcher-shaped leaves and employ the same strategy for capturing prey. Yet they evolved from different ancestors.

In several cases scientists can see how complex carnivorous plants evolved from simpler ones. Venus flytraps, for example, share an ancestor with Portuguese sundews, which only make passive flypaper glands on their stems. They share a more recent ancestor with *Drosera* sundews, which not only make flypaper glands but can also curl their leaves over their prey. Venus flytraps appear to have evolved an even more elaborate version of this kind of trap, complete with jawlike leaves.

UNFORTUNATELY, THE ADAPTATIONS that enable carnivorous plants to thrive in marginal habitats also make them exquisitely sensitive to environmental changes. Agricultural runoff and pollution from power plants are adding extra nitrogen to many bogs in North America. Carnivorous plants are so finely tuned to low levels of nitrogen that this extra fertilizer is overloading their systems. "They eventually burn themselves out," says Ellison.

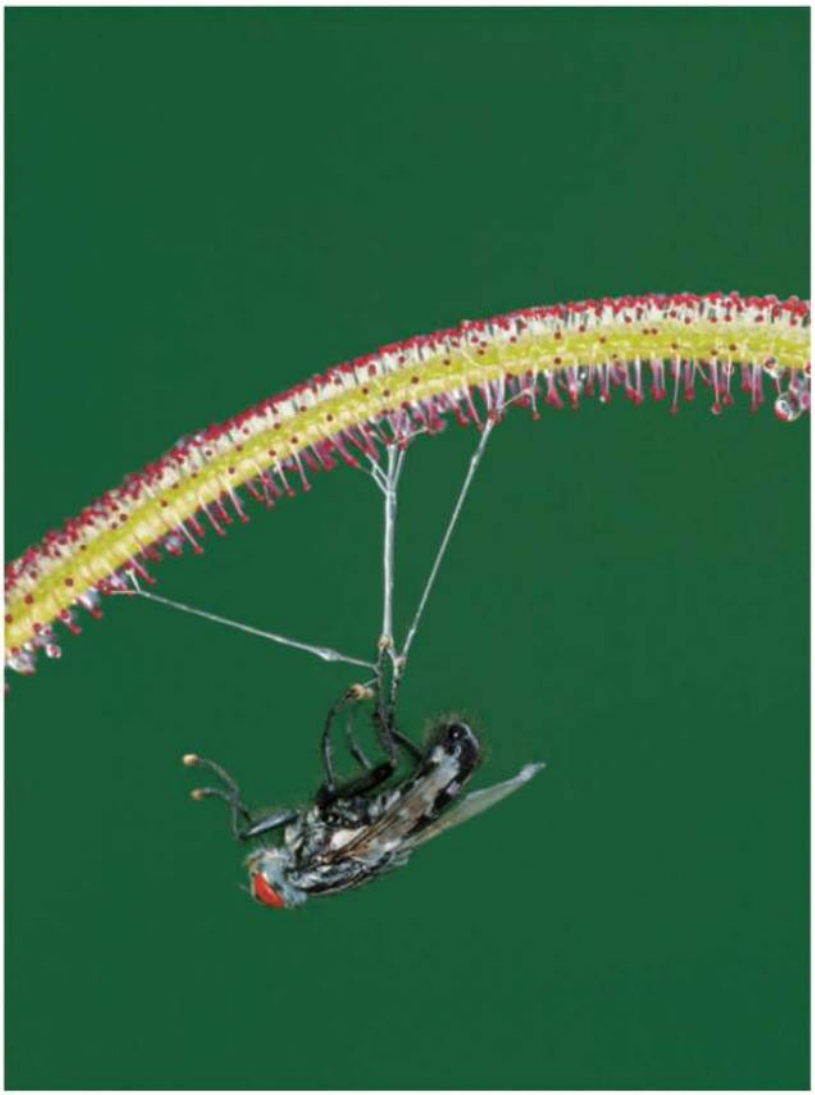
Humans also threaten carnivorous plants in other ways. The black market trade in exotic carnivorous plants is so vigorous now that botanists are keeping the location of some rare species a secret. Venus flytraps are being poached from North Carolina by the thousands to be sold at roadside stands. The North Carolina Department of Agriculture has been dabbing wild Venus flytraps with harmless dye that's normally invisible but glows in UV light so that inspectors who come across Venus flytraps for sale can quickly determine if the plants were raised in a greenhouse or poached from the wild. But even if the poaching of carnivorous plants can be halted (a very big if), they will continue to suffer from other assaults. Their habitat is disappearing, to be replaced by shopping centers and houses. Fires are being suppressed, allowing other plants to grow quickly and outcompete the Venus flytraps. Good news, perhaps, for flies. But a loss for all who delight in the sheer inventiveness of evolution. □

Sensing food, a roach peers into a two-foot-tall pitcher plant. Carnivorous species photosynthesize like other plants, but most live in bogs and other nutrient-poor habitats. Enriching their diets with nitrogen captured from animals helps them thrive.

SARRACENIA FLAVA

Most carnivorous plants eat some insects for supper but need others to help them reproduce. To avoid capturing and consuming prospective pollinators, pitcher plants keep their flowers (left) far away from their traps via long stalks. Blooms hang upside down like Chinese lanterns, luring bees into an elaborate pollen chamber. Some carnivorous species, such as this budding sundew (right), can self-pollinate if no insect emissary can be enlisted.

SARRACENIA HYBRID (TOP LEFT); *SARRACENIA FLAVA* (BOTTOM LEFT); *DROSERA* SP.



Largest of its kind, the South African king sundew unfurls (right). Leaves of this florid species can reach two feet in length. Yet size doesn't ensure success. If a gluey tentacle grabs too little of a big fly (left), the bug may suffer injury but still struggle to freedom. In the realm of carnivorous plants, says William McLaughlin, curator at the United States Botanic Garden, "some insects aren't digested but are still victimized."

DROSERA REGIA (BOTH)

The thimble-size west Australian pitcher plant (left) has a taste for insects that crawl. Its guide hairs and cloying scent encourage ants to clamber into its digestive depths. A water-filled North American hybrid (right) tempts bees with the promise of nectar and a rim that looks like a prime landing pad. Carnivory is not the most efficient way for a plant to secure nutrients, but it is certainly among the most exotic.

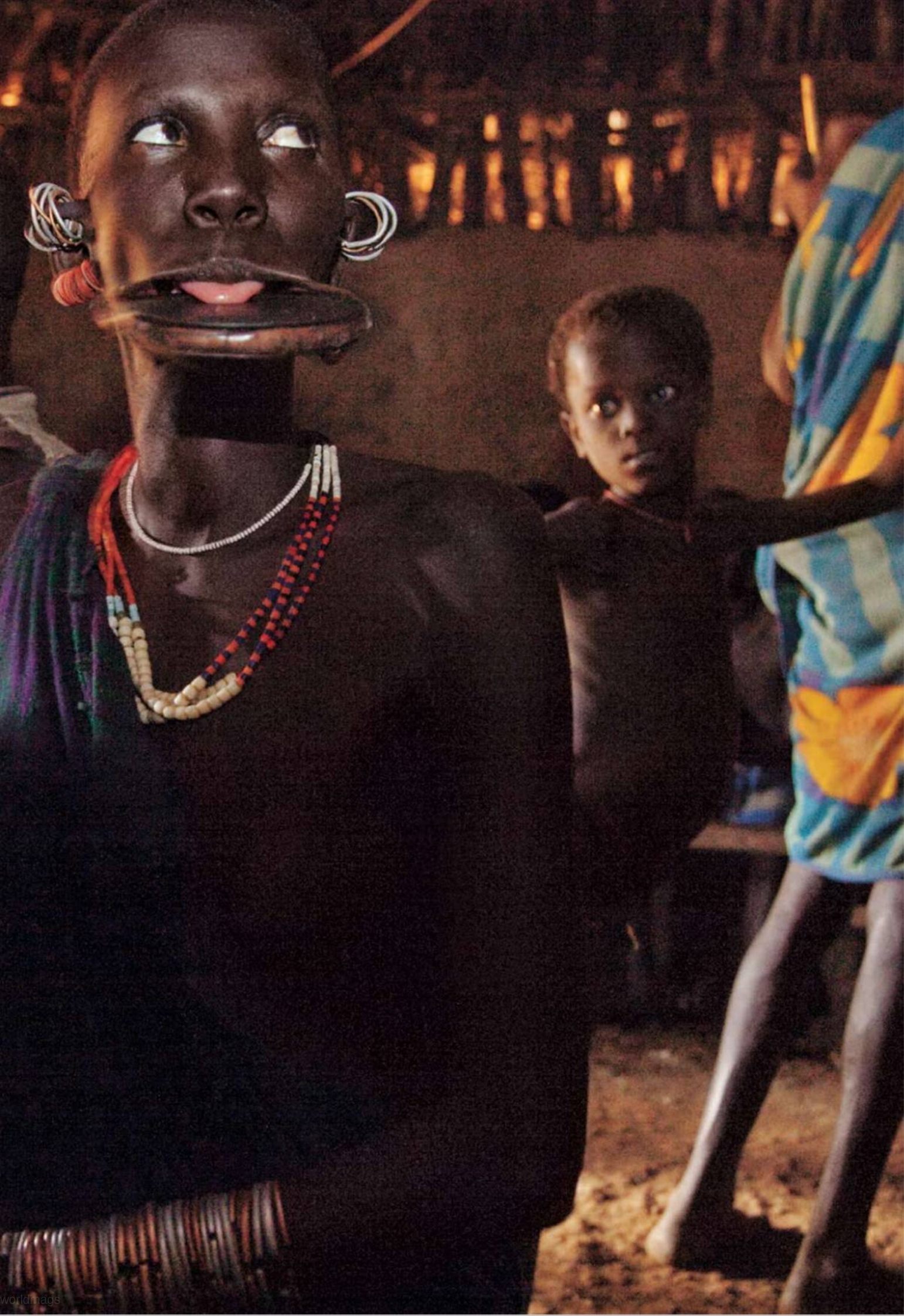
CEPHALOTUS FOLLICULARIS (LEFT); *SARRACENIA* HYBRID

An elder of the Kara tribe, his body decorated with crushed minerals, peers out over the Omo River at dusk. His people once controlled land on both sides of the river, but an enemy tribe has gradually encroached on their territory.

