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NOVEMBER 2001

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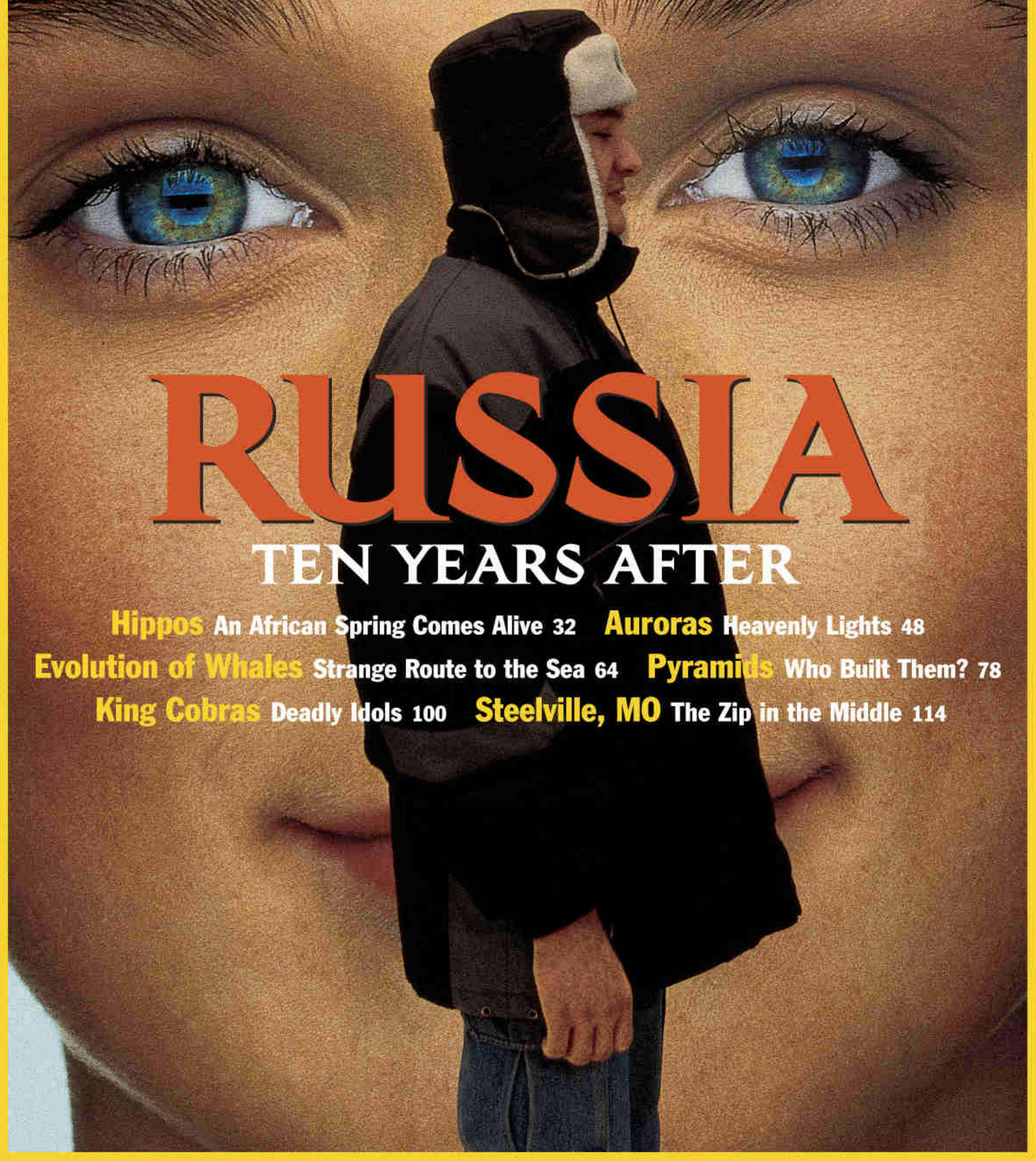

RUSSIA

TEN YEARS AFTER

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Motor Trend, September 2001. **Ward's Upper Middle segment, import only vs. MY01 competitors. Interior volume based on manufacturer's data. Nissan, the Nissan Logo, DRIVEN. and Nissan Model Names are Nissan trademarks.

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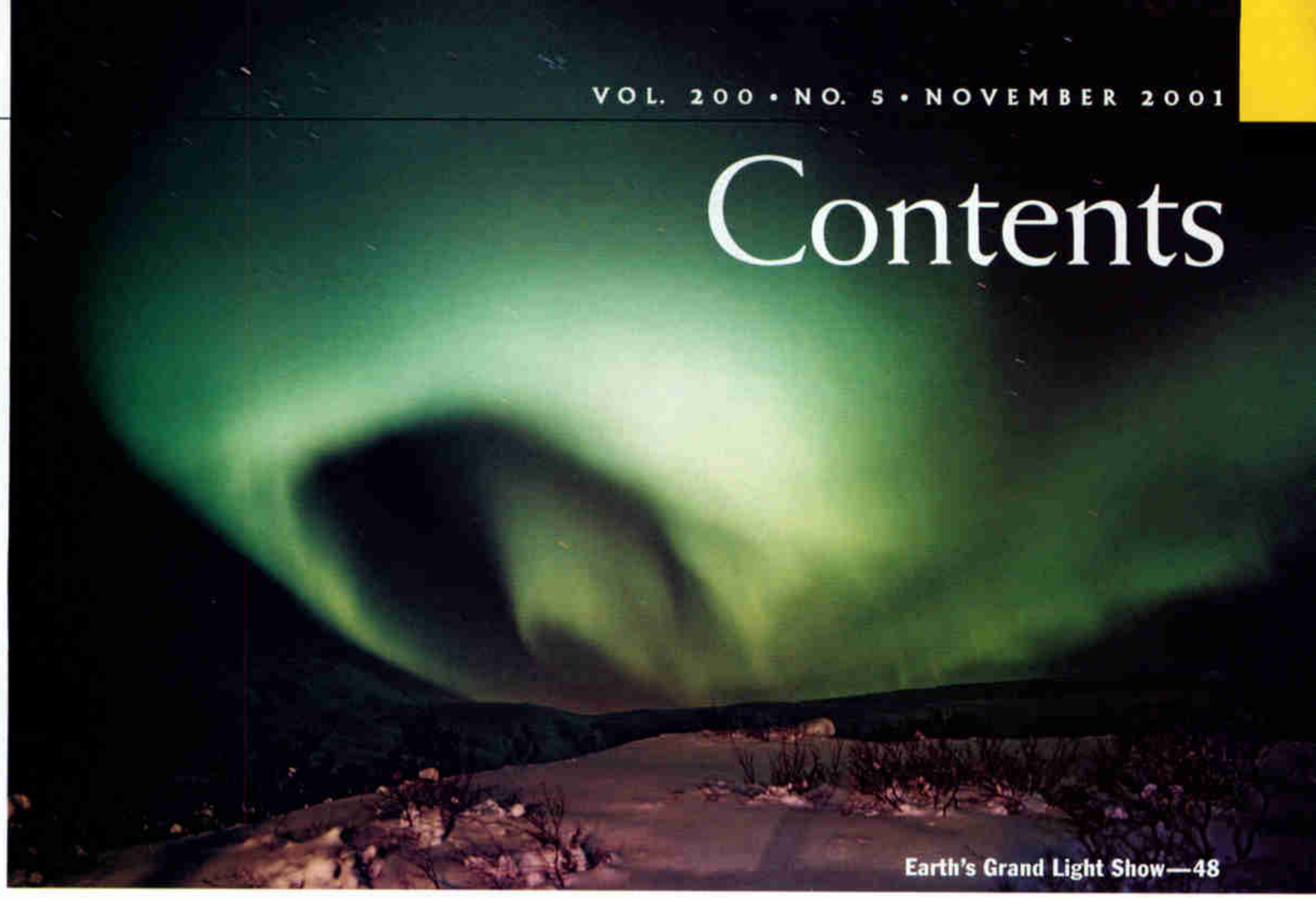

Earth's Grand Light Show—48

FEATURES

DEPARTMENTS

THE COVER

An ad in a Benetton megastore dwarfs a shopper in Moscow. The store sits on lively Pushkin Square, surrounded by cafés and theaters.
BY GERD LUDWIG

Cover printed on recycled-content paper

ON THE NGM WEBSITE

nationalgeographic.com/ngm/0111

SIGHTS AND SOUNDS See a Russia in transformation.
RUSSIA TODAY Hear the challenges the photographer faced.
HIPPOS Watch the underwater ballet at Kenya's Mzima Spring.
AURORAS See them in motion.
KING COBRAS Come face-to-face with a 17-foot cobra.

From the Editor

GERD LUDWIG

How many revolutions for Russia? From the tsars to the Bolsheviks to the disintegration of the U.S.S.R. and now to the revolutionary world of high tech, the people of the largest nation on Earth have endured one racking change after another. Though seeds of a middle class are sprouting in Moscow and in a few other centers of education and science, widespread corruption diverts untold resources. In truth most of the country remains untouched by the latest revolution, driven by software and M.B.A.'s.

Step into a remote Russian village and you enter a microcosm of the former Soviet Union in its vast reaches. Farmers still use watering holes (above) in scenes that could have occurred a hundred years ago. Slowly the fledgling market economy and information technology are creating points of light, but the glow flickers as citizens increasingly feel the loss of social services taken for granted under the Soviet system. So far, rural Russians have been all but bypassed by any advances. Nurtured and guided well, the light will spread.

Political winds also threaten the flame, which could sputter and go out if despots in new guises replace those of old. Lip-service trappings of democracy must become true trademarks of democracy, including an independent judiciary and a free press. With enlightened leadership—and a lot of patience—prosperity may finally come to this long-suffering land.

Bill Allen

MONDAY: *Conference Call*

TUESDAY: *Status Meeting*

WEDNESDAY: *Presentation*

THURSDAY: *Retirement Party*

FRIDAY: *Permanent Vacation*

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Forum

July 2001

Not as wild as he looks, Brody, our cover bear, is a Hollywood entertainer trained by Jeff Watson of Spencer, Indiana. Brody and his wild cousins, according to one reader, have "just as much right to this planet as we do, yet we persist in pushing them to the point of extinction." But another reader balked at linking isolated grizzly populations in the lower 48: "I would not want them in my state," she wrote.

Urban Sprawl

John Mitchell is right on the mark when he writes of our sprawl predicament that "perhaps it is tolerable to so many because it has become so familiar." We no longer notice the irony of the names of subdivisions so often referring to what they themselves eradicated: Harvestview (no more harvest), Village Square (killed the real one), Pine Meadows (has neither). There may not be a simple solution to sprawl, but it is time to stop accepting the familiar. It's time for a new dream.

KIRK-EVAN BILLET
Middletown, Pennsylvania

Underlying the arguments against urban sprawl is a not so subtle cultural elitism and classism. Many urban sprawl critics assume everyone shares their fine sensibilities and that we should drive only through quaint little neighborhoods dotted with just the right number of rationally spaced family-owned stores. They assume that because they are willing to pay a premium to live in such a community, everyone should. In other words, everyone should finance their vision of a more aesthetically pleasing America.

MARK VAKKUR
Decatur, Georgia

New suburban developments are churned out like mass-produced junk food: quickly, predictably, and with little lasting value. Within one lifetime we have let the automobile become the master, rather than the servant, of our growth.

DREW KEELING
Berkeley, California

In England the sprawl problem was identified for London before World War II, and the solution was to put a "green belt" around the metropolis and create "new towns" beyond it to supply the demand for higher housing standards as well as cater to population growth and migration. Traveling in the U.S. over the past 50 years, I have always been impressed by the general disregard for such matters and the odd assumption that green belts and new towns are somehow socialist. Naturally the enormous spaces of the U.S. and the

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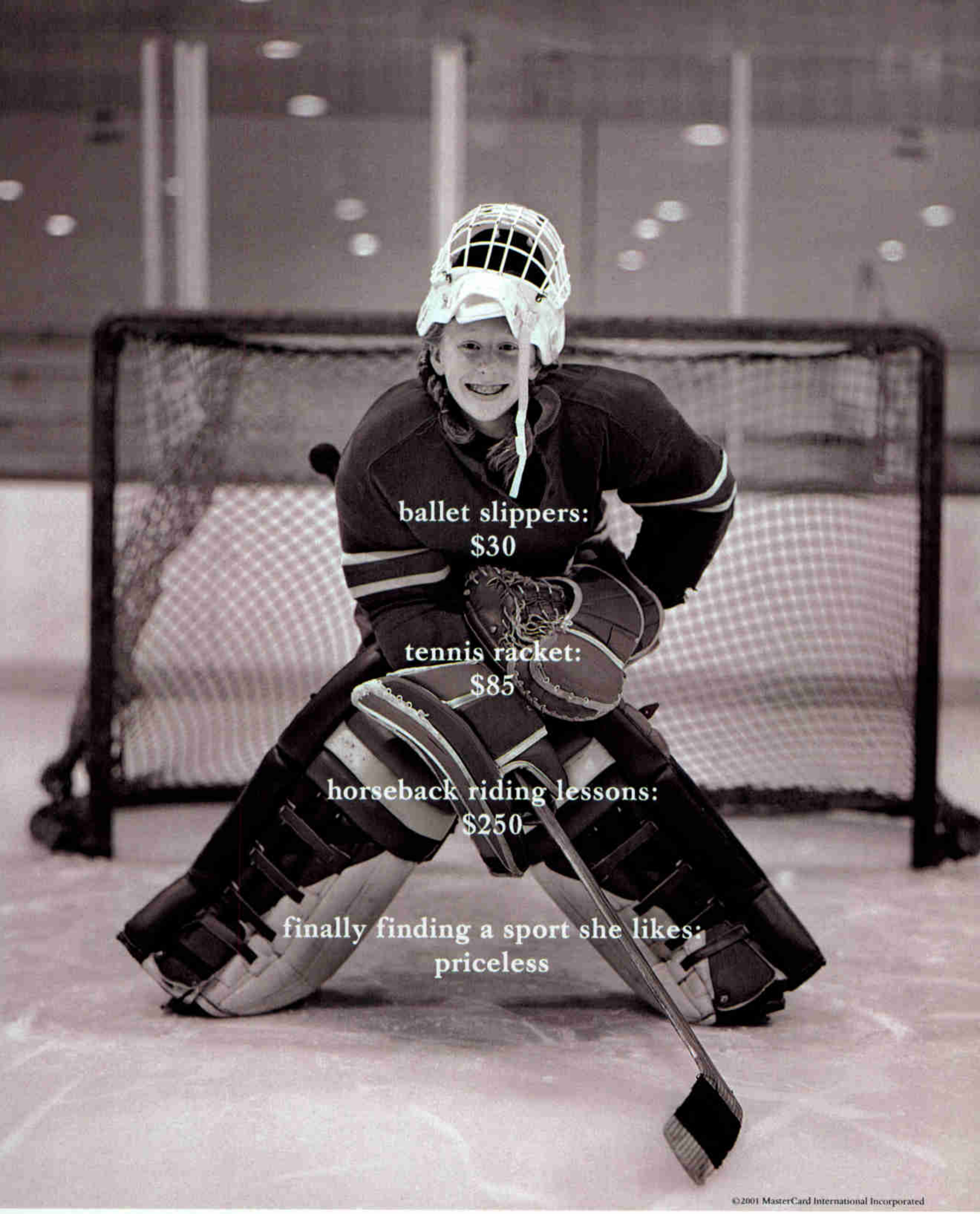

Having to deck her out from head to toe all over again? Well, visit the hockeydepot.com and get 20% off any order of $75 or more when you use MasterCard.® Just sign up with MasterCard Exclusives Online™ at mastercard.com

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Monhegan Island

I was dismayed that the article took the easy route of using outdated stereotypes of the coastal Maine resident. Photographs of weather-beaten, unsmiling faces are presented out of context alongside tales of surly, revenge-seeking lobstermen and inhospitable local residents to perpetuate the myth of the unfriendly, uncultured Mainer.

ERICA STEVENS
Wells, Maine

We recently spent a few days on Monhegan and read in your article about the unfriendliness of the natives. It is true, but their manners are so extreme that we still have many laughs about it—shopkeepers and passersby who refused to speak and an innkeeper who constantly left little notes about our habits.

DOUG RAND AND RUTH ANGELETTI
Bozeman, Montana

My father's family trapped lobster and fished off the coast of Maine starting when my relative Henry Donnell sailed from Europe in 1631. Trapping lobster is arduous, and the chances of coming up empty are always there, so one must make every effort to reap what he can. The challenges of working the sea tend to make men stern and cold, but once the day's work is done and the catch is secured, these solitary men seek companionship and mirth.

WILLIAM J. DONNELL, JR.
Alma, Michigan

AMY TOENSING

Readers who enjoyed Cathy Newman's article on Monhegan Island may wish to read "Monhegan" in the February 1959 issue. The earlier black and white photographs by Kosti Ruohomaa captured the wintry insularity unique to life on the island. There was even a photo of the Odom brothers in their slickers and sou'westers.

CHUCK McLEAN
Driggs, Idaho

free market discourage controls and encourage the profitable construction of homes on "green field sites" rather than the more difficult redevelopment of inner-city or industrial sites. But even in the U.S. consequences will eventually catch up with you. There's really no such thing as an infinite resource, is there?

TONY LAKE
Hertford, England

The caption on page 71 describing crimes by the radical environmental group Earth Liberation Front omitted the key element: the word "terrorist." The FBI has identified the ELF and like groups as a domestic terrorist threat.

JIMMY B. PICKENS
Abilene, Texas

The viewpoint from the farmer you interviewed on the subject of urban sprawl is not convincing. Many individual farmers have owned hundreds of acres of farmland for generations. Now farmers are telling me that development for my quarter-acre yard is not fair. Isn't farmland just another form of development? I doubt that Lewis and Clark stumbled upon too many hundred-acre cornfields.

WADE A. MITCHELL
Lexington, Kentucky

Grizzlies

Although grizzlies are natural to this country and were more numerous at the time of the American Revolution, much was different then. It was natural for a lot of women to die in childbirth. Natural is not always good. They should introduce grizzlies to Central Park and see how long environmentalists, who are always wanting to limit others' freedom, could endure the grizzlies.

KATHERINE SECHRIST
Mountain Brook, Alabama

I was disturbed by the hunting guide's comments. How could anyone take pride in killing defenseless bears? He is proud of getting hunters close to their quarry because "I want to be where the bear has a chance to hit back." Let's put some of those bear hunters in the woods without their guns and see how they fare then.

WILLIAM GRAVEREAUX
Norwalk, Connecticut

Grizzlies have the same problems that most other animals do—lack of space, food, and natural habitat. There is one common

WRITE TO FORUM

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denominator: too many people. Instead of trying to keep wildlife space protected—we will never find a compromise among logging companies, land developers, tourism companies, and governments—maybe we should start fencing human habitat and reducing it each year. Then maybe humans would understand that every living being has a reason for inhabiting the Earth and that biodiversity is important for the well-being of the planet.

ERNESTO RODRÍGUEZ
Mexico City, Mexico

I was disappointed in your cover selection depicting only the jaws of a snarling grizzly. Your photograph merely perpetuates the stereotype of a grizzly as a menace. It betrayed an otherwise thoughtful article on this great land animal.

BARRY CLIVER
McLean, Virginia

On page 19 you state that British Columbia officials claim there are 10,000 to 13,000 grizzlies in the province. These officials are the game biologists employed as professionals to make such a claim. I question your statement that "skeptics" say the true figure may be much lower. Who are these skeptics? The media often gives credence to statements by so-called skeptics when there is no foundation for such statements. The newly elected provincial government has announced a more realistic look at the numbers with a view to reinstituting controlled hunting in areas where it is known for sure there are high numbers of bears.

RONALD SAUVE
Cranbrook, British Columbia

A number of professional wildlife biologists as well as environmental advocates have reservations about the grizzly bear figures, which are very difficult to determine. Even in the greater Yellowstone ecosystem officials can say only that the actual number of grizzlies is anywhere from around 400 to 600.

I was disappointed in your cover selection depicting only the jaws of a snarling grizzly. Your photograph merely perpetuates the stereotype of a grizzly as a menace.

Cuba's Golden Past

I read with awe about the fabulous riches of Cuba. However, I was disturbed by the fact that centuries-old coral had to be removed to get to the sunken gold. Thinking of depleted coral reefs all over the world, I wonder if the environmental price was worth the gold recovered.

HO JOON WEE
Alor Setar, Malaysia

EarthPulse

In recent years your ill-disguised green editorializing has become irritating. The implied criticism of industrialized nations for the relative size of citizens' ecological footprints is misleading. Were those footprints not so large, many of our planet's denizens would not have footprints. To a great extent the citizens of underdeveloped nations are able to exist only because industrialized nations have made the progress necessary for the whole world to have its large population.

H. R. BOB MANNING
Charleston, South Carolina

Truth is, we do not need anywhere near the amount of resources that we consume, and most of our consumptive "need" is falsely created. Perhaps you need a reality-based issue that takes the reader by the hand—or the scruff of the neck—and says, "This is the way it is. We have to change our lifestyles if we wish to sustain our own existence."

JIM MILES
Vernon, British Columbia

Geographica

The only quote in the article on the Gaviota Coast was from National Park Service employee Ray Murray, who said "the real tussles are whether land will go to trophy homes and subdivisions or to permanent protection and compatible uses." He should know that county zoning laws in place for many years say that no home can be built on less than a hundred acres. Wildlife currently thrives because of this regional approach to open space. Turning this special place into a national seashore leaves me with nightmares of the federal government's management of national parks such as Yosemite. With a national seashore come more people and more infrastructure. If I were a wild creature, I would certainly prefer the land as it is.

LARRY PROSOR
Gaviota, California

DID THE SEA CALL HER BY NAME?

As a child, the sea fascinated her. Every wave, shell and creature held her spellbound. Years later, this incredible bond has grown. Her name is Sylvia Earle. She's pioneered research on marine ecosystems. Led more than 50 expeditions. Logged over 6,000 hours underwater. And holds numerous diving records. She even played a key role in the U.S. government's decision to double the budget of the National Marine Sanctuaries. Dr. Sylvia Earle, marine biologist, and National Geographic explorer-in-residence, is one of Ford Motor Company's Heroes for the Planet. A program that's part of ongoing Ford Motor Company initiatives to underwrite and support efforts that make the world a better place. To learn more about Dr. Earle and other Heroes for the Planet, visit our website. You'll find fascinating information, including links to her favorite sites. Around the globe, there are amazing individuals who've dedicated their lives to our planet. You'll find them at www.ford.com/heroes. Stop by. The world is waiting.

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EarthPulse

ECOSYSTEMS

Valuing the Invaluable

When natural resources are depleted, there's often a hidden cost

How many cell phones is a gorilla worth? In the Democratic Republic of the Congo, eastern lowland gorillas are being killed for food by miners searching for coltan, a mineral in demand for making capacitors used in high-tech electronics. Each gorilla lost diminishes the country's potential to attract ecotourists.

The gorillas' forest habitat is not the only ecosystem taking a beating. With globalization, humans are increasingly mismanaging such ecosystems, from prairies to forests to oceans. This abuse harms not only wildlife but also our own economic interests.

Grasslands, for example, store huge amounts of carbon dioxide in plants and soil; when the land is plowed or burned, that greenhouse gas enters the atmosphere, which adds to global warming, spurring sea level rise and increasing major storms that destroy coastal property. In coastal forests logging increases runoff, polluting streams; we gain the wood but lose the fish. In China, cutting forests in the Yangtze River watershed led to siltation and massive flooding in 1998, killing 3,600 people.

Yet sometimes we can reverse the tide. Prairies overrun with alien species can be restored, giving native plants the room to thrive. An old dam, no longer useful, can be torn out, allowing fish—and paying fishermen—to return.

FRESH WATER SYSTEMS

BENEFITS

- Water for domestic, agricultural, and industrial use
- Filtration and flood control
- Scenic value

COSTS IF LOST

$60 million Projected cost to establish program in Nigeria to combat schistosomiasis, a parasitic disease contracted from contaminated water

$1.5 billion Amount allocated by New York City to protect its watershed; building a water filtration plant: $4 billion

$200,000 Market value of Maine lakefront site; comparable site inland: $50,000

OCEANS AND COASTS

BENEFITS

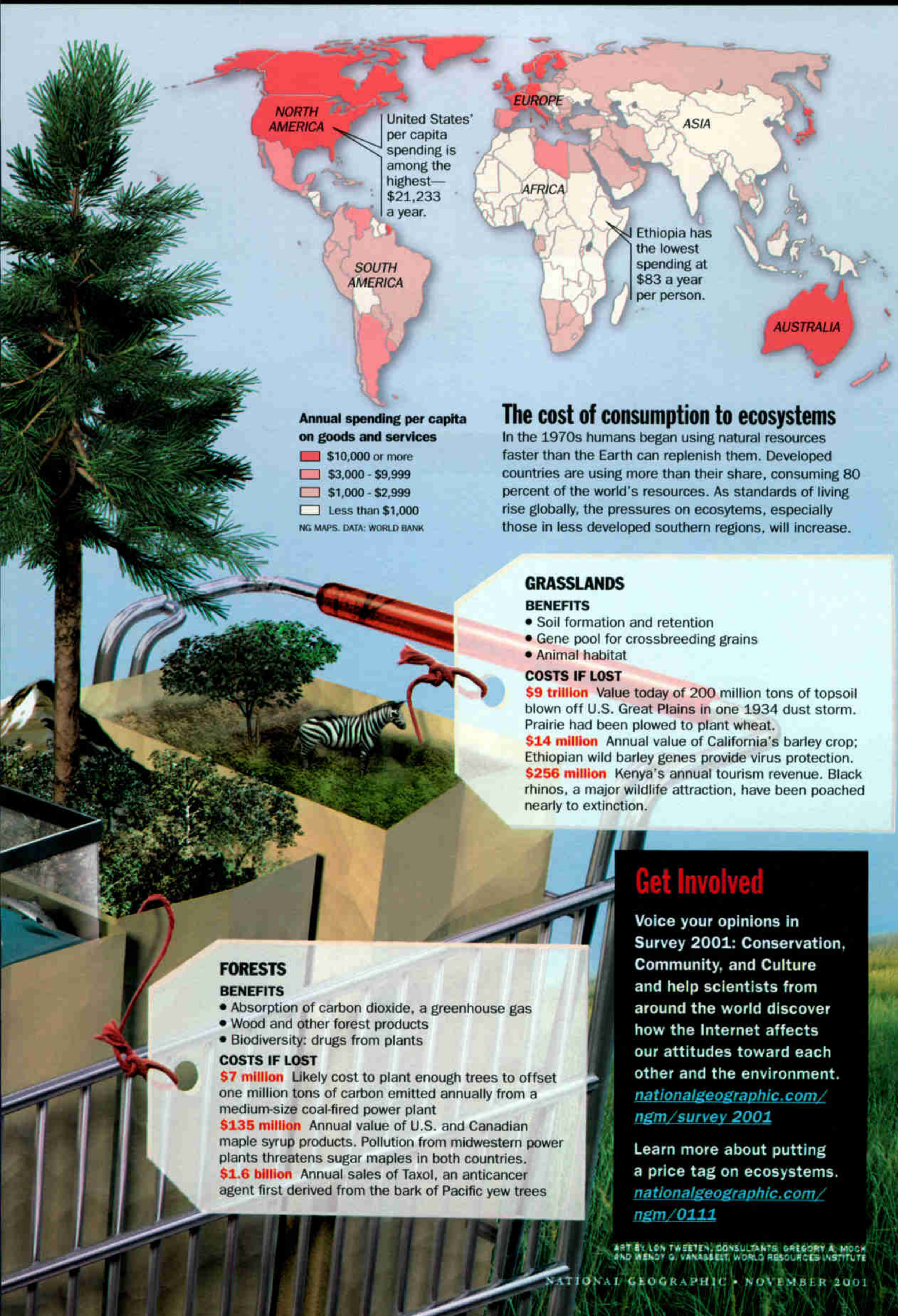
- Major source of food protein
- Protection against coastal flooding and erosion
- Tourist and recreational revenue

COSTS IF LOST

$51 million Value of Canada's annual Atlantic cod catch, down from $148 million in 1989. Catch fell from 426,000 to 47,000 tons due to overfishing.