Africa's Last Frontier

Ethiopia's Omo Valley is still a place ruled by ritual and revenge. But change is coming, from upriver.

The bar is walled in mud, its floor a cement of spit, sweat, and old bottle caps. But for this Suri woman, drinking honey beer over her traditional clay lip plate, a frontier saloon offers novelty. As strong, cheap alcohol is trucked to areas where it was once scarce, excessive drinking has become a problem.



Boring through a mountain, workers finish a tunnel that will divert the Omo River so a massive hydro-electric dam called Gilgel Gibe III—one of the largest on Earth—can be built. The dam could generate up to 1,870 megawatts of power, which cash-starved Ethiopia plans to sell to its neighbors.

By Neil Shea

Photographs by Randy Olson

Dunga Nakuwa cups his face in his hands and remembers his mother's voice. She has been dead nearly two years, but for Dunga's tribe the dead are never very far away. In the villages they are buried just below the huts of the living, separated from hearths and sleeping skins by only a few feet of dry, depleted soil. They remain near in the mind too. This is why Dunga still hears his mother: When will you take revenge on your brother's killer?

When she was alive, she had occasionally asked this, each time giving the vendetta new life just as Dunga was trying to escape it. He had become the eldest son after his brother, Kornan, was killed by a member of an enemy tribe. It had been an ambush, a choreographed execution. The nature of it, so premeditated, only deepened the insult.

Dunga's father had also been killed by a warrior from the same tribe, and the duty of vengeance had fallen first on his older brother. But after Kornan was killed, the double weight fell to Dunga along paths of tradition worn as hard as the trails leading down to the river. Men from his tribe, the Kara, are renowned marksmen. They had resisted the invasions of the far larger and better armed tribe, the Nyangatom. In both tribes a man who kills an enemy is decorated with special scars dug into the flesh of his shoulder or abdomen. Faced with the murder of his kin, a man would demand vengeance.

And so, in his mother's question, Dunga hears another: When will you finally become a man?

Dunga is small, slender, not yet 30. His hands are soft from years spent reading books, not living in the bush. He wears a silver crucifix, a symbol of newly acquired beliefs. We sit in a small restaurant in a town several days' walk

Contact with tourists, missionaries, and merchants means Omo tribes now have increasing access to foreign goods—from clothing and weapons to nails and water pumps. On the morning before a local festival one young Kara woman debated whether to add a bra to her costume.

from his homeland, his face knotted against the memories. Knowing that I also have brothers, he asks, "What would you have done?" In the West revenge is left to courts. But in this corner of Ethiopia, there is little history of such institutions. There are only the demands of the dead.

DUNGA WAS BORN at Dus, a village of stick-and-grass huts set on a bluff high above the Omo River. From the central highlands the river flows wide and deep and fast toward the country's southwestern border, where it pours into Kenya's Lake Turkana. In its 500-mile course the river curls through gorges of volcanic rock and channels of ancient mud.

Near the Kenyan border the Omo carves serpentine oxbows as the countryside flattens, and ribbons of forest appear along its banks. Riverine creatures, including crocodiles and hippos, become more abundant. The landscape grows thick with tribes, including the Kara, Mursi, Hamar, Suri, Nyangatom, Kwegu, and Dassanech, a population of roughly 200,000. Herdsmen drive animals through the bush, and farmers pole upstream and downstream in lumpy canoes. Depending on the season, the riverbanks

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Neil Shea is a contributing writer for the magazine. Photographer Randy Olson documented Russia's Kamchatka Peninsula in the August 2009 issue.

are golden with the stubble of past harvests or sheathed in the moist green of new crops.

Dus lies three hours by truck from the nearest road, and in the wet season it is islanded in a sea of mud. Like many settlements along the Omo, the village is a cluster of huts with goat pens and grain cribs set at the periphery, everything sun bleached, everything washed in dust. Some days dust devils gather outside the village, pacing in the bush like malevolent spirits, spitting soil into the air.

Cattle and goats are a family's most meaningful possessions here, but it is the crops, nourished by the Omo River, that sustain the people of Dus and other villages. After the Omo's seasonal floods soak and replenish the riverbanks, Kara farmers pierce the dark mud with sticks and drop in seeds of sorghum or corn. It is simple, ancient, little different from what the Egyptians did along the Nile. If the floods are meager, the harvest is poor, but the system has kept the Kara here for a long time. The river's predictability allows the 2,000 or so Kara a life without the restless movement of some of their neighbors, who must constantly drive their animals to new pasture. The name of the village—Dus—means, roughly, "I have seen other places, but it is good here. I'll stay."

When I mention the dam, a crowd presses in. Some have heard of this thing. "What, exactly, is a dam?"

For generations the tribes of the Omo were shielded from the outside world by mountains, savanna, and by Ethiopia's unique status as the only African nation never to have been colonized by Europeans. In the late 1960s and '70s, anthropologists began recognizing what that meant—people living near the river had largely escaped the colonial blundering and conflict that shredded other societies. The tribes remained intact, migrating, warring, and making peace in ways that had vanished almost everywhere else. Hints of this Africa still appear in the ornamental clay lip plates worn as symbols of beauty by Mursi women or in the seasonal dueling contests of the Suri, who tie on armor made of goat hide and fight each other with long poles. There is still the Hamar ritual in which women demand to be whipped until they bleed, and there's the cattle-jumping initiation rite, in which boys run along the backs of cattle to prove they are ready for manhood.

Today the Omo Valley is a destination for wealthy tourists who cross vast, uncomfortable distances to witness those same rituals—vanloads of white faces, most from Europe, hoping for something of the Africa that exists in the Western imagination, all wild animals and face paint and dancing. Tourists say they have come to see the Omo before it becomes like everywhere else, as though a McDonald's might suddenly descend from the sky.

Yet it's true: The Omo region, still one of Africa's most intact cultural landscapes, is changing. The big game are mostly gone, hunted out with weapons that flow in from wars across the borders in Sudan or Somalia. Aid organizations deliver food, build schools, and plan irrigation projects, all of which make life more stable but inevitably, unstoppably, change the way it has long been lived. The government, which for generations essentially ignored this place, now works to modernize Omo tribes, and some officials speak as if timetables have been drawn up describing exactly when and how the old ways will be replaced. Not long before my visit, government representatives offered new incentives to tame the warring tribes and incorporate them into the nation. Blood feuds, like the one tugging at Dunga Nakuwa, are meant to be a thing of the past.

IT WAS THE CATTLE that betrayed Dunga's secret. When he disappeared, leaving his family's herd in the bush, the beasts circled around and grazed their way home, a cloud of dust rising behind them. At the village, Dunga's brother, Kornan, was surprised the animals were returning so soon—without Dunga.

This was in the late 1980s or early 1990s. Lions, leopards, and hyenas roamed the savanna. Elephants and buffalo occasionally came bulldozing out of the bush. Enemy tribes patrolled it too: The Nyangatom, the people who had killed the brothers' father, had been pushing into the area, armed with automatic rifles. Since their father's murder, Kornan had taken charge of family matters, but he wasn't worried about

Choking the Omo

The Omo River is a lifeline to indigenous tribes, a total population of 200,000 Ethiopians who depend on flood-recession agriculture to survive. The Gilgel Gibe III dam will generate electricity but also alter the river's natural cycles—threatening food production downstream. Dwindling resources could heighten tensions between local tribes.

Future Gilgel Gibe III Reservoir

Scheduled for completion by 2013, the Gilgel Gibe III dam could generate up to 1,870 megawatts of power and be one of the tallest dams in Africa. Additional dams are planned.

GILGEL GIBE III DAM

Omo

Mt. Smith
8,294 ft
2,528 m

Tulgit
Maji
DIZI
BODI
ETHIOPIA

During August and September flooding brings nutrient-rich silt to the valley. Just weeks after the floods, the river drops significantly, allowing tribes to plant sorghum and corn in the fertile mud.

Approximate area of flood-recession agriculture and fodder production

Mt. Mago
5,827 ft
1,776 m

KWEGU
SURI (SURMA)
Dirka Hills
Jinka
Lake Chamo

Mt. Dara
5,285 ft
1,611 m

Omo
MURSI (MUN)
Mago
NYANGATOM
KWEGU
Key Afer
BANNA
KARA
Kibish
Dus
Newly built roads pave the way for resource extraction—and more tourists.

AFRICA
Addis Ababa
ETHIOPIA
AREA ENLARGED
Konso

ILEMI TRIANGLE
Administered by Kenya, conflicting claims by Ethiopia and Sudan

Kangaten
Korcho
BASHADA
Dimeka
Omo
Buska Mts.

Mt. Nakua
2,992 ft
912 m

Turmi
HAMAR
5°N

Kelem
Omorate
DASSANECH

TURKANA
Boundary claimed by Sudan
KENYA
Namuruputh

Linguistic diversity
Tribes with linguistic affinities tend to have fewer conflicts, with a few exceptions.

Afro-Asiatic family
CUSHITIC *Dassanech*
OMOTIC *Banna, Bashada, Dizi, Hamar, Kara*

Nilo-Saharan family
EASTERN NILOTIC *Nyangatom, Turkana*
SURMIC *Bodi, Kwegu, Mursi, Suri*

Lake levels already lowered by climate change could drop another 23 to 33 feet once the dam's impact is felt, killing off fisheries on the brink of collapse.

Lake Turkana
KENYA

0 mi 10
0 km 10

37°E

MARTIN GAMACHE, NG STAFF

SOURCES: AFRICA RESOURCES WORKING GROUP; AFRICAN STUDIES CENTRE, UNIVERSITY OF OXFORD; ETHIOPIAN ELECTRIC POWER CORPORATION; *ETHNOLOGUE: LANGUAGES OF THE WORLD*; INTERNATIONAL RIVERS

Cattle and goats have pulverized the drought-prone Omo region into dust. The animals are prized symbols of wealth; in many tribes men cannot marry without paying large bride-prices of livestock.

A young Kara boy surveys the crowd at a wedding party, where guests of all ages are offered sorghum beer by the families of the betrothed. Celebrations depend on the season and resources—in times of plenty, festivities abound and can last several days.

Above fields of sorghum, girls chew sweet stalks after laying out seeds to dry. Annual flooding not only helps farmers grow food but also renews grazing lands for herders' livestock. A ten-day, artificial flood has been proposed to mimic the natural cycle once the dam is completed—a remedy critics say is inadequate.

his brother's safety. He had an idea where Dunga had gone, and he was furious.

The brothers had grown up as Kara boys do—chasing animals through the bush with bows and arrows. They pulled guard duty in the sorghum fields, slinging clay pellets at thieving birds. They learned to beware of crocodiles during the wet season, when the Omo runs high and dark with sediment. And they learned the foundation of male responsibility: care for the herds.

Along the Omo, cattle and goats embody wealth and prestige. Without them a man is considered poor and, in most tribes, cannot get married because he has nothing to offer as a bride-price. In time of famine the animals can be sold for food or their milk, and blood can be slowly siphoned off, like interest. Abandoning your cattle is like dumping your family's savings into the river.

Kornan selected a slender stick, then marched to the nearby schoolhouse and found Dunga there. The brothers were close, but this? Leaving the herd for school? Kornan beat Dunga until the boy wept. Some 15 years later Dunga tenses as he remembers the blows. The next morning, sore and chastened, Dunga led the cattle to water at dawn. But a few days later he ran away to school again. And Kornan beat him again.

"I loved Kornan," Dunga said. "He was a father for me, he was everything. But my mind was going to school."

The beatings hardened Dunga's resolve, but they seemed to soften Kornan's. He had been to school himself for a few years, and he eventually realized punishment wouldn't dissuade Dunga. They struck a deal. The boy could go to school as long as he achieved good grades. If his performance fell, he'd be back in the bush with the herd. Dunga was ecstatic. He advanced to a boarding school in a nearby town, each grade taking him deeper into a new world. He returned home less frequently.

Meanwhile, Kornan had become a respected young leader. He had a wife, several children, and a reputation as an unrivaled hunter. The wives of other men presented Kornan with bullets and

said, Take this and go hunting for me. They placed orders for meat or skins. But the task of avenging his father's murder still lay ahead. Relatives, friends, and elders urged him to set things right. You're a strong hunter, people said. When will you go after your father's killer?

THIS IS ONE WAY change is coming to the Omo: In the wilderness, amid swirling dust and the gnawing sounds of heavy machinery, a dam is being built 320 miles upriver from the Kara homeland. The construction site is enormous, with camps, bunkhouses, cookhouses, and winding service roads. The dam, called Gilgel Gibe III, will be one of the largest dams in the world. It will create an equally massive reservoir, and the water will be used to generate up to 1,870 megawatts of power that Ethiopia plans to sell to energy-strapped neighbors, such as Kenya and Sudan. It is not scheduled for completion until 2013, but contracts have already been signed.

Gibe III will bring cash to Ethiopia and produce much needed electricity in a country where only 33 percent of the population has electrical power. But it will also reduce the river's flow and tame the seasons of flood and recession that the tribes living downstream, such as the Kara, the Nyangatom, and others, rely on to nourish their crops. The indigenous tribes have little power to oppose a project that has official blessings and massive momentum. Many are unaware of the dam's potential to transform their lives; many others support the government, even if they do not fully understand its plans.

In Dunga's village each month around the new moon, near where the Omo River empties into Lake Turkana, the man who speaks to crocodiles descends in darkness to perform a short ceremony that protects his people from the massive creatures that cruise the Omo. He carries a bundle of leafy branches, dips them into the water, then shakes them upriver and downriver, while speaking with an authority not given by men.

"You, crocodiles! Listen! This place is mine, from my father, from my father's father. Stay away from here. Let my people and their herds come down to drink, and let the children swim. If you come close, my bullets will find you!"

He then lays the branches on the mud and steps down into the black water, joining its silt and its secrets, and he bathes.

The man has a special relationship with the ancient reptiles, as his father did before him. The ties between human clan and crocodile are strong and deep. The crocodiles even speak to him in his dreams.

"What do they tell you?" I ask.

"That is none of your business," he replies.

Whatever the crocodiles tell, they also listen, for as far back as collective memory reaches, no crocodile has taken a human below the village. A wave of nods from old men arranged in a circle around us on their wooden stools attest to this truth. "What about the pregnant woman who was killed last year?"

"Well. She didn't listen." The man waves his hand downriver. "She was killed over there. I do not protect that place."

The elders nod, the caveat is plain. The woman had strayed onto someone else's property.

I ask the king why, if he can summon rain, he has not done it earlier to avoid the looming drought.

I ask the man about Gibe III. Suddenly the scene changes, as it always does when I mention the dam. A crowd presses in. Some have heard of this thing. The man asks, "What, exactly, is a dam?"

And then they all want to know what it will do to their lives.

ONCE THE KARA controlled land on both sides of the Omo River, but gradually the Nyangatom pushed them across to only the eastern side. A seminomadic tribe from southwestern Ethiopia, the Nyangatom were one of the first groups in the region to gain access to automatic rifles, mostly from Sudan. During the 1980s and '90s they enlarged their territory, bullying neighbors, like the Kara, who still carried spears. Their population grew. They began changing the order of the Omo.

The Kara didn't give up territory easily, however. By Dunga's last years of secondary school, most Omo tribes had guns, and tensions boiled. The Ethiopian government did little to

Gaito Loka becomes a man during his initiation ritual, sometimes called cattle jumping. Male friends and relatives hold the animals in place as the jumper runs along their backs. Afterward, the young Hamar man must adhere to a strict diet including blood, milk, and honey until he marries.

Austrian travelers click souvenirs near the town of Jinka. With its rich culture still intact, the Omo region has seen tourism boom—and tensions between visitors and residents rise. "They know that tourists want to come see them because they are viewed as savages," says one anthropologist. "They are angry with this."

stop the intertribal warfare. Kara sharpshooters hid in trees along the riverbank, sniping at Nyangatom who approached the water. The Nyangatom sometimes crossed in small raiding parties, setting their rifles on automatic. Other times they crossed in massive groups. It was during this time that Kornan went with his cousin on a hunting trip in the bush. Much of the big game had been decimated, but the bush still sheltered gazelles, kudu, bushbuck, even elephants in places. It was a matter of stalking through thickets of thorn trees and seeing what awaited.

When the hunters came upon a group of Nyangatom warriors, a firefight erupted. Kornan shot a Nyangatom in the stomach before retreating, and the man later died. He had not intended to kill the man, so it did not fulfill the vendetta for his father's murder. At the same time, Kornan knew what he had begun. He knew that now he would be hunted too.

DESPITE THEIR WAR the Kara often bought ammunition from the Nyangatom. It was complicated, but even conflict didn't prevent a good sale. Kornan had given a man from the Kwegu, a small tribe that lived on both sides of the river, money to buy bullets. The Kwegu man never delivered, and Kornan grew angry. After a while the dealer invited Kornan over for coffee at his hut on the Nyangatom side of the river to settle the matter. It was a normal request; tribes all through the Omo do business and make social calls over gourds filled with a weak, thin liquid brewed from coffee-bean husks. Kornan took his AK-47 and his *borkoto,* the small saddle-shaped stool Kara leaders carry at all times, and he crossed the wide, brown river.