$100,000 Yearly cost to some Bali hotels to combat beach erosion caused by destruction of coral reefs

$33,500 Annual value of a single shark to diving industry in Maldive Islands; value to a fisherman: $32



The cost of consumption to ecosystems

In the 1970s humans began using natural resources faster than the Earth can replenish them. Developed countries are using more than their share, consuming 80 percent of the world's resources. As standards of living rise globally, the pressures on ecosytems, especially those in less developed southern regions, will increase.

GRASSLANDS

BENEFITS

- Soil formation and retention
- Gene pool for crossbreeding grains
- Animal habitat

COSTS IF LOST

$9 trillion Value today of 200 million tons of topsoil blown off U.S. Great Plains in one 1934 dust storm. Prairie had been plowed to plant wheat.

$14 million Annual value of California's barley crop; Ethiopian wild barley genes provide virus protection.

$256 million Kenya's annual tourism revenue. Black rhinos, a major wildlife attraction, have been poached nearly to extinction.

FORESTS

BENEFITS

- Absorption of carbon dioxide, a greenhouse gas
- Wood and other forest products
- Biodiversity: drugs from plants

COSTS IF LOST

$7 million Likely cost to plant enough trees to offset one million tons of carbon emitted annually from a medium-size coal-fired power plant

$135 million Annual value of U.S. and Canadian maple syrup products. Pollution from midwestern power plants threatens sugar maples in both countries.

$1.6 billion Annual sales of Taxol, an anticancer agent first derived from the bark of Pacific yew trees

Get Involved

Voice your opinions in Survey 2001: Conservation, Community, and Culture and help scientists from around the world discover how the Internet affects our attitudes toward each other and the environment.
nationalgeographic.com/ngm/survey 2001

Learn more about putting a price tag on ecosystems.
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ART BY LON TWEETEN, CONSULTANTS GREGORY A. MOCK AND WENDY G. VANASSELT, WORLD RESOURCES INSTITUTE

When fires in Mexico destroyed 490,000 acres of forest and 870,000 acres of grassland, Ford Motor Company, our dealers, and the government of Mexico joined together to plant more than 3 million trees in an effort to bring the ecosystem back into balance.

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Seedlings

TRES MARIA, MEXICO

Sometimes people can't

see the forest

for the trees.

Sometimes they can't see the forest, period.

AMERICANA

Fighting Words Remembered

Legacy Project is looking for veterans' letters

While inspecting Adolf Hitler's abandoned apartment after the fall of Munich in 1945, Staff Sgt. Horace Evers took more than just a look around. The young American soldier took a sheet of the former occupant's stationery, replaced the engraved name with his own (below), and wrote a letter home.

Such correspondence is a neglected source of American history, says Andrew Carroll, who founded the nonprofit Legacy Project in 1998. (For more

information, see the Legacy Project website at *warletters.com*.) The all-volunteer organization encourages preservation of letters written during any American military action. It has amassed copies of more than 60,000 such documents, from the Civil War (opposite, bottom) to Vietnam (opposite, top) to the most recent Bosnian conflict. "People are throwing these letters away because they think nobody cares," says Carroll. "We care. We want them saved for posterity."

NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN

APHICA

CREATURES OF OUR UNIVERSE

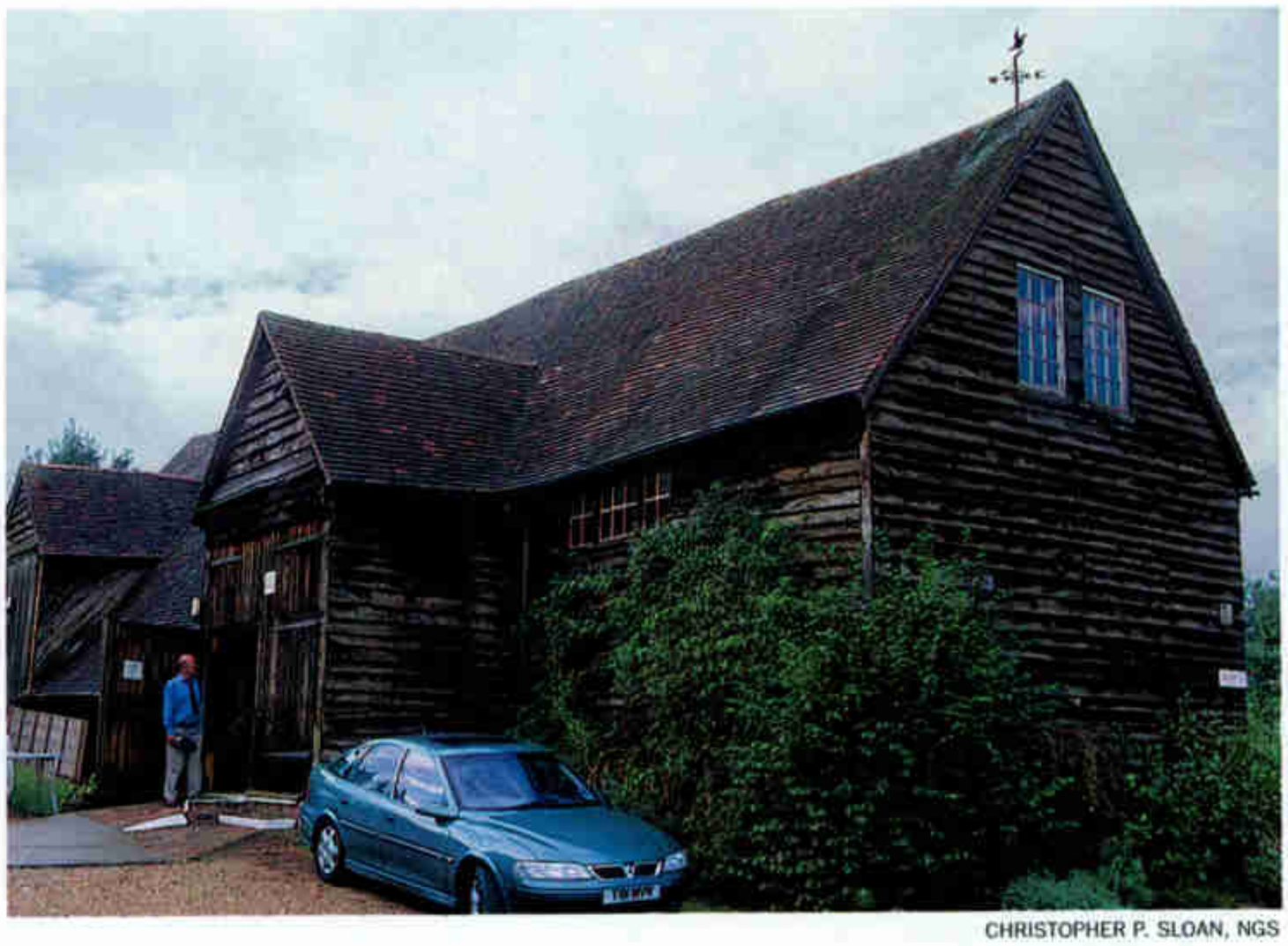
Some letters are particularly poignant. After enduring the Bataan Death March, Lt. Thomas Kennedy addressed a family snapshot (opposite, bottom) to his parents; it was smuggled out by a survivor after Kennedy died on a Japanese POW ship. "I'm not afraid to die," he had penciled in tiny letters on the photograph's back, "I just hate the thought of not seeing you again."

Other letters had happier endings. The bullet from the Battle of Anzio that burned through Pvt. John P. McGrath's 1944 letter to a school friend (opposite, top) never pierced the writer himself—just his backpack. He lived to bring the letter home from Italy, hole and all.

HISTORY

Mayflower Dry Dock

The Pilgrims' ship *Mayflower* spent the winter of 1620 at Plymouth with its Puritan and other passengers, but its final harbor may well have been a Quaker farm back in England. In the village of Jordans, Buckinghamshire, oak beams in a building now known as the Mayflower Barn (right) reportedly came from the vessel, which was dismantled in 1624, about the time the barn was built by local shipwrights.



CHRISTOPHER P. SLOAN, NGS

ENVIRONMENT

Cleaner Machines?

Whether or not a proposed ban on snowmobiles in national parks is approved, the Society of Automotive Engineers International is proceeding with college competitions to design machines that are clean, quiet, and still fun to ride. Four-stroke engines are considered "greener," but in trials last March (left) a two-stroker placed first, with the best combination of low emissions, quiet operation, fuel efficiency, and performance. "We're outside the political arena. We want to prepare young engineers for the industry," says SAE's Steve Yaeger.

LUCAS GILMAN

ALMANAC

November

Unlike many rodents, porcupines do not cache food in the fall; they feed on bark available through the winter. In autumn they're free to focus on sex. The female comes into estrus in October. She keeps her quills flat against her body so her mate isn't impaled.

ART BY SHAWN GOULD

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AND "MUSCLE-BOUND" IN THE SAME SENTENCE.