Kornan was in enemy territory, so he would have been alert. But he didn't know the meeting had been arranged by the younger brother of the warrior he had killed that day in the bush. Kornan met the Kwegu man under a shelter of sticks. Coffee simmered in a clay pot; the men chatted. When a group of Nyangatom approached and sat nearby, making small talk, Kornan was on guard, but nothing happened.

It was hot, even in the shade, and eventually he relaxed, setting his rifle aside.

The conversation wandered. The Kwegu man said he had been hoping to carve a large gourd into a bowl. Would Kornan help him? Even if he was irritated with this Kwegu, Kornan was a man of action. He took the gourd and began cutting. The Kwegu said he needed to relieve himself and ducked out of the shelter. It was a signal. Kornan, focused on the gourd, missed it.

He didn't notice one of the Nyangatom stand and slowly walk behind him outside the shelter. The man fired once into Kornan's back, then fled as he bled into the dust.

IT DIDN'T TAKE LONG for news of Kornan's murder to spread. Enraged Kara spilled across the river, attacking the Nyangatom. If they saw the irony—that their actions would only prolong the revenge cycle that had claimed their friend—they ignored it.

Kornan's friends ferried his body back across the river. That evening they sought out Dunga in the town of Dimeka, but the Kara do not deliver bad news directly. There's a problem, they kept saying. You must come home with us now. In darkness the group traveled toward home, Dunga fearing the worst. The next morning, as they neared Kornan's village, the men finally told Dunga his brother was dead.

In that moment Dunga became responsible for everything—his family's land and its herds, the well-being of his mother and Kornan's wife and children. He became responsible for vengeance. He couldn't sleep under the weight of it. Whenever he returned home, revenge was waiting for him, in his mother's inquiries, in all the history of his people. Killing a Nyangatom would be easy; the bush was so enormous. You might wait in ambush by the river, when the cattle were driven down to drink. Or in the fields of sorghum lining the bank. Or along one of the lonely trails at night, leaving the body to hyenas in the starlight. Vengeance lay one bullet away. Why, God, have you brought this upon me? Dunga thought. It is a test. It must be a test.

He considered dropping out of school but decided against it. He was in college now, and after years of education, most based on Western thought and influenced by Christianity, Dunga had grown. In his Western clothes and sneakers, he appeared more like a highlander now, a member of one of the ethnic groups that control the government. His ideas had changed as well. He spoke the highlanders' language and several others, assimilating the ideas embedded within them. He'd begun learning about Western notions of law and justice. He'd been raised in a culture where killing was accepted, but now he lived in one that considered it immoral. When he thought of becoming a man according to Kara custom—enduring a long set of rituals—it was in the gauzy way one daydreams of the future. He thought less and less of revenge. Dunga knew he would always be a Kara, but he no longer felt bound by the authority of the tribe.

THE MAN THEY CALL KING SITS just inside the door of the large, mud-walled hut on a white, plastic grain sack that bears the fading seal of the U.S. Agency for International Development.

> If children are born deformed, or if their top teeth erupt before their bottom teeth, tradition dictates they must be killed.

It is an unlikely throne, donated by a people who do not know his highness exists and who certainly have not heard of his power to control the elements, the animals, even the reach of death. He taps snuff from a plastic bottle. His hair, slick with butter and brilliant with crushed minerals, is perfect.

"If there is a problem, with cattle, people, the land—I resolve it," the king says. He inhales the snuff. In his face is a rare and complete confidence. "If there is a problem in my kingdom," he says, "the solution is me."

From his hut high in the Buska Mountains, Wangala Bankimaro rules some 30,000 members of the Hamar tribe. The Hamar are mostly pastoralists, herding cattle and goats across a broad bushland east of the Omo River. They also work small fields of sorghum and corn. They are neighbors and allies of the Kara. In an environment that is not forgiving, the Hamar have managed to thrive, growing into one of the region's largest tribes. For this the Hamar thank the rain, which feeds their cattle and

Chanting songs of victory, young Suri men parade with weapons in hand. After the harvest, crowds of men from Suri clans compete in bloody ceremonial pole fights. This particular battle—out of season—was called by rivals vying for a girl's favor.

Despite recent peace deals between Omo tribes, most remain well armed and proud of their fierceness, as revealed in scars running down the center of this Nyangatom man's chest. The scars, and others on his shoulder, offer a warning: He has killed at least two enemies from other tribes.

crops. For rain they thank Wangala Bankimaro.

Hamar women, their hair rolled into gleaming red-dyed braids, tell me Wangala commands the respect of even the Ethiopian government, which rules from a distant capital. Hamar men, rifles looped over their shoulders, say Wangala's curse is feared more than bullets. Bullets can miss. The curse guarantees death.

When I meet Wangala in his hut, he is just back from a rain ceremony. It has been a success. Rain will come, he says, shifting his weight on the grain sack. Brass coils wind around his wrists. He wears a T-shirt, white shorts, and sandals made from old tires.

I've never met a king before; I am not sure how to behave. In the dim, smoky hut, one of the king's wives boils coffee over a hearth. I ask the king why, if he can summon rain, he has not done it earlier to avoid the looming drought. He looks at me with the expression of a man humoring his guest.

"The people did not come to me," he says. "They did not make sacrifices to ask for rain."

Rules. An error of protocol. Like straying into crocodile territory.

Slowly, as the Ethiopian government has extended its influence and its legal code into tribal life, federal officials have worked to win Wangala's support. When they need him, they send a truck to pick him up—no small feat in this distant, asphalt-free region. One government plan aims to abolish what have been termed "harmful traditional practices." These include, ironically, the very things most tourists come to see: the ritual whipping of women or the stick fights or the cattle-jumping ceremony.

The list of targeted practices includes female circumcision (which is not practiced by the Hamar but is common throughout Ethiopia) and something called *mingi* killing. Mingi is a kind of very bad luck. In southern Ethiopia many tribes believe it is a bad omen if children are born deformed, if their top teeth erupt before their bottom teeth, or if they are born out of wedlock. Tradition dictates such children must be killed before mingi spreads. I met a Kara woman who

gave birth to 12 children before she was able to be married; she said she killed all of them. Parents do not necessarily want to obey, but communal pressure is strong. Sometimes the child is abandoned in the bush, its mouth filled with earth; sometimes it is hurled into the river.

The Kara are discussing the practice with the government and with an NGO that works to save mingi babies. But Wangala has already made up his mind. Not long ago, after heavy government lobbying, he decided to support a ban. "Now there will be no more mingi killing among the Hamar," the king tells me. "I have made it so."

He says it without arrogance. Tradition, magic, and fear wiped away. Discarded like old clothes that no longer fit. *The solution is me.*

LATE ONE AFTERNOON last March, in a shaded clearing high on a bank above the Omo River, some 200 Nyangatom gathered to celebrate peace with the Kara. Clay paint the color of flour streaked their bodies, rendering them ghostly, pale, skeletal. Beyond the clearing, enormous slabs of beef roasted on spits, dripping and popping. Beyond the fire, men from both tribes had stacked their automatic rifles in a gesture of goodwill and as a simple, practical matter. Given their history, it was better to keep the guns out of reach.

An old man paced before the crowd, waving his hands and shouting, the paint on his legs turning gray with dust.

"You, Nyangatom people! You must want peace!"

A small false beard, like that of an Egyptian pharaoh, pierced his lower lip and fluttered in his excitement. He turned to another section of the audience.

"You, Kara people! You must want peace! Let no one destroy your peace!" the elder shouted.

"So let it be!" the crowd chanted, the men's voices a low roll of thunder, the women heaving under pounds of necklaces coiled around their bone-thin shoulders.

"So let it be!"

Spears of meat were thrust into the ground before us. Soon the dancing would begin, and the clearing would shake with the rhythms of feet thudding into the tired earth.

At the celebration I met a young man named Ekal, who had recently become an elected leader of the Nyangatom. He was under 30 and college educated, like Dunga. He wore an oversize polo shirt, baggy slacks, and a baseball cap slightly askew. While his people danced, all of them nearly naked, Ekal filmed it with his cell phone. He looked like a hip-hop star on safari.

Ekal said that the days of war were over and that the government was firmly establishing itself here. Even those who talked of upsetting the new balance could be arrested, Ekal said, and he told of a Nyangatom man who had recently bragged that he would cross the river for a Kara killing spree. Ekal sent the police. The man landed in jail.

The Omo region was transforming. The peace deal was part of it, and the proof was visible where we sat. This clearing on the west side of the river had once belonged to the Kara. Now, under the terms of the truce, the Nyangatom would remain on the land. The river had drawn them in and, like the Kara before them, they had decided *dus,* we will stay here.

It was the answer Dunga had hoped for: his old world acknowledging the power of his new one.

WHEN I MET DUNGA several days after the celebration, he told me his mind was finally clear. He wanted no part of revenge. "To me it must be the same as if a snake bit my brother in the bush. As if my father was hit by a car. Revenge is not my path."

The tribal elders supported his decision. They saw the changes sweeping the region. They had heard of the dam being built upriver and of the programs the government had begun to control certain customs. They saw the trap of tradition that awaited Dunga, the one that had claimed Kornan. The elders understood Dunga was now more than a man caught in a blood feud—he was an educated representative of his people, a future leader and role model. Cool yourself, they told him. You have many responsibilities, to your family, to the tribe. Do not think of vengeance.

It was the answer Dunga had always hoped for: his old world acknowledging the power of his new one. In addition to courting established leaders like Wangala Bankimaro, the government

Clouds of dust—flooding the lungs, coating the mouth, burning the eyes—don't stop Kara women from dancing outside an improvised beer hall as their sons prepare for initiation into manhood. Married Kara women share relatively equal status with men but often perform more physical labor.

recently implemented a program to promote law and order by putting young, freshly trained professionals in positions of local power. When he graduates, Dunga will be the first lawyer in his tribe; he is likely to be sent back to the Omo Valley as a judge or a government prosecutor. He is aware that he will be a kind of missionary, and it has become his personal mission to modernize the Kara people and prepare them for the future as part of the Ethiopian state. He even invokes one of U.S. President Barack Obama's election slogans.

"Change must come," he said. "I have a big responsibility to change my tribe in a big way. My revenge is to make the killing stop."

SEVERAL MONTHS LATER I return to Dus and find the peace holding, at least among the Ethiopian tribes. The Nyangatom, former aggressors, are now suffering at the hands of the Turkana, a Kenyan tribe that has crossed the border and is said to have rustled more than 13,000 cattle. Few of the Kara gloat. A drought is settling over the land, and one day I watch as several Nyangatom pole across the river and ask Kara friends for help. Immediately the Kara provide their former enemies with sacks of grain.

But all is not forgiven. In Kornan's village, his young widow, Bacha, is still haunted. After his murder, Bacha entered traditional mourning; she removed her jewelry, let her hair grow untamed, wrapped herself in rough leather skin. Bacha mourned for two years—longer than custom requires—refusing to emerge until elders and friends practically dragged her out. Eventually she cut her hair and slipped on her bracelets and necklaces again, but she was not healed. A suitor approached; she rejected him. She has kept many of Kornan's possessions—clothing, beads. She keeps his AK-47.

One day I ask her about the rifle. Bacha's face is striking, unlined, her eyes like almonds. A roofing nail protrudes through her bottom lip. She doesn't want to talk about the rifle. Her face remains dark and smooth as the river.

"I keep it so my sons will see it," she says finally, twisting her callused hands in her lap. "So they will grow up familiar with it."

She seems unimpressed with Dunga. He is technically the head of the family, but it is she who is in charge of day-to-day affairs, with the help of her two young sons, both under ten.

A boy and his pet baboon wander the Suri village of Tulgit. Although a difficult terrain has long sheltered his people from the outside world, this boy will grow up in a nation pushing hard to modernize and integrate its far-flung tribes. "It's important to stop the nomadic life," one Suri official says. "Peace and stability are the most important things for us now."

"My sons will know their father was killed by a Nyangatom," she says.

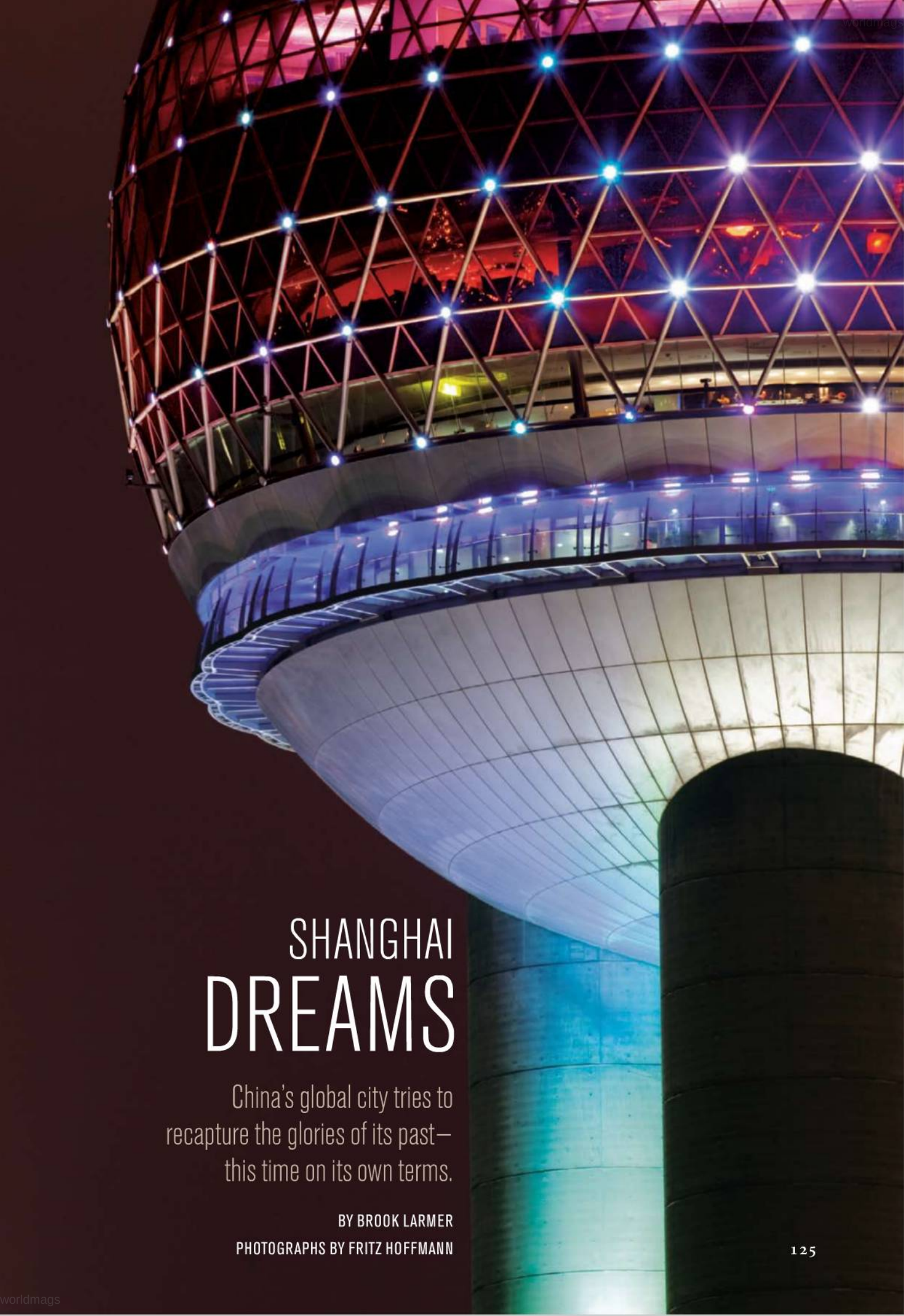
Before I leave Ethiopia, I reach Dunga in Jinka, a bustling frontier town where he had attended boarding school. He is giving his nephew, Bacha's younger son, a tour of the place. He plans to send the boy to school there, to follow in his footsteps. I mention what Bacha said.

"She's not free of this idea," he says. "Sometimes when I explain it to her, she says 'OK.' But she's not saying it from her heart. It seems sometimes that only revenge will make her happy."

Dunga thinks of it simply as an argument he must win. If he cannot persuade Bacha, he will persuade her sons, using his lawyer's skills, his missionary's zeal. Dunga has not officially become a man according to Kara tradition, but in the eyes of the Ethiopian nation he is more than that. He is the future.

Before we hang up, Dunga says that it has been decided that Bacha's older son will remain at home, like Kornan had, tending to herds and fields and family matters. He will live with Bacha and grow up among his father's old friends. Certainly he will dwell for a time in Kornan's shadow. I think of Bacha's face, the set of her jaw, the stillness of her gaze. When her son is old enough, she will tell the boy his father's story. Then, probably, she will give him his father's rifle. □

The 101-story World Financial Center, China's tallest building (above), Jin Mao Tower (center), and Oriental Pearl TV Tower signal the city's rising ambition.



SHANGHAI DREAMS

China's global city tries to recapture the glories of its past—this time on its own terms.

BY BROOK LARMER

PHOTOGRAPHS BY FRITZ HOFFMANN

BARBIEI SH UGE *for ten-year-old Lin Yinghui, crowned and manicured as she celebrates her birthday with friends at a superstore devoted to the blond, blue-eyed American export. Western fashions and ideas have*

traditionally entered China through Shanghai, a former treaty port hospitable to foreigners and today a free-spending financial capital regarded as one of the world's most desirable markets.

THE TIDE OF DAILY LIFE *flows through an alley of row houses in an old neighborhood, or* lilong, *where early rising residents stretch, hang laundry, and empty chamber pots. Built as elegant single-family homes, the*

buildings aged into crowded tenements after the Communists appropriated them in the 1950s, using some as government offices. Since the 1990s the city has demolished most lilong in favor of high-rises.

THE SECRET WORLD of the old Shanghai bomb shelter seems to exist in a parallel universe. On the sun-splashed street above, migrant laborers slurp down rice and tofu lunches, while clusters of office workers in crisp white shirts walk past the small sign on the sidewalk. But in the dark recess behind a display of foreign-brand toilet seats, a young woman descends a staircase into a place she knows only as "0093."