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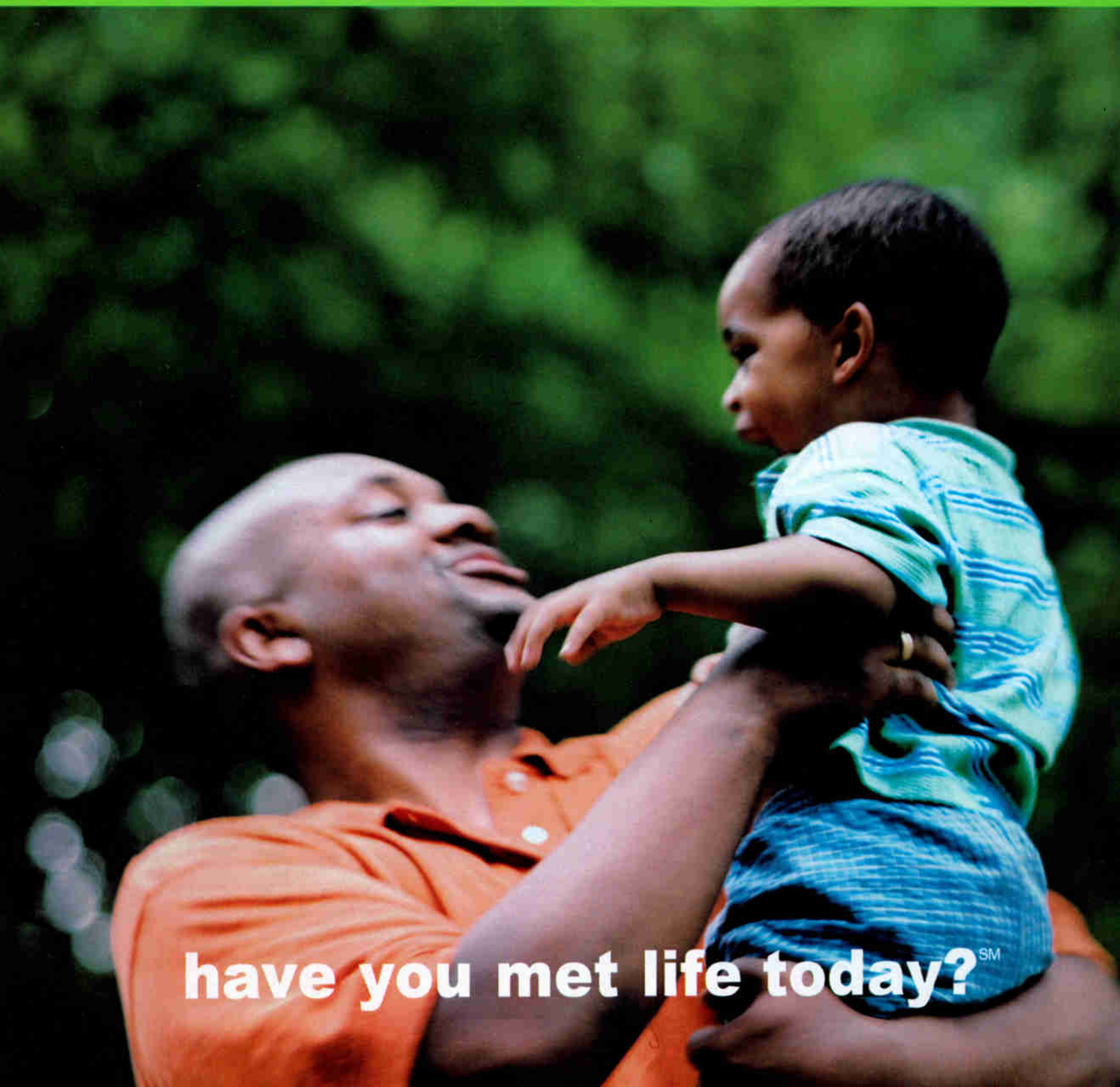
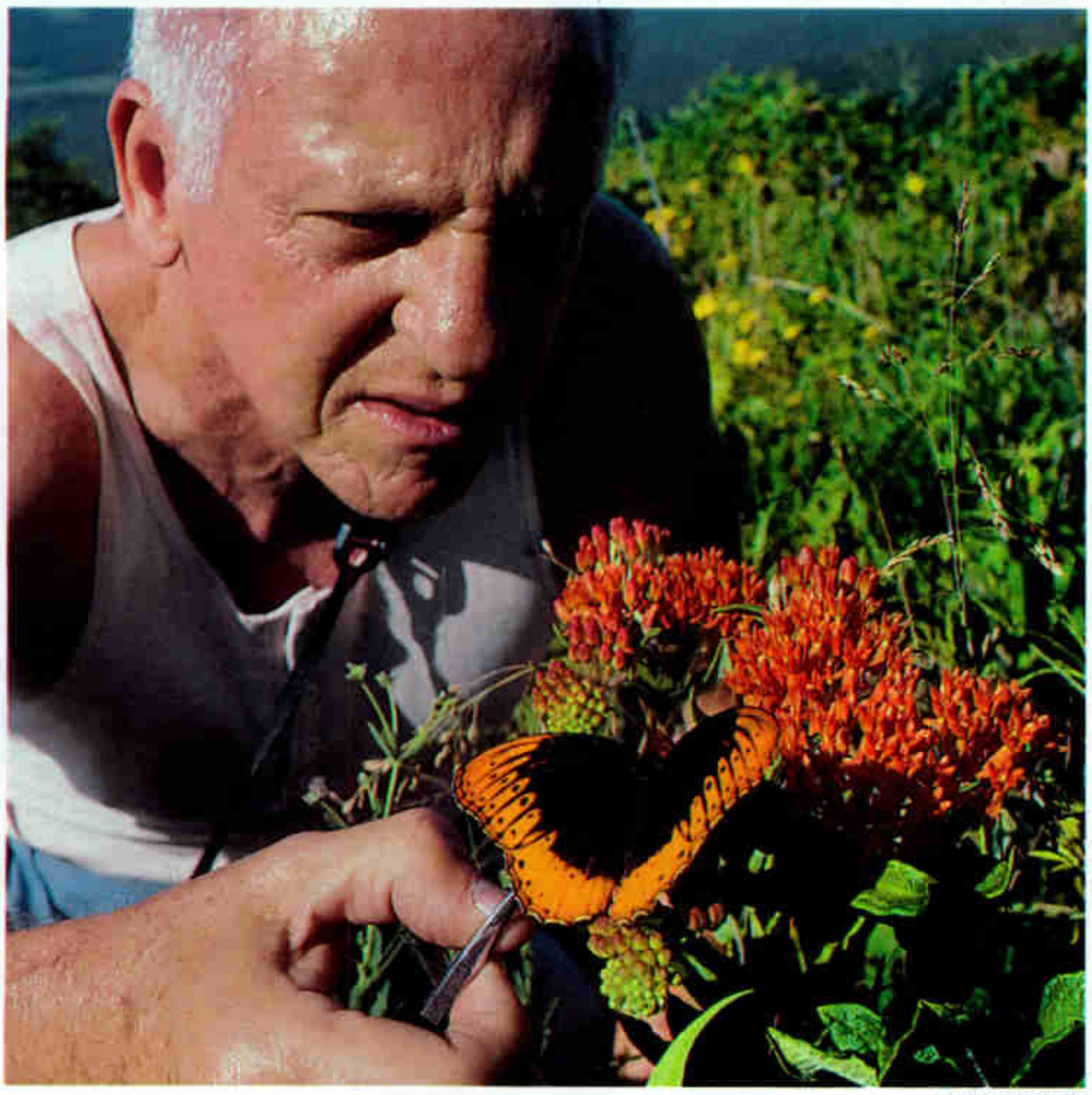




GARY NOEL ROSS

NGS RESEARCH GRANT

Butterflies Losing Habitat

Gary Noel Ross has spent much of his life studying the large and lovely Diana butterfly. One of the species' haunts is Mount Magazine in Arkansas, where butterfly weed (left), purple coneflower, mountain mint, blazing star, and thistles bloom, favorite nectar plants of Dianas. The mountain had been undisturbed as part of a national forest. Now a state park is being created, and many plants have been bulldozed for a road, parking lots, cabins, waterlines, and sewers. "The park is trying to limit the impact," says Ross, "but the Diana is still at risk."

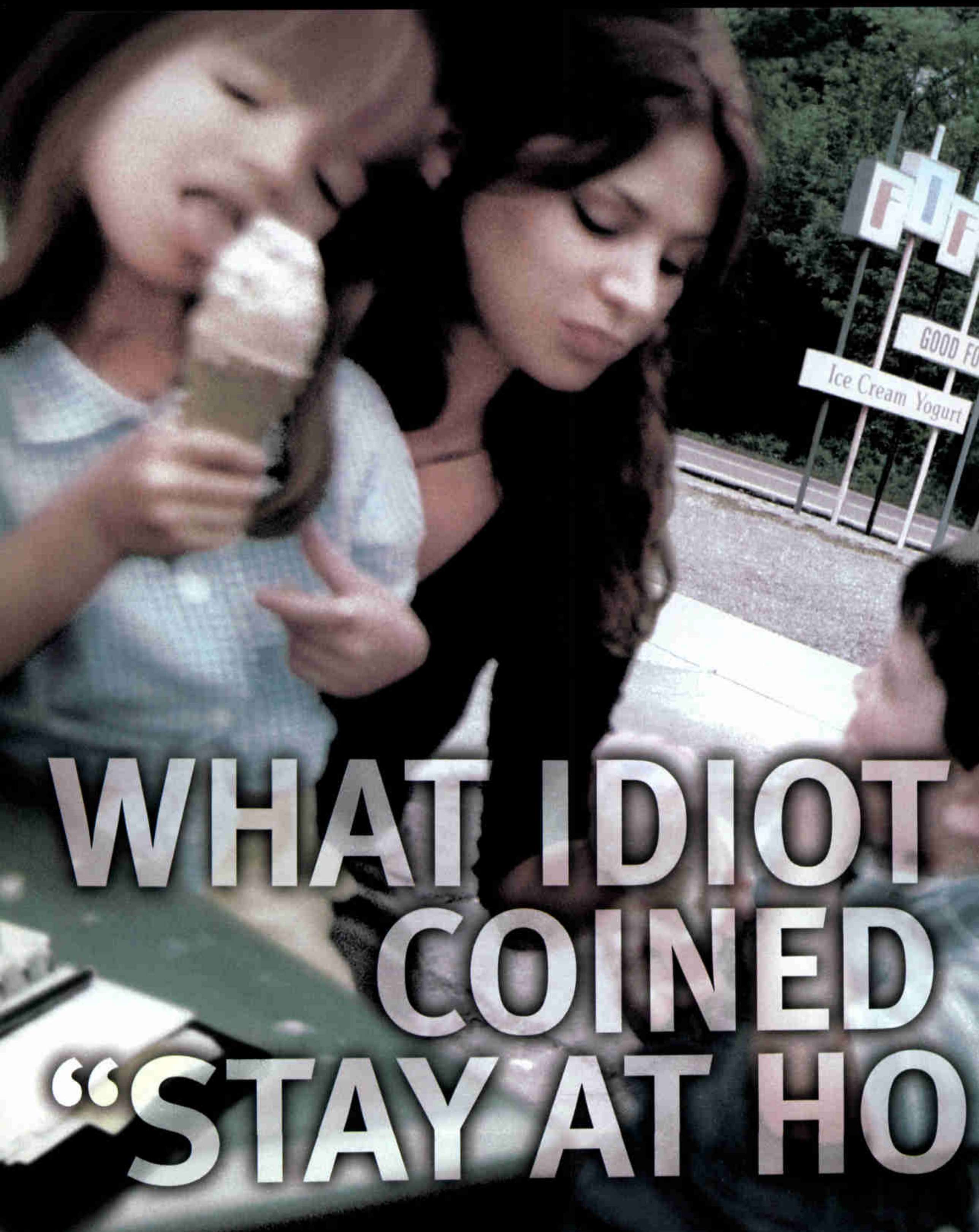
ICE AGE HUMANS

Ancient Rock Art Found in Italy

BOTH BY GIOVANNI LATTANZI

Fumane Cave (above) near Verona, Italy, has long provided scientists with clues about life in prehistoric Europe. Now fragments found on its floor may exhibit some of the world's oldest cave paintings—nearly twice the age of art at the caves of Altamira and Lascaux.

One of the red ocher paintings may portray a human with horns (left). Experts estimate they were originally drawn on the cave ceiling some 35,000 years ago, about the same time as images found at France's Chauvet Cave. According to French archaeologist Jean Clottes, "It means that painting in caves and shelters was probably widespread" during this European Stone Age culture.



WHAT IDIOT COINED "STAY AT HO

GRAB LIFE BY THE HORNS

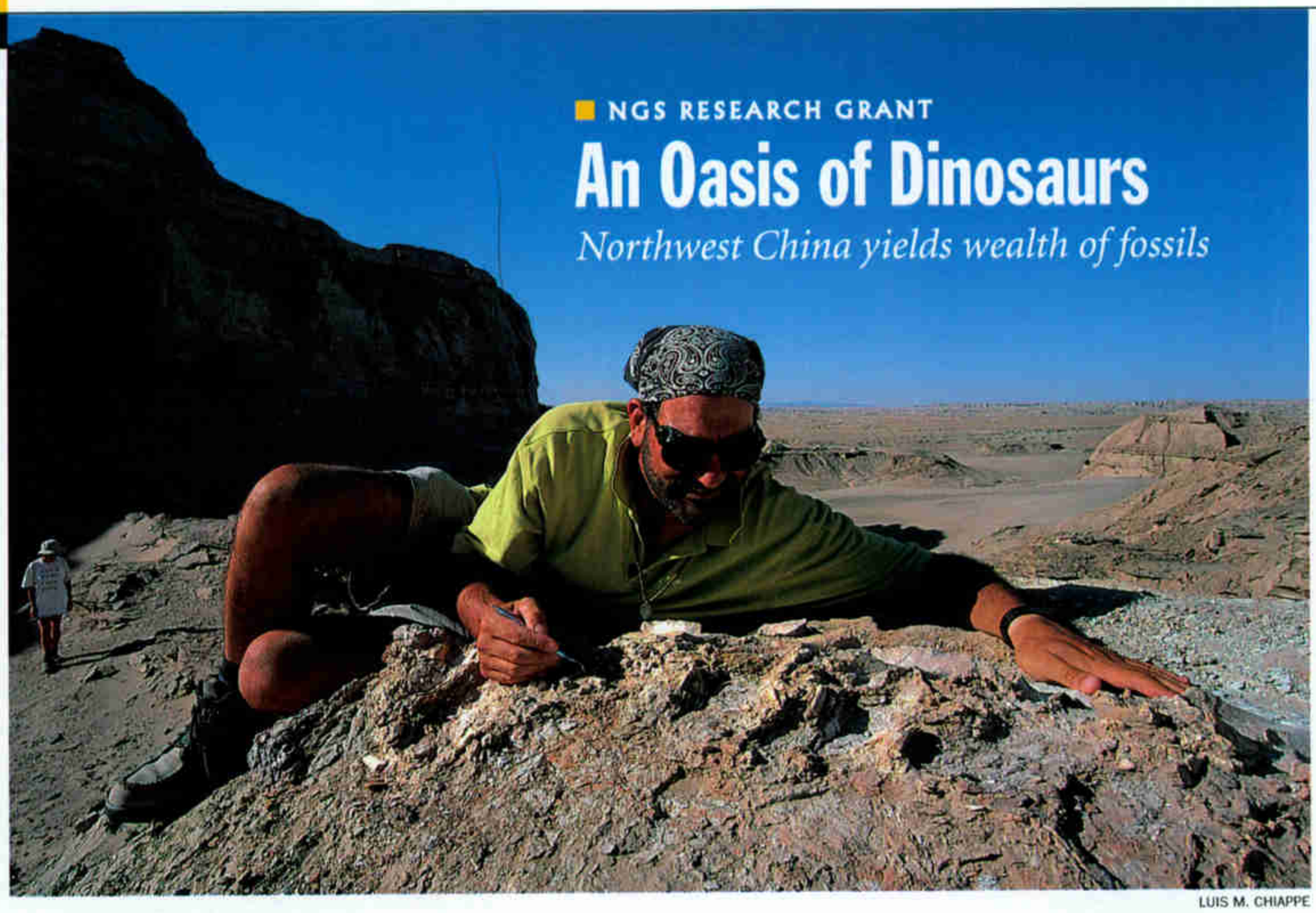
DODGE

THE PURPOSE OF THE PHRASE "GRAB ME MOM?"

NGS RESEARCH GRANT

An Oasis of Dinosaurs

Northwest China yields wealth of fossils



LUIS M. CHIAPPE

The Junggar Basin in the far northwest corner of China is "a phenomenal place for dinosaur hunting," says Society grantee Luis M. Chiappe. "It is virtually unexplored, there are plenty of outcrops, and they contain a lot of fossil remains." Recent discoveries made by Chiappe and his international team include the vertebrae of a large stegosaur (above), two possibly new species of small bipedal plant-eating dinosaurs, several pterodactyls, aquatic turtles, and tiny crocodiles. The crocodiles had skulls about an inch long and multicuspidal teeth, like a mammal's molars rather than a lizard's sharp, conical teeth.

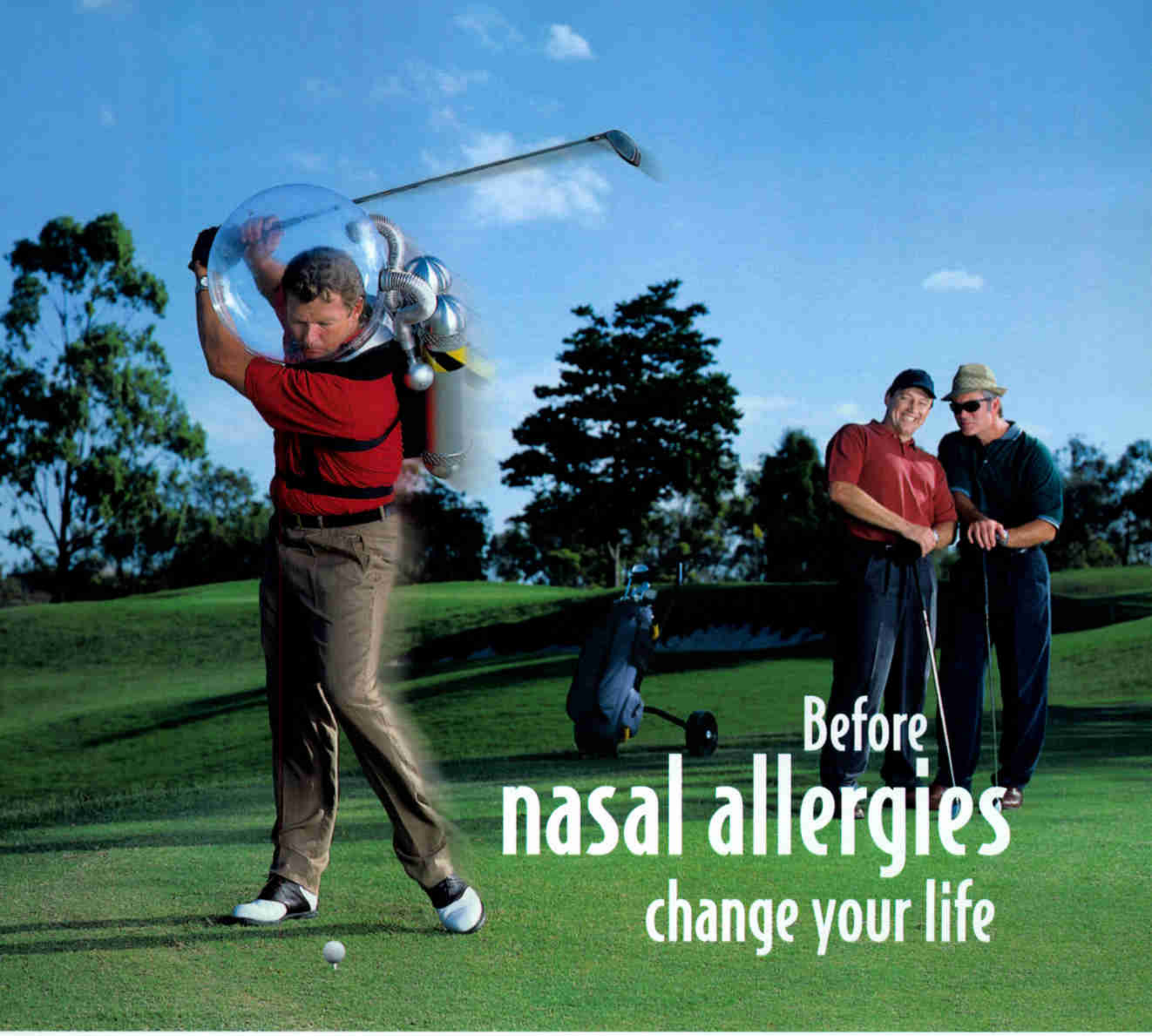
Many fossils in this age range —135 million to 115 million years old, dating from the early to middle Cretaceous period— have been found in northeastern China, and Chiappe hopes to combine finds from both areas to get "a much better picture of Cretaceous vertebrate life across Asia."

THOMAS EISNER

INSECT WORLD

Beetles Waste Not

Vulnerable to many enemies, larvae of blue tortoise beetles have a self-made defense—a thatch-like shield they construct from strands of their own dung. The shelter completely hides the baby beetles, which live on palm fronds in Florida, Georgia, and Texas. Researchers Thomas and Maria Eisner of Cornell University found that the defense thwarts two common predators but not a third. Purplish green, iridescent carabid beetles (left) bite through the top of the hideout and devour the prize within.



Make an easier Change

Coping with the handicap of nasal allergies can get really frustrating.

Of course, you would never go to these extremes. But before you change your life, maybe you should make an easier change. Ask your doctor about FLONASE.

Using multi-symptom FLONASE Nasal Spray once a day can relieve all these nasal allergy symptoms — congestion, sneezing, and itchy, runny nose — all day and night. Results may vary.

If side effects occur, they are generally mild, and may include headache, nosebleed, or sore throat. For best results, use daily. Maximum relief may take several days. Available by prescription only.

Ask your doctor about multi-symptom FLONASE, or call 1-800-FLONASE, or visit www.flonase.com.

gsk
GlaxoSmithKline

When you get it all, all it takes is Flonase® (fluticasone propionate) Nasal Spray, 50 mcg

Please see important information on the following page.

FLONASE®
(fluticasone propionate)
Nasal Spray, 50 mcg

BRIEF SUMMARY

SHAKE GENTLY BEFORE USE.

For Intranasal Use Only.

The following is a brief summary only; see full prescribing information for complete product information.

CONTRAINDICATIONS: FLONASE Nasal Spray is contraindicated in patients with a hypersensitivity to any of its ingredients.

WARNINGS: The replacement of a systemic corticosteroid with a topical corticosteroid can be accompanied by signs of adrenal insufficiency, and in addition some patients may experience symptoms of withdrawal, e.g., joint and/or muscular pain, lassitude, and depression. Patients previously treated for prolonged periods with systemic corticosteroids and transferred to topical corticosteroids should be carefully monitored for acute adrenal insufficiency in response to stress. In those patients who have asthma or other clinical conditions requiring long-term systemic corticosteroid treatment, too rapid a decrease in systemic corticosteroids may cause a severe exacerbation of their symptoms.

The concomitant use of intranasal corticosteroids with other inhaled corticosteroids could increase the risk of signs or symptoms of hypercorticism and/or suppression of the HPA axis.

Patients who are on immunosuppressant drugs are more susceptible to infections than healthy individuals. Chickenpox and measles, for example, can have a more serious or even fatal course in patients on immunosuppressant doses of corticosteroids. In such patients who have not had these diseases, particular care should be taken to avoid exposure. How the dose, route, and duration of corticosteroid administration affects the risk of developing a disseminated infection is not known. The contribution of the underlying disease and/or prior corticosteroid treatment to the risk is also not known. If exposed to chickenpox, prophylaxis with varicella zoster immune globulin (VZIG) may be indicated. If exposed to measles, prophylaxis with pooled intramuscular immunoglobulin (IG) may be indicated. (See the respective package inserts for complete VZIG and IG prescribing information.) If chickenpox develops, treatment with antiviral agents may be considered.

PRECAUTIONS:

General: Rarely, immediate hypersensitivity reactions or contact dermatitis may occur after the administration of FLONASE Nasal Spray. Rare instances of wheezing, nasal septum perforation, cataracts, glaucoma, and increased intraocular pressure have been reported following the intranasal application of corticosteroids, including fluticasone propionate.

Use of excessive doses of corticosteroids may lead to signs or symptoms of hypercorticism, suppression of HPA function, and/or reduction of growth velocity in children or teenagers. Physicians should closely follow the growth of children and adolescents taking corticosteroids, by any route, and weigh the benefits of corticosteroid therapy against the possibility of growth suppression if growth appears slowed.

Although systemic effects have been minimal with recommended doses of FLONASE Nasal Spray, potential risk increases with larger doses. Therefore, larger than recommended doses of FLONASE Nasal Spray should be avoided.

When used at higher than recommended doses, or in rare individuals at recommended doses, systemic corticosteroid effects such as hypercorticism and adrenal suppression may appear. If such changes occur, the dosage of FLONASE Nasal Spray should be discontinued slowly consistent with accepted procedures for discontinuing oral corticosteroid therapy.

In clinical studies with fluticasone propionate administered intranasally, the development of localized infections of the nose and pharynx with *Candida albicans* has occurred only rarely. When such an infection develops, it may require treatment with appropriate local therapy and discontinuation of treatment with FLONASE Nasal Spray. Patients using FLONASE Nasal Spray over several months or longer should be examined periodically for evidence of *Candida* infection or other signs of adverse effects on the nasal mucosa.

FLONASE Nasal Spray should be used with caution, if at all, in patients with active or quiescent tuberculous infection; untreated local or systemic fungal or bacterial, or systemic viral infections or parasitic infection; or ocular herpes simplex.

Because of the inhibitory effect of corticosteroids on wound healing, patients who have experienced recent nasal septal ulcers, nasal surgery, or nasal trauma should not use a nasal corticosteroid until healing has occurred.

Information for Patients: Patients being treated with FLONASE Nasal Spray should receive the following information and instructions. This information is intended to aid them in the safe and effective use of this medication. It is not a disclosure of all possible adverse or intended effects.

Patients should be warned to avoid exposure to chickenpox or measles and, if exposed, to consult their physician without delay.

Patients should use FLONASE Nasal Spray at regular intervals as directed since its effectiveness depends on its regular use. A decrease in nasal symptoms may occur as soon as 12 hours after starting therapy with FLONASE Nasal Spray. Results in several clinical trials indicate statistically significant improvement within the first day or two of treatment; however, the full benefit of FLONASE Nasal Spray may not be achieved until treatment has been administered for several days. The patient should not increase the prescribed dosage but should contact the physician if symptoms do not improve or if the condition worsens. For the proper use of the nasal spray and to attain maximum improvement, the patient should read and follow carefully the accompanying patient's instructions.

Drug Interactions: In a placebo-controlled, crossover study in eight healthy volunteers, coadministration of a single dose of orally inhaled fluticasone propionate (1000 mcg, 5 times the maximum daily intranasal dose) with multiple doses of ketoconazole (200 mg) to steady state resulted in increased mean fluticasone propionate concentrations, a reduction in plasma cortisol AUC, and no effect on urinary excretion of cortisol. This interaction may be due to an inhibition of the cytochrome P450 3A4 isoenzyme system by ketoconazole, which is also the route of metabolism of fluticasone propionate. No drug interaction studies have been conducted with FLONASE Nasal Spray; however, care should be exercised when fluticasone propionate is coadministered with long-term ketoconazole and other known cytochrome P450 3A4 inhibitors.

Carcinogenesis, Mutagenesis, Impairment of Fertility: Fluticasone propionate demonstrated no tumorigenic potential in mice at oral doses up to 1000 mcg/kg (approximately 20 times the maximum recommended daily intranasal dose in adults and approximately 10 times the maximum recommended daily intranasal dose in children on a mcg/m² basis) for 78 weeks or in rats at inhalation doses up to 57 mcg/kg (approximately 2 times the maximum recommended daily intranasal dose in adults and approximately equivalent to the maximum recommended daily intranasal dose in children on a mcg/m² basis) for 104 weeks.

Fluticasone propionate did not induce gene mutation in prokaryotic or eukaryotic cells in vitro. No significant clastogenic effect was seen in cultured human peripheral lymphocytes in vitro or in the mouse micronucleus test when administered at high doses by the oral or subcutaneous routes. Furthermore, the compound did not delay erythroblast division in bone marrow.

No evidence of impairment of fertility was observed in reproductive studies conducted in male and female rats at subcutaneous doses up to 50 mcg/kg (approximately 2 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis). Prostate weight was significantly reduced at a subcutaneous dose of 50 mcg/kg.

Pregnancy: ***Teratogenic Effects:*** Pregnancy Category C. Subcutaneous studies in the mouse and rat at 45 and 100 mcg/kg, respectively (approximately equivalent to and 4 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis, respectively) revealed fetal toxicity characteristic of potent corticosteroid compounds, including embryonic growth retardation, omphalocele, cleft palate, and retarded cranial ossification.