Passing through a pair of metal blast doors, the woman—22-year-old Sheng Jiahui, who goes by the nickname "Sammy"—moves deep into dimly lit corridors. The bunker glows an unnatural shade of green. In its perpetual twilight, 0093 still evokes the deadening claustrophobia of war and communist revolution that snuffed out Shanghai's swinging heyday, when the mingling of East and West transformed the city into the Paris of the Orient.

A door cracks open, and a blast of electric guitar erupts into the corridor. Inside the small room, under a poster of guitar legend Jimi Hendrix posing as Uncle Sam, four young Shanghainese women—the other members of Sammy's punk rock band, Black Luna—are starting to jam. It is a serendipitous twist of history: The bunker, once the symbol of a wounded and cowering society, has become a breeding ground for Shanghai's music scene. The rehearsal rooms at 0093—the moniker is a phonetic combination of its street name and number—have helped incubate more than a hundred local bands, reinvigorating a culture that now, as before, blurs the East-West divide.

Sammy sheds her jacket as the band lets loose. Orange, 20, pounds on the drums; Juice, 23, shreds chords at the speed of Shanghai's maglev train. Sammy sings, and her bangs flop up and down in double time. The daughter of a traditional Shanghainese opera singer, she is taking her family's musical talent in a new direction. "We are newborn birds, but we have big dreams," Sammy cries. "Let the whole world hear us sing."

EVERY CITY HAS A RHYTHM, a pulse that makes it move. In Shanghai, one of the fastest growing megacities in the world, it's easy to get lost in the relentless percussion of jackhammers and pile drivers, bulldozers and building cranes. The proliferating skyscrapers and construction sites are part of a stunning metamorphosis that Shanghai will show off as host of Expo 2010, the contemporary version of the World's Fair, which runs from May through October. The rise of China's only truly global city, however, is driven not by machines but by an urban culture that follows its own beat—embracing the new and the foreign even as it seeks to reclaim its past glory.

Shanghai natives form an urban tribe, set apart from the rest of China by language, customs, architecture, food, and attitudes. Their culture, often called *haipai* (Shanghai style), emerged from the city's singular history as a meeting point of foreign merchants and Chinese migrants. But over the years it has become a hybrid that confounds the very idea of East

Brook Larmer is a former Shanghai bureau chief for Newsweek. *Fritz Hoffmann lived in the city for 13 years and studied Mandarin at Shanghai University.*

NOTHING IS PERMANENT. *That's the lesson facing student Chen Sudan, visiting her father at a demolition site near the docks. A laborer from Anhui Province, he squats in one of the doomed buildings until it comes time to help tear it down and move on. Urban renewal projects have uprooted nearly a million households.*

and West. "In foreigners' eyes Shanghai is part of 'mysterious China,'" says Zhou Libo, a local comedian. "In the eyes of other Chinese, Shanghai is part of the outside world."

An upstart by Chinese standards, Shanghai—unlike imperial Beijing—was just a modest fishing town a century and a half ago. The city was born with a sense of manifest destiny. In the beginning it was a foreign dream, a Western treaty port trading opium for tea and silk. The muscular buildings along the riverfront known as the Bund (a word derived from Hindi) projected foreign, not Chinese, power. From around the world came waves of immigrants, creating an exotic stew of British bankers and Russian dancing girls, American missionaries and French socialites, Jewish refugees and turbaned Sikh security guards.

By the 1930s Shanghai was among the ten largest cities in the world. But it was like no other place on Earth: a mixed-blood metropolis with a reputation for easy money—and easier morals. The British, French, and Americans carved the city into concessions, building gracious homes along tree-lined streets. Local shops carried the latest fashions and luxuries. The racecourse dominated the center of town, while the city's nightlife offered everything from dance halls and social clubs to opium dens and brothels. (At one time, Shanghai reputedly had more prostitutes than any other city in the world.)

The whole enterprise, however, rested on the

QUICK-CHANGE CITY
Since 1975 the official number of people living in China's most populous city—dubbed "New York on steroids"—has almost doubled. More than six million temporary migrants raise the total population to 20 million. To make room for newcomers and industrial growth, the urban imprint has increased by almost 400 square miles. The Huangpu River (right), trafficked by barges, splits the booming city.

several million Chinese immigrants who flooded the city, many of them refugees and reformers fleeing violent campaigns in the countryside, beginning in the mid-1800s with the bloody Taiping Rebellion. The new arrivals found protection in Shanghai and set to work as merchants and middlemen, coolies and gangsters. For all the hardships, these migrants forged the country's first modern urban identity, leaving behind an inland empire that was still deeply agrarian. Family traditions may have remained Confucian, but the dress was Western and the system unabashedly capitalist, and the favorite soup, borscht, came from Russians escaping the Bolsheviks. "We've always been accused of worshipping foreigners," says Shen Hongfei, one of Shanghai's leading cultural critics. "But taking foreign ideas and making them our own made us the most advanced place in China."

The curtain finally came down in 1949. For the next four decades China's socialist overlords made Shanghai suffer for its role as a modern-day Babylon. Besides compelling the economic elite to leave and suppressing the local dialect, Beijing siphoned off almost all the city's revenues. When China's economic reforms began in the 1980s, Shanghai had to wait nearly a decade before the regime in Beijing allowed it to develop. "We kept wondering, When is it going to be our turn?" says Huang Mengqi, a fashion designer and entrepreneur who owns a shop off the Bund.

Shanghai's moment has arrived. Fueled by years of growth faster than China's as a whole—and a culture now unshackled and dealing comfortably with the outside world—the city is eager to recapture the glories of the past, only this time on its own terms. Twenty years ago the European buildings on the Bund stared across the

Huangpu River at low-lying farmland dotted by factories; today that same land bristles with skyscrapers, including the 101-story World Financial Center. All told, the city has added more than 4,000 high-rises. For a place once dominated by rickshaws and bicycles, the most extraordinary statistic may be not vertical but horizontal: nearly 1,500 miles of roads in and around Shanghai that did not exist a decade ago.

And now comes Expo 2010, part of a fading franchise Shanghai hopes to resuscitate as a global launching pad. It's a gamble, but the city has reportedly anted up $45 billion, more than Beijing spent on the 2008 Olympic Games. The bulk of the money has gone into infrastructure, including two new airport terminals, a subway expansion, and a Bund makeover. But amid a global economic crisis, will the projected 70 million visitors come? Shanghai hopes to outshine rivals Beijing and Hong Kong, but it also harbors a loftier ambition: to be the global capital of the 21st century. "If any city has a chance, it's Shanghai," says Xiangming Chen, a professor at Fudan University in Shanghai. "But the city can't just build its way to greatness. The bigger question is, How does it rebuild a sense of community that's been lost in tearing down the old and building up the new?"

JIN QIJING PRETENDS not to notice the rat scurrying across the pipe in her room. Dinner is on the table—a sweet and fatty braised-pork dish, *hongshaorou,* that is a Shanghainese favorite—and the elegant 91-year-old with a sweeping, gray coiffure doesn't want to spoil the family meal.

Nobody needs to remind Jin that conditions in her traditional Shanghai neighborhood, or *lilong,* have deteriorated since she moved here

SPICING THE AIR *with stir-fry and fruit, a portable market springs up at night to serve office workers hurrying home to high-rise apartments. As the densely populated city grows upward, the famous Shanghai street*

life of buying, selling, and gossiping is disappearing. Concerned about hygiene—and the city's image—officials are reportedly chasing off street vendors in the run-up to the May opening of Expo 2010.

as a teenager in 1937. Back then her lilong—one of thousands in Shanghai that set modified Chinese courtyard houses on tight European-style lanes—lived up to its name: Baoxing Cun, or "treasure and prosperity village." One family lived in each house, often with a coterie of servants and rickshaw pullers.

Today eight families cram into Jin's two-story home, one per room. There is no plumbing. Jin's kitchen is an electric stove erected on a rickety, makeshift balcony. Nonetheless, when Jin's grandson invited her and her husband to move into a modern apartment complex in the suburbs, she refused. "Where else," Jin asks, "could I find this sense of community?"

Shanghai's old neighborhoods are disappearing. In 1949 at least three-quarters of Shanghainese lived in lilong; today only a fraction do. Two lilong adjacent to Baoxing Cun have been demolished, one to make room for an elevated highway, the other for a power switching station to light up Expo 2010. But Baoxing Cun's densely packed alleyways still evoke the communal feeling that made lilong the cradle of Shanghainese culture. In the morning, on her way back from the open-air market, Jin passes the shop selling *shengjian bao,* sweet, pork-filled breakfast buns. She chats with a neighbor hanging laundry on one of the poles that festoon the lane, while a man, still in pajamas, waters his plants. "I'm back!" Jin yells, as she climbs the unlit stairs to her second-floor room. Neighbors' heads pop out of their rooms to greet her.

In the afternoon Jin and her oldest friends gather on wooden stools in the alleyway—a daily ritual they have followed for decades. With indoor space at a premium, life in the lilong spills outside, turning the lanes into public living rooms. As the women chat in Shanghainese dialect, neighbors stop by to listen, laugh, and interject: a man in an ill-fitting gray suit, a vendor walking his bicycle, an officious woman with a badge from the neighborhood-watch committee reminding Jin to show enthusiasm for Expo 2010.