In the rabbit, fetal weight reduction and cleft palate were observed at a subcutaneous dose of 4 mcg/kg (less than the maximum recommended daily intranasal dose in adults on a mcg/m² basis).

However, no teratogenic effects were reported at oral doses up to 300 mcg/kg (approximately 25 times the maximum recommended daily intranasal dose in adults on a mcg/m² basis) of fluticasone propionate to the rabbit. No fluticasone propionate was detected in the plasma in this study, consistent with the established low bioavailability following oral administration (see CLINICAL PHARMACOLOGY section of full prescribing information).

Fluticasone propionate crossed the placenta following oral administration of 100 mcg/kg to rats or 300 mcg/kg to rabbits (approximately 4 and 25 times, respectively, the maximum recommended daily intranasal dose in adults on a mcg/m² basis).

There are no adequate and well-controlled studies in pregnant women. Fluticasone propionate should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus.

Experience with oral corticosteroids since their introduction in pharmacologic, as opposed to physiologic, doses suggests that rodents are more prone to teratogenic effects from corticosteroids than humans. In addition, because there is a natural increase in corticosteroid production during pregnancy, most women will require a lower exogenous corticosteroid dose and many will not need corticosteroid treatment during pregnancy.

Nursing Mothers: It is not known whether fluticasone propionate is excreted in human breast milk. When tritiated fluticasone propionate was administered to rats at a subcutaneous dose of 10 mcg/kg (less than the maximum recommended daily intranasal dose in adults on a mcg/m² basis), radioactivity was excreted in the milk. Because other corticosteroids are excreted in human milk, caution should be exercised when FLONASE Nasal Spray is administered to a nursing woman.

Pediatric Use: Five hundred (500) patients aged 4 to 11 years of age and 440 patients aged 12 to 17 years were studied in US clinical trials with fluticasone propionate nasal spray. The safety and effectiveness of FLONASE Nasal Spray in children below 4 years of age have not been established.

Oral and, to a less clear extent, inhaled and intranasal corticosteroids have been shown to have the potential to cause a reduction in growth velocity in children and adolescents with extended use. If a child or adolescent on any corticosteroid appears to have growth suppression, the possibility that they are particularly sensitive to this effect of corticosteroids should be considered (see PRECAUTIONS).

Geriatric Use: A limited number of patients above 60 years of age (n =275) have been treated with FLONASE Nasal Spray in US and non-US clinical trials. While the number of patients is too small to permit separate analysis of efficacy and safety, the adverse reactions reported in this population were similar to those reported by younger patients.

ADVERSE REACTIONS: In controlled US studies, more than 3300 patients with seasonal allergic, perennial allergic, or perennial nonallergic rhinitis received treatment with intranasal fluticasone propionate. In general, adverse reactions in clinical studies have been primarily associated with irritation of the nasal mucous membranes, and the adverse reactions were reported with approximately the same frequency by patients treated with the vehicle itself. The complaints did not usually interfere with treatment. Less than 2% of patients in clinical trials discontinued because of adverse events; this rate was similar for vehicle placebo and active comparators.

Systemic corticosteroid side effects were not reported during controlled clinical studies up to 6 months' duration with FLONASE Nasal Spray. If recommended doses are exceeded, however, or if individuals are particularly sensitive, or taking FLONASE Nasal Spray in conjunction with administration of other corticosteroids, symptoms of hypercorticism, e.g., Cushing's syndrome, could occur.

The following incidence of common adverse reactions (>3%, where incidence in fluticasone propionate-treated subjects exceeded placebo) is based upon seven controlled clinical trials in which 536 patients (57 girls and 108 boys aged 4 to 11 years, 137 female and 234 male adolescents and adults) were treated with FLONASE Nasal Spray 200 mcg once daily over 2 to 4 weeks and two controlled clinical trials in which 246 patients (119 female and 127 male adolescents and adults) were treated with FLONASE Nasal Spray 200 mcg once daily over 6 months. Also included in the table are adverse events from two studies in which 167 children (45 girls and 122 boys aged 4 to 11 years) were treated with FLONASE Nasal Spray 100 mcg once daily for 2 to 4 weeks.

Overall Adverse Experiences With >3% Incidence on Fluticasone Propionate in Controlled Clinical Trials With FLONASE Nasal Spray in Patients ≥4 Years With Seasonal or Perennial Allergic Rhinitis

	Vehicle Placebo (n=758) %	FLONASE 100 mcg Once Daily (n=167) %	FLONASE 200 mcg Once Daily (n=782) %
Headache	14.6	6.6	16.1
Pharyngitis	7.2	6.0	7.8
Epistaxis	5.4	6.0	6.9
Nasal burning/ nasal irritation	2.6	2.4	3.2
Nausea/vomiting	2.0	4.8	2.6
Asthma symptoms	2.9	7.2	3.3
Cough	2.8	3.6	3.8

Other adverse events that occurred in ≤3% but ≥1% of patients and that were more common with fluticasone propionate (with uncertain relationship to treatment) included: blood in nasal mucus, runny nose, abdominal pain, diarrhea, fever, flu-like symptoms, aches and pains, dizziness, bronchitis.

Observed During Clinical Practice: In addition to adverse events reported from clinical trials, the following events have been identified during postapproval use of fluticasone propionate in clinical practice. Because they are reported voluntarily from a population of unknown size, estimates of frequency cannot be made. These events have been chosen for inclusion due to either their seriousness, frequency of reporting, causal connection to fluticasone propionate, occurrence during clinical trials, or a combination of these factors.

General: Hypersensitivity reactions, including angioedema, skin rash, edema of the face and tongue, pruritus, urticaria, bronchospasm, wheezing, dyspnea, and anaphylaxis/anaphylactoid reactions, which in rare instances were severe.

Ear, Nose, and Throat: Alteration or loss of sense of taste and/or smell and, rarely, nasal septal perforation, nasal ulcer, sore throat, throat irritation and dryness, cough, hoarseness, and voice changes.

Eye: Dryness and irritation, conjunctivitis, blurred vision, glaucoma, increased intraocular pressure, and cataracts.

OVERDOSAGE: Chronic overdosage with FLONASE Nasal Spray may result in signs/symptoms of hypercorticism (see PRECAUTIONS). Intranasal administration of 2 mg (10 times the recommended dose) of fluticasone propionate twice daily for 7 days to healthy human volunteers was well tolerated. Single oral doses up to 16 mg have been studied in human volunteers with no acute toxic effects reported. Repeat oral doses up to 80 mg daily for 10 days in volunteers and repeat oral doses up to 10 mg daily for 14 days in patients were well tolerated. Adverse reactions were of mild or moderate severity, and incidences were similar in active and placebo treatment groups. Acute overdosage with this dosage form is unlikely since one bottle of FLONASE Nasal Spray contains approximately 8 mg of fluticasone propionate.

The oral and subcutaneous median lethal doses in mice and rats were >1000 mg/kg (>20000 and >41000 times, respectively, the maximum recommended daily intranasal dose in adults and >10000 and >20000 times, respectively, the maximum recommended daily intranasal dose in children on a mg/m² basis).

GlaxoWellcome

Glaxo Wellcome Inc.
Research Triangle Park, NC 27709
October 2000
RL-868

U.S. Patent 4,335,121
INSEAL™ is covered by the following Inprint Systems patent applications: European 94916311.7, Canada 2140025, USA 08/373,213.

Printed in USA. 128ABSR1 FL2294R0 May 2001

PRESERVATION

Ossabaw Adrift

Former owner presses Georgia to protect pristine barrier island

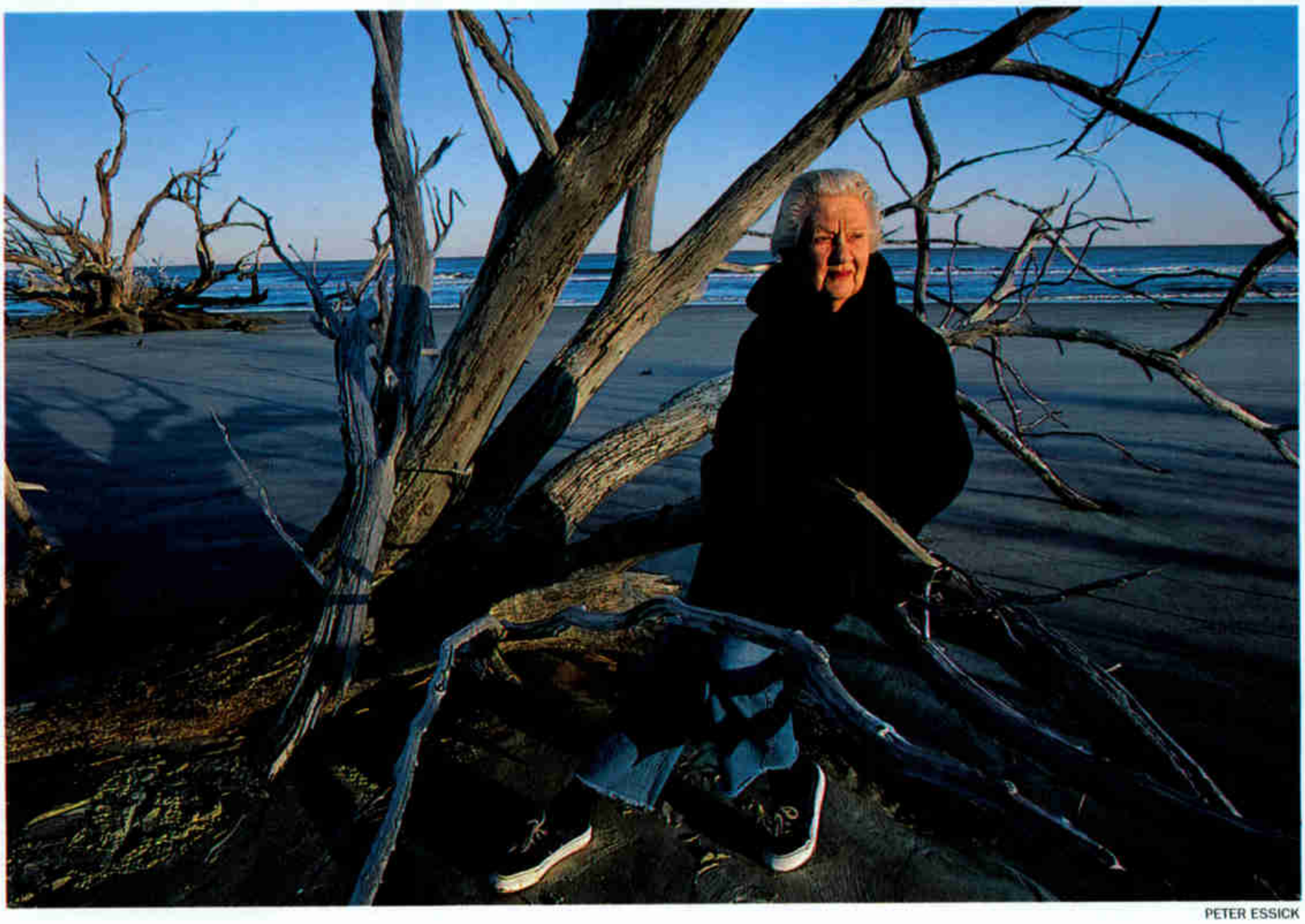
In 1978 Eleanor Torrey West sold Ossabaw Island to Georgia for a bargain price. As the state's first Heritage Preserve, the island was to be used not for general recreation but for "scientific and cultural study, research and education." In large part it has been. Now, 88-year-old West (below), who still lives on Ossabaw, is worried that Georgia's Department of Natural Resources will give in to public pressure for expanded recreational use. "Taxpayers support the upkeep of Ossabaw. They expect to be able to use state property" says the DNR's Todd Holbrook. Says West, "I expect the state to keep its word."

PAUL HILTON

CONSERVATION

Rescuing China's "Farmed" Bears

After a long ordeal this Asiatic black bear in China will soon be free. The bear had a catheter implanted in its gallbladder to drain bile, which was sold dried in Asia to treat maladies like liver disease. "These bears have suffered the most terrible physical and mental impacts," says Jill Robinson of the Animals Asia Foundation. Last year AAF signed an agreement with the Chinese government to release 500 bears and over the next 20 years phase out its 247 "bear farms." Until then, about 6,500 bears remain caged in such facilities.



PETER ESSICK

I check 'worry' at the border.
For I hold the pass that opens doors.
Wherever we go, with our
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Swapfest at the Bee

Geographic trades

NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN

The smiles of Ben Rothenberg of Washington, D.C., (right, at left) and Ford Flippin of Jackson, Mississippi, tell the tale: The two contestants in the 2001 National Geographic Bee hauled home dozens of souvenirs after swapping with their fellow competitors. "We want them to give items that tell something about their state," says Mary Lee Elden, director of geography competitions. "Vermont brings maple sugar, Louisiana usually brings Tabasco sauce and Mardi Gras beads."

Kyle Haddad-Fonda, 14, of Bellevue, Washington, arrived with state magnets to share. He left with first prize, a $25,000 scholarship, after topping 54 other finalists in his third appearance. "He was watching the Bee on TV when he was five and told us he was going to be in it someday," says his mother, Laura Haddad.

O. LOUIS MAZZATENTA

100 of the Best

Sifting through more than a century of extraordinary photography left NATIONAL GEOGRAPHIC Editor in Chief Bill Allen (above, with Illustrations Editor Susan Welchman, at left, and Senior Editor for Design Constance Phelps) proud, humbled—and exhausted. It also left us with a true GEOGRAPHIC collector's issue, *100 Best Pictures,* which debuts at newsstands and bookstores November 1. The images will be showcased in a format larger than the monthly magazine. If you are unable to find the issue in stores in your area, call toll free in the U.S. or Canada 1-800-777-2800 (elsewhere, 1-813-979-6685) or visit us online at *nationalgeographic.com/ngm/100best.*

joy


HOT!
HOT!
HOT!
OUCH!
The Explorer. Our high-tech pack mule.
Techa
ONE DOZEN
Rattlesnak
EGGS
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N GOLD MINE
Going below sea level without scuba gear!
·[Jack bringing me more water.]·
Our annual trip from L.A. to Lake Mead. Always tore through the desert. Not this time.
Decided to do Death Valley.
Taking the Explorer deep.
Drove up these major ridges, then down onto the Valley floor. Scary-hot, but amazingly beautiful!
lowest point in the U.S.
BADWATER
DAY 3

ride

2002 FORD EXPLORER
HANDLING AND SUSPENSION
Independent Rear Suspension Testing
Conducted January-March 2001

OBJECTIVE:

Use computer modeling to design world-class driving dynamics for the 2002 Ford Explorer. 1,000 suspension setups initiated and tested.

Rick-
our final suspension ruled at the proving grounds. 250 passes on Power Hop Hill. 3000 through Twist Ditch. Best Explorer stuff we've had in Yucca.

-Doug

KENJI YAMAGUCHI, NGS

Giraffe-ic Art

Spotlight on Africa

There are giraffes loose amid the trees in the courtyard of our Washington, D.C., campus. A cast of this full-size 20-by-16-foot mold (above) of giraffes that were etched into Sahara rocks in Niger 7,000 years ago and documented by David Coulson in our June 1999 issue will be around until the end of February. David is chairman of the Trust for African Rock Art. The Bradshaw Foundation funded the molding of four casts, one of which belongs to the government of Niger. "Our" giraffes appear as part of the Society's fall/winter focus on Africa.

MARK THIESSEN

Taking the Long View

Internship program celebrates a milestone

High on a Maryland hilltop Greg Barney and three fellow Society geography interns—Anne Pollard, Jennifer Caito, and Nancee Hunter—peer into a future in their field. Our program for geography and cartography majors at U.S. universities marks its 20th anniversary this year. Some 430 students have come to our campus, working in more than 20 departments. Many have ended up in academe, and some later recommended their own students for internships. Greg is now a permanent staff member of our Explorers Hall museum. He followed a path blazed by Bob Dulli, deputy to the Society's Chairman and the program's director: Bob was in the first intern group.

FOR MORE INFORMATION

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Talk to Us

Participate in Survey 2001: Conservation, Community, and Culture, and help us better understand how evocative pictures of rare animals like these Siberian tigers affect how we think about endangered species. This groundbreaking new survey strives to uncover how attitudes on conservation correspond to messages gathered from the environment and the Internet. The survey will be available on our website—log on to *nationalgeographic.com/ngm/survey2001*—through the end of next month.

NATIONAL GEOGRAPHIC PHOTOGRAPHER MICHAEL NICHOLS

Useful Tools

■ **MAP MACHINE**
Create your own custom maps at *nationalgeographic.com/mapmachine*

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Plan your next great adventure vacation—and book it—online at *nationalgeographic.com/iexplore*

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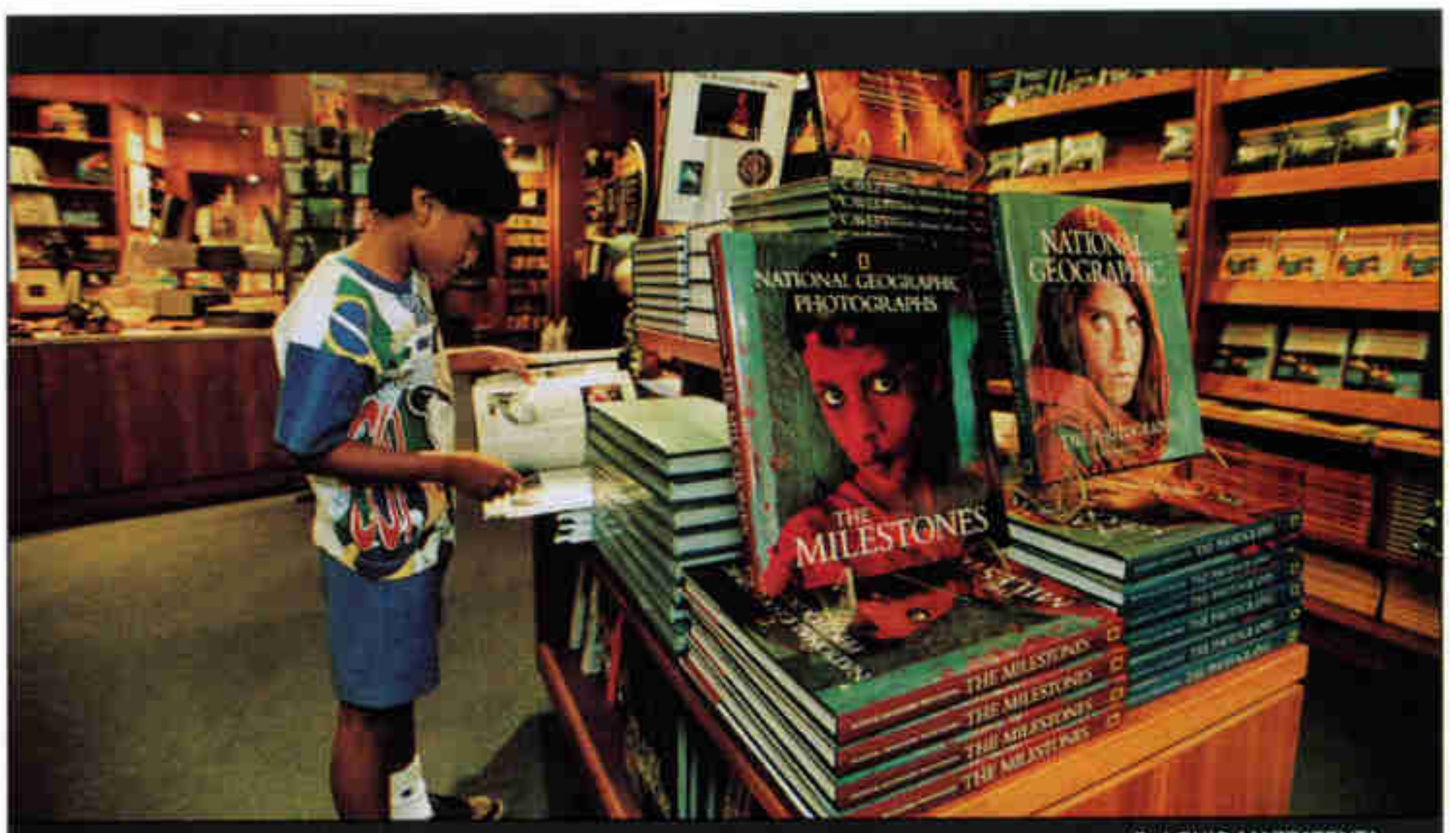

O. LOUIS MAZZATENTA

The Store That Never Closes

With every gift you purchase at the National Geographic store at our Washington, D.C., headquarters (above), you help the Society educate the next generation and support expeditions and research. We're also open for holiday shopping 24 hours a day online at *nationalgeographic.com/store.*

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Photographed by André Bätschi

WILDLIFE AS CANON SEES IT

A male yellow-footed tortoise follows a female along the shore of Bolivia's Rio Alto Madidi. The female usually nests more than once a season, burying her four to eight eggs under leaf litter on the forest floor. Newly hatched, the tortoise is about five centimeters long, and its shell clearly shows the denticulate edge for which the species is named; these tooth-like projections disappear after several years. This terrestrial chelonian feeds on mushrooms, grasses, fruits and flowers. The yellow-footed tortoise has become increasingly vulnerable to habitat loss and hunting pressures, having already disappeared from the Atlantic forests of Brazil.

As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

Yellow-footed Tortoise
(Geochelone denticulata)

Carapace length: 35-70 cm

Weight: 10-50 kg

Habitat: Rainforests in South America

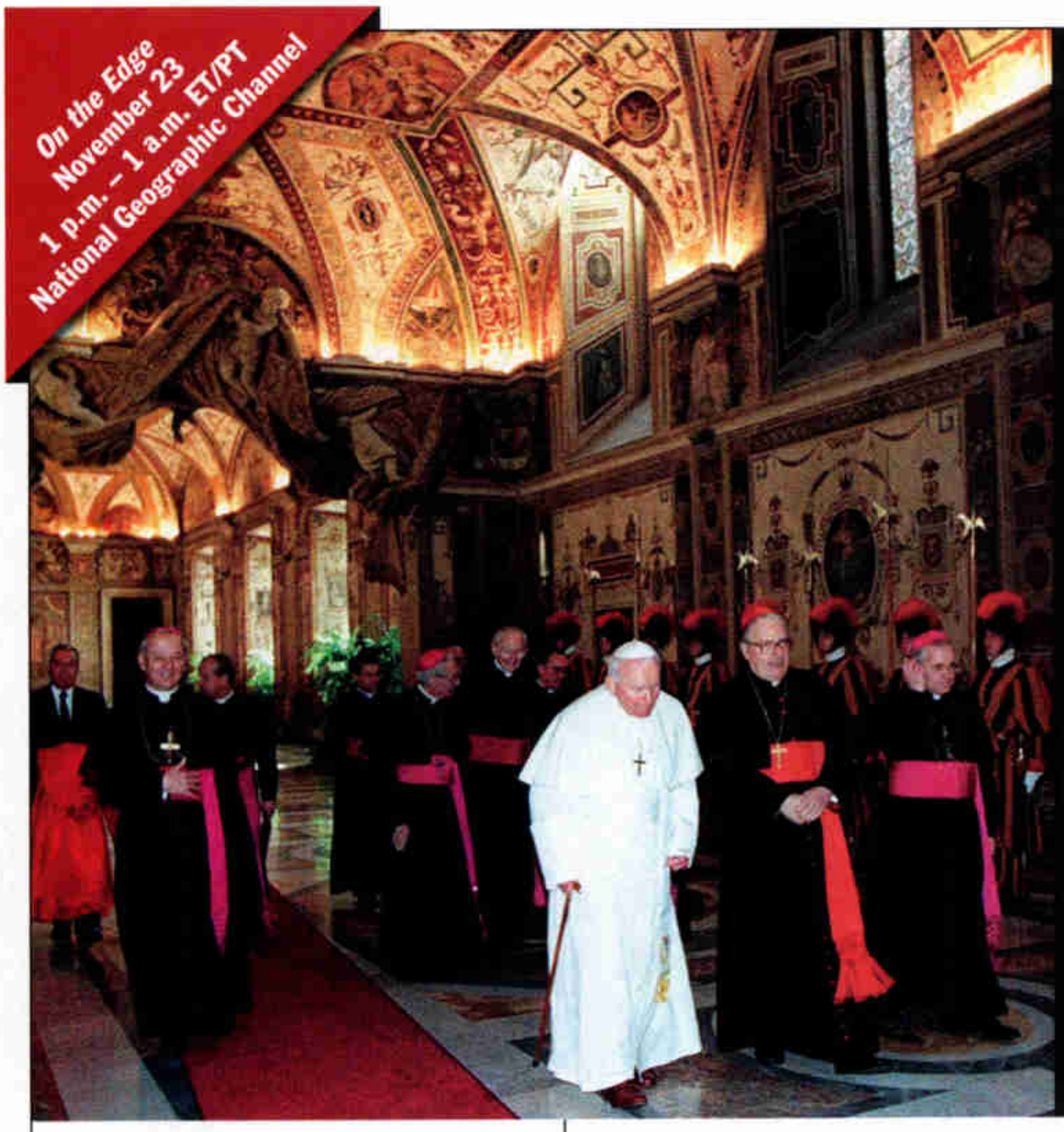
Surviving number: Unknown

NATURE

Watch NATURE on PBS. This program is funded, in part, by Canon.

Canon

National Geographic TV



SPECIAL, PBS
NOV. 21, 8 P.M. ET/PT

The Vatican

History and grandeur shine on Pope John Paul II as he leads prelates down an ornate hall in the Apostolic Palace, the pope's private residence inside Vatican City. A National Geographic Special premiere, *Inside the Vatican* takes viewers to rarely seen inner sanctums of the papal enclave to reveal the everyday operations of the world's smallest sovereign state. Given extraordinary access, NGT meets nuns carefully repairing Raphael's brilliant tapestries and young Swiss Guards pledging their lives to protect the pope.