Today the ladies' banter is darkened by speculation. "We keep hearing we're next in line for demolition," Jin says. For many Shanghainese, the decades of neglect and overcrowding have turned the lilong's intimacy into something more like asphyxiation. But Jin worries that the razing of Baoxing Cun will scatter her friends to distant suburbs. "Who knows how much longer we have?" she asks.

Shanghai has taken more care than most Chinese cities to preserve its historic architecture, sparing hundreds of pre-Communist-era mansions and bank buildings from the wrecking ball. Yet only a few lilong appear on the list of protected areas. Ruan Yisan, a professor of urban planning at Tongji University, is waging a campaign to save these living repositories of Shanghai culture. "The government should demolish poverty, not history," he says. "There's nothing wrong with improving people's lives, but we shouldn't throw our heritage away like a pair of old shoes."

Not long ago a government work crew swooped in to splash Baoxing Cun with a fresh coat of cream-colored paint. The Potemkin makeover does little to conceal the neighborhood's dismal condition. Nevertheless, Jin is happy to know that, at least until after Expo 2010, Baoxing Cun will not be torn down. "Here," she says, as a bare-bellied neighbor listens in, "it's all like family."

FOLLOWING THE CROWD has never been Zhang Xin's way. Born in a Shanghai lilong during the Cultural Revolution, the 42-year-old conceptual artist likes to jolt audiences with images of Chinese intellectuals as birds trapped in a cage—and biting critiques of her own hometown. "We suffer from the psychology of colonialism," she says. "We act proud that we were worthy of being colonized."

It took some of her friends by surprise, then, that Zhang joined the stampede into the suburbs. Several million Shanghainese have moved out of the city's core in the past 15 years, catapulted by the destruction of the lilong and the long-suppressed dream of having a space of their own. Zhang's family lives in a three-bedroom apartment amid a cluster of high-rises with

ONE IS NOT ENOUGH *is the mantra of officials eager to trigger a baby boom in Shanghai. With more than a fifth of residents over 60, the city is encouraging young parents—such as mothers at the Kang Cheng gated community—to have a second child, a local exception to China's long-standing one-child rule.*

manicured lawns and a playground for her seven-year-old daughter, Jiazhen. But the American-style, gated compound lacks the vibrant street life of Zhang's childhood lilong.

New construction and suburban migration have eased Shanghai's congestion, more than tripling the living space per capita in 30 years. Yet the transition is tearing the fabric of Shanghainese culture. Neighbors in suburbia rarely know each other well, despite community-building efforts such as sports leagues and children's playgroups. At this stage the strongest bond among new suburbanites may be their status as property owners—a link that brought residents together last year to fight the proposed extension of a high-speed railway.

One casualty of urban flight may be Shanghai's local dialect. Rich and guttural, the language has been losing ground since the 1950s, when Beijing launched its campaign to unify the country with standardized Mandarin. The crowded lilong served to sustain the dialect; in the suburbs, families often retreat to their private spaces, blocked off from each other. Even so, many proud Shanghainese use the language as a secret code to signal that they belong to the in crowd—and often to ensure fair deals in local shops.

For Zhang, the allure of the suburbs soon waned. This year the artist and her family will move back downtown. The ostensible reason is to enroll Jiazhen in a top school, but Zhang also

AS UMMER WEEKEND *sends people flocking to the seaside-like setting of Dino Beach, a suburban water park. Ample spending money and a taste for the exotic make Shanghai fertile ground for fantasy, at home and at*

play. A development called Rancho Santa Fe features Spanish mission–style villas. Another mimics an English village with half-timbered houses. And now the ultimate theme park is coming: Disneyland.

wants to give her daughter a deeper sense of identity. "All of my best memories come from the sounds I heard as a six-year-old waking up in the lilong," she says. "The chattering on the street, the vendors selling shrimp—real life."

CHEN DANDAN SPENDS his days suspended hundreds of feet above downtown Shanghai, building one of the city's newest skyscrapers. What gives the 26-year-old migrant worker a sense of vertigo, though, is his daily walk home down Nanjing Road, the city's glitziest shopping street. In soiled, blue overalls and a yellow safety helmet, Chen gawks at a Gucci storefront. At a place called Tomorrow Square, he ogles a red Ferrari whose price tag equals about 80 years of his $3,500 annual income. "All these people may have money," he says, "but we are the ones who are building Shanghai."

As with its former growth spurts, the city's current boom would not be possible without an influx of foreign investment—and armies of migrant workers. Of Shanghai's 20 million people, a third are migrants without residency permits and some associated benefits. Many of these *waidiren*—outsiders—live in well-established communities, some with their own private schools to accommodate children whose

THES ELF-ASSURANCE *of migrant workers cooling off on a bridge reflects their rising status. Until a few years ago laborers from all over China were treated as invisibles. Now the local government acknowledges their role in shaping the city, officially anointing recent arrivals as "new Shanghai people."*

unofficial status bars them from public education. Others, like Chen, form a floating population on the lowest rung of Shanghai society.

In Shanghai's early days most migrants became part of the culture, living in lilong and learning the local dialect. Today, in an era of easy travel and communication, such assimilation is rare. Chen has worked in Shanghai for two years, but he's never considered staying permanently—and he hasn't learned a word of Shanghainese. Most of his wages go to his family in nearby Jiangsu Province.

At the end of his walk down Nanjing Road, Chen heads into the workers' "dormitory"—plywood rooms on the third floor of an unfinished high-rise. Across the street is the 22-story Park Hotel, the tallest building in Asia when it went up in the early 1930s—and a symbol of Shanghai's earlier global pretensions. It too was built by migrant labor. Chen may not be welcome in Shanghai during Expo 2010. In those six hallowed months, construction will halt, and most contract workers will be sent home. But Chen will be back. "As long as Shanghai keeps growing," he says, "it will always need people like me."

WHEN SAMMY ISN'T UNDERGROUND playing punk rock, she's often perched in the 24th-floor apartment she shares with four other single women in a new tower downtown. Back in 1987, when she was born, her 28-story building would have dominated the skyline; now hundreds are taller. Looking out her bedroom window, she points past a jungle of green-sheathed high-rises under construction. There, across the Huangpu River, is the inverted pyramid that will serve as the central hall of Expo 2010.

Shanghai's urban explosion will continue long after the expo is over. All the tearing down and building up underscores one Shanghainese trait: its obsession with the new. Unlike other parts of China, which feel the weight of ancient history, young Shanghai is always seeking the cutting edge. Sammy's bandmates call her "the quintessential Shanghai girl" not simply because she looks abroad for her cues in music (rocker Avril Lavigne), fashion (the Japanese magazine *Vivi*), and lifestyle (her living arrangement is more *Friends* than Confucius). It's mainly because of the unapologetic ease with which she mixes new ideas with her Shanghainese style.

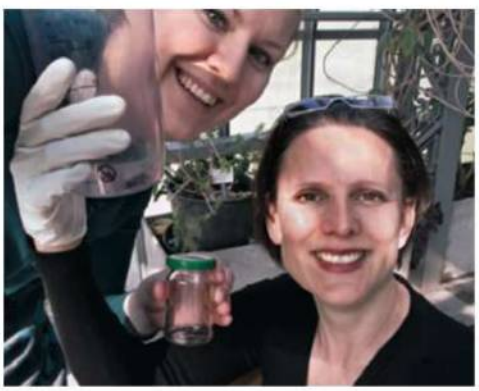
When Black Luna shot some promotional photos recently, the rockers put on flouncy cocktail dresses, with Sammy wearing a 1930s-style choker. "We wanted to capture the glamour of old Shanghai," she says. This wasn't nostalgia, though. It was a hip Shanghainese band plundering history for a cool new motif. In this city of constant renewal, the beat pounds so fast that the past can be turned into the future. The old can be made new again. □

INSIDE GEOGRAPHIC

Neil Shea, his guides, and two villagers rescue a cow from the Omo River.

ON ASSIGNMENT **Cattle Tale** Heading around a bend along Ethiopia's Omo River, writer Neil Shea and his guides Lale (above, in red polo shirt) and Bache (at left of Lale) spotted an odd situation. A Kara man (at right of Lale) and a Hamar woman (at far left) were struggling to haul a cow from the water after it had slipped and fallen in. "The cow was fully submerged, except for the top of its head, when we arrived," recalls Shea, who then pitched in with his guides to help heave the beast up the hill. Between the river's plummeting banks and the animal's slippery hide, the rescue was challenging—but not insurmountable. "Eventually," says Shea, "we managed to shove the cow to a flat spot, where it stood up and trotted off. It didn't even thank us."

ON ASSIGNMENT **Plant Manager** For Swedish photographer Helene Schmitz (below, at right, with assistant Karin Foberg), showcasing the "surreal quality" of her carnivorous subjects was key. To achieve this she set them against colored backdrops and used a macro lens with ring flash plus a second flash to illuminate insects. Greenhouses in Germany and Sweden served as studios; bugs were collected. The shoots required planning, but spontaneity prevailed when Foberg snapped this lighthearted shot in Frankfurt. "It looks like we have two beers," laughs Schmitz, "but actually they are jars of roaches."



Society Updates

NG BOOKS
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NG FILMS
City of Life and Death, a film by acclaimed director Lu Chuan, uses stark black-and-white cinematography to powerfully portray Japan's 1937 seizure of Nanjing, China. A National Geographic World Films Release, *City of Life and Death* is now playing in select theaters.

NG CHANNEL
Can a high-tech map help decipher an ancient Peruvian mystery? Watch *Nasca Lines: The Buried Secrets,* a one-hour special airing February 21 at 8 p.m. on the National Geographic Channel, and find out.

GeoPuzzle Answers

PHOTOS: RANDY OLSON (TOP LEFT); KARIN FOBERG (BOTTOM)

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Wolf Dancers It was a performance "so real that it was difficult to believe that they were simply men wearing wolf masks," noted an observer in 1914. Participants in the Inupiat eagle-wolf dance honored slain animals, sending their spirits home to ensure future hunting success. According to Deanna Kingston, professor of anthropology at Oregon State University, the dance's wolves appeared—bursting through holes in a platform onstage—as part of a hunter's mystical vision. Performances traditionally took place during a feast that gathered residents of neighboring Alaska settlements. But these men posed in a Nome, Alaska, photo studio sometime early in the 20th century. *—Margaret G. Zackowitz*

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

PHOTO: CARL J. LOMEN, NATIONAL GEOGRAPHIC STOCK

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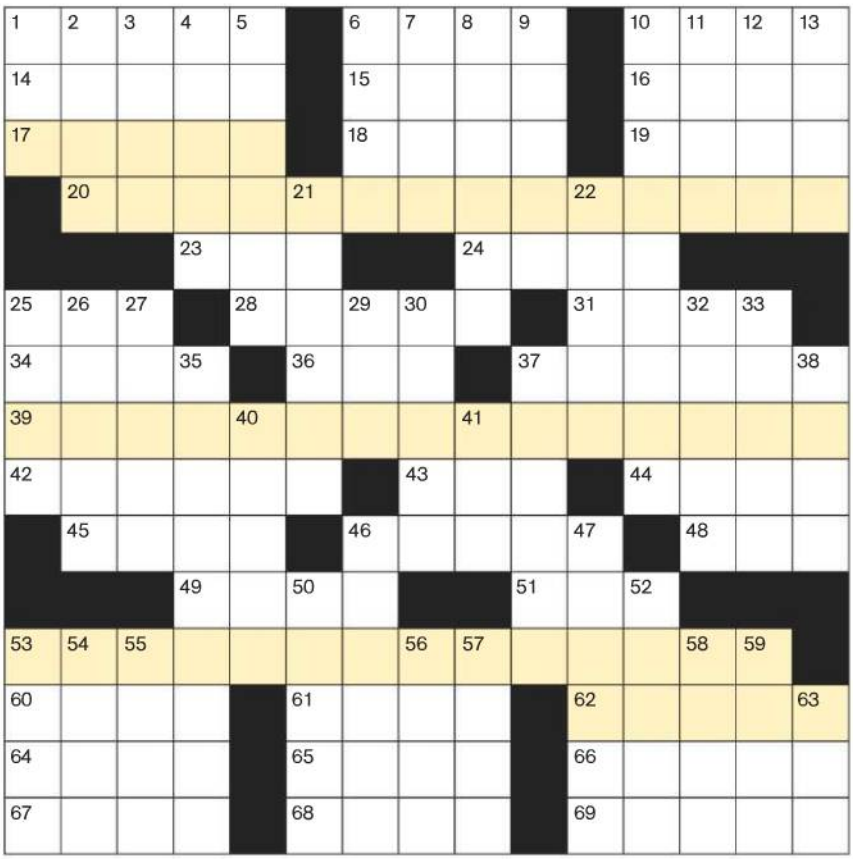

Mean and Green

Puzzle by Cathy Allis

The world's 675-plus carnivorous species (story, page 80) have evolved a variety of strategies to snare a meal, which is typically an insect. The famous Venus flytrap (left) has what botanists call an active trap: The victim hits trigger hairs on the plant's inner surface, the trap snaps shut, as shown in the photo, and…hello, dinner. Tinted answers offer a sci-fi scenario of plant predation.

ACROSS

1 Succulents native to Africa
6 __ Taft Benson, Agriculture Secretary under Eisenhower
10 Lacking slack
14 Avenue through Hell's Kitchen
15 Aaron Burr won one
16 Violist's clef
17 Start of a quip about carnivorous plants
18 Small scoop?
19 Incisive
20 Part 2 of the quip
23 Camera type: abbr.
24 Bobbin
25 Incoming flight info
28 "Take a hike!"
31 Classic cars, including Royales
34 Unicorn tale, e.g.
36 Guzzler's sound
37 One of the "ice giant" planets
39 Part 3 of the quip
42 35 Down's "Santiago," for one
43 Like a light?
44 Prefix meaning "within"
45 Holder, Obama's Attorney General
46 Recurrent theme
48 *Drosera* plants' mucilage, figuratively
49 Kind of bean
51 Old ewe in the film *Babe*
53 Part 4 of the quip
60 Attract
61 Stratford-Avon link
62 End of the quip
64 "Puppy Love" singer Paul
65 Venus Flytrap's was Cincinnati, on TV
66 Sleep-study subject
67 Copacetic
68 "Serves you right!"
69 Mount with a mane

DOWN

1 "Gimme __!" (start of an Iowa State cheer)
2 Vitality
3 How *Dog Whisperer* is viewed
4 Community cultural character
5 Clam digs?
6 Perfect text
7 Pueblo tribe of New Mexico
8 Activist's goal
9 Sans support
10 Depart
11 Away from the wind, at sea
12 The Sun Bowl's sch.
13 A load
21 Ragamuffin
22 Olympic gymnast Strug
25 Avian red meat sources
26 Melville's first book
27 Doing battle
29 Fix unfairly
30 Allergic outburst
32 Without letup
33 Piece from Handel's *Water Music*, e.g.
35 "Papa" who created Mr. Macomber
37 A word's final syllable
38 Kind of pea
40 Big-beaked, loud-mouthed parrot
41 Famed boy pharaoh
46 Distance-vision problem
47 Islamic decrees
50 Provide supporting evidence
52 Help out, as a highway, nowadays
53 Jewish month February 15 to March 15, 2010
54 Debut film for the "James Bond Theme"
55 Some hardwoods
56 Biblical auxiliary
57 *Amarantine* Grammy winner
58 River through Caen
59 Jubilant delight
63 Ringo, to Zak

Answers in Inside Geographic

PHOTO: HELENE SCHMITZ

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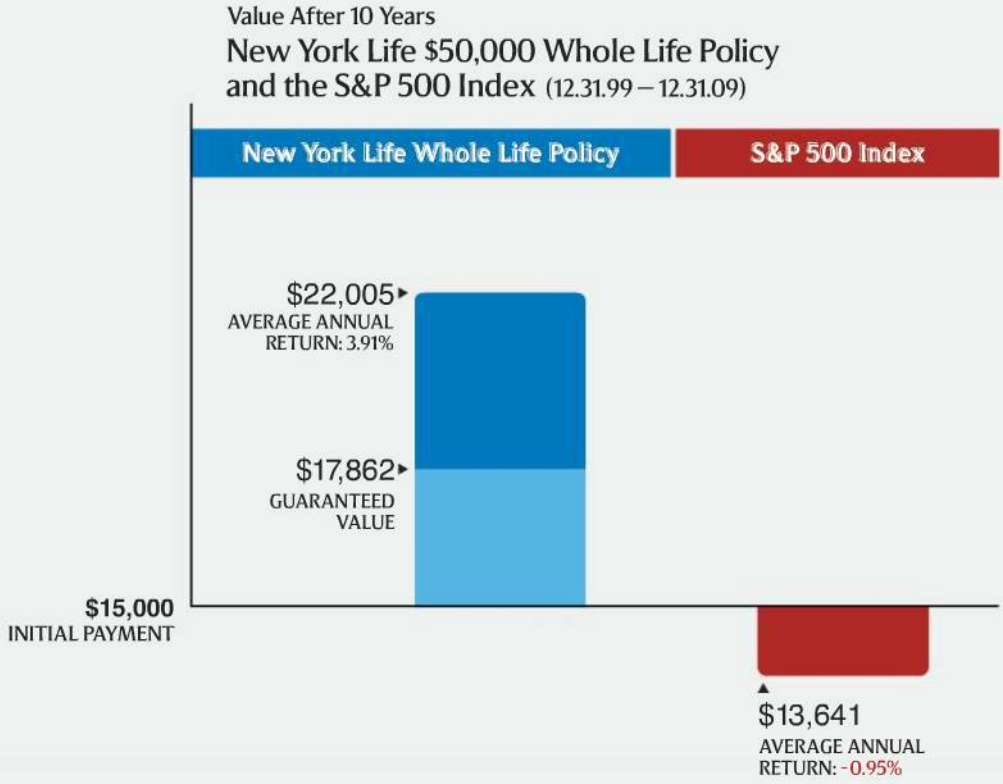

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