MASSIMO SAMBUCETTI, ASSOCIATED PRESS

NATIONAL GEOGRAPHIC CHANNEL, 9 P.M. ET/PT

Going Deep

Shipwrecks, sea battles, treasure hunts, and experts such as Robert Ballard (below) headline the new Saturday series *Mysteries of the Deep.*

NORBERT ROTTCHER (ABOVE); JONATHAN BLAIR

EXPLORER, MSNBC, NOVEMBER 11, 8 P.M. ET/5 P.M. PT

Family Adventure

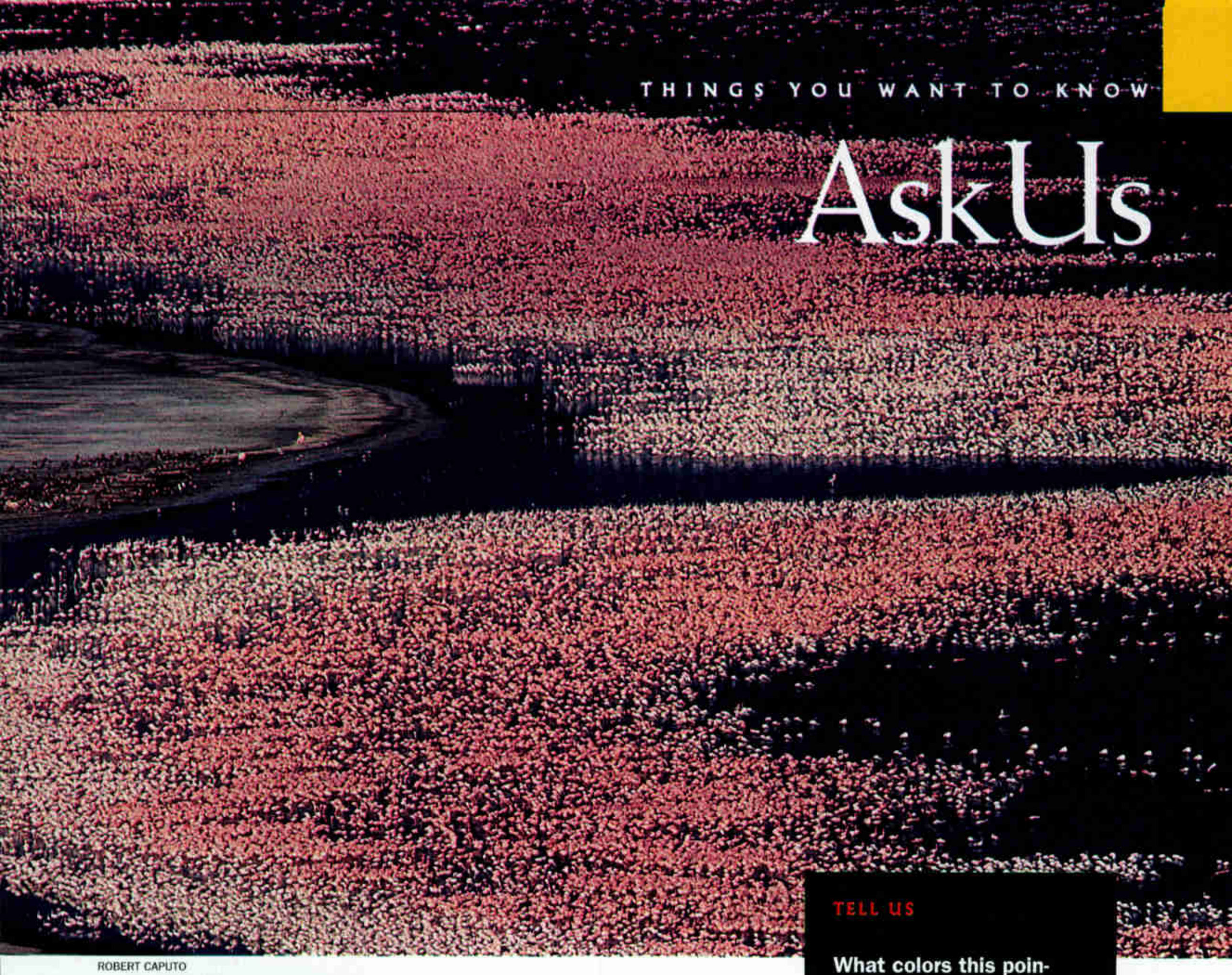
"He's a laid-back croc," says Victoria Stone, explaining how she and her husband, Mark Deeble, could bring their two sons close to a toothy predator at Kenya's Mzima Springs. The family spent two years in the wild filming *Haunt of the Hippos.*

National Geographic EXPLORER MSNBC. Sundays, 8 p.m. ET/5 p.m. PT. **National Geographic Specials** PBS. See local listings. **National Geographic Videos, Kids Videos, and DVDs** Call 1-800-627-5162. **National Geographic Channel** Call your cable or satellite provider.

■ Programming information accurate at press time; consult local listings or our website at nationalgeographic.com.

THINGS YOU WANT TO KNOW

AskUs



ROBERT CAPUTO

THE ANSWER PLACE

Our Research Correspondence staff responds to questions from curious readers.

Q How did driving on the left in the United Kingdom and on the right in the U.S. arise?

A In the U.K. the custom of keeping to the left may have arisen in feudal times when horse riders, wielding weapons in their right hands, preferred left-side travel. In 1722 the Lord Mayor of London ordered traffic to keep left on London Bridge. Today motorists in roughly 50 countries, many of them former British colonies, adhere to this tradition. In the U.S. right-side driving may have been encouraged by freight wagons like the Conestoga, often drawn by six horses. At the approach of another wagon the driver, sitting on the left-rear horse, pulled to the right, where he could better judge the clearance between the passing wagons. Pennsylvania enacted a keep-right law in 1792 for the Lancaster Turnpike.

Q I have heard arrowheads referred to as "elf-shot." What does that mean?

A For centuries European farmers had found arrowheads and other stone tools in their fields. Many people believed these artifacts to be supernatural weapons created by elves. Some collected the arrowheads, convinced that they held magical properties. By the 17th century their origins became widely recognized as explorers brought home similar tools still being created and used by the inhabitants of the Americas.

TELL US

What colors this pointillist scene in Kenya's Lake Nakuru National Park?

Think you know the answer? Go online to nationalgeographic.com/ngm/tellus/0111 and test yourself, or read it here in next month's issue.

October Answer Barbed spear grass spikelets adhere to dew on the photographer's SUV after a drive down an overgrown road in Western Australia.

MORE INFORMATION

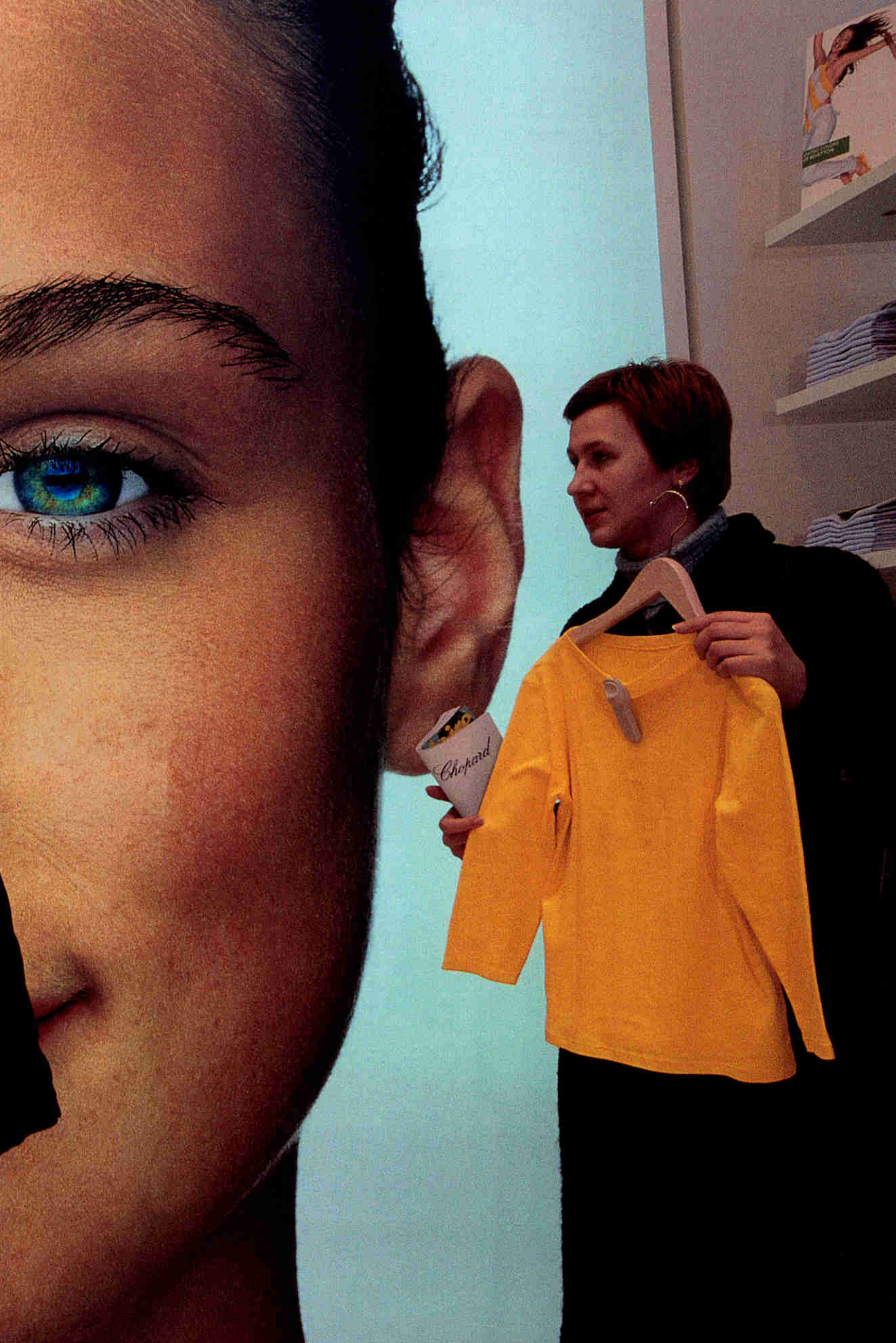
Send questions to **Ask Us, National Geographic Magazine, PO Box 96095, Washington, DC 20090-6095** or via the Internet to **ngsaskus@nationalgeographic.com.** Include name, address, and daytime phone number.

A decade has passed since the U.S.S.R. ceased to exist, and during that

New breed or old school? Both describe President Vladimir Putin (facing camera)—and the country he leads.

time the Russian people have been subjected to an economic and social revolution.

Makeover: Benetton's new 21,500-square-foot megastore in Moscow replaced the state-run Natasha, purveyor of what Russians sardonically called Soviet fashion. The Italian clothing giant now has 40 stores in Russia.


Chopard

BY FEN MONTAIGNE

PHOTOGRAPHS BY

GERD LUDWIG

From the outside the Institute of Mathematics in Akademgorodok looks much as it did in its Soviet heyday, a long, four-story, beige stone monolith that epitomized the intellectual might of the Communist regime. After the founding of Akademgorodok, or Academic City, in Siberia in 1958, this institute and several dozen others hummed with the research activity that undergirded the military-industrial complex and helped make the U.S.S.R. a superpower. In the 1990s, following the demise of the Soviet Union, the institute and Akademgorodok

Coke—and other liquids—fuel New Year's Day partying near Red Square.

became symbols of a different kind—of the decay of Russian science and the decline of a great state. Government funding fell sharply, and impoverished researchers fled overseas or quit science in a massive brain drain.

But walk into the Institute of Mathematics today, ten years after the collapse of the U.S.S.R., and something intriguing is taking place. I strode down a long, dark corridor that, with its mustard-colored walls and peeling brown linoleum floor, exuded a Soviet shabbiness I had come to know as a Moscow correspondent in the era of Mikhail Gorbachev. Soon, however, I entered another wing of the institute and plunged into a different world. Young workers, most of them under 30, sat behind computers in offices newly renovated with white tile floors and pale wooden desks. A handful of people relaxed in a room with plants and a small waterfall. Across the hall, in a modest office, the 29-year-old CEO of this enterprise—a 500-person computer software company called Novosoft—was furiously tapping out e-mails as his eyes darted between the computer screen and several visitors.

Founded in 1992, Novosoft—which does computer programming for foreign firms such as IBM and creates new software applications for mobile phones, websites, and other technologies—has enjoyed explosive growth since 1998. It is one of many new high-tech companies that have sprung up in Akademgorodok's research institutes, where fledgling enterprises can draw on a large pool of talented physicists, mathematicians, and computer scientists and offer their services, relatively cheaply, to the West and Japan. In this city of 130,000, dubbed "Silicon Taiga," young workers can earn as much as a thousand dollars a month—many times what their parents usually make and enough to keep most techies from emigrating.

I asked the CEO, Serge Kovalyov, a restless, dark-haired man with an excellent command of English, if he had ever considered leaving Russia. Letting out an explosive laugh, he replied, "Me! Is there anything better that can be offered me than creating the new Russian economy?"

Down the hall one of the founders of Novosoft, Vladimir Vaschenko, said he and Kovalyov were building more than a company. They were helping create a new Russian society.

"What we are doing in our company is growing a middle class," said Vaschenko, 36. "Everyone in our company is middle class—they have enough money to enjoy a good meal, they have a nice place to live, and they have a car. They feel life is stable, and they feel they have room to grow in the future."

Vaschenko acknowledged that even in Akademgorodok, with its highly educated

Christmas has made a comeback, though businesses and churches observe it on different dates. Today's Russians also live with dueling holiday patriarchs: recent import Santa Claus and Grandfather Frost, the homegrown favorite.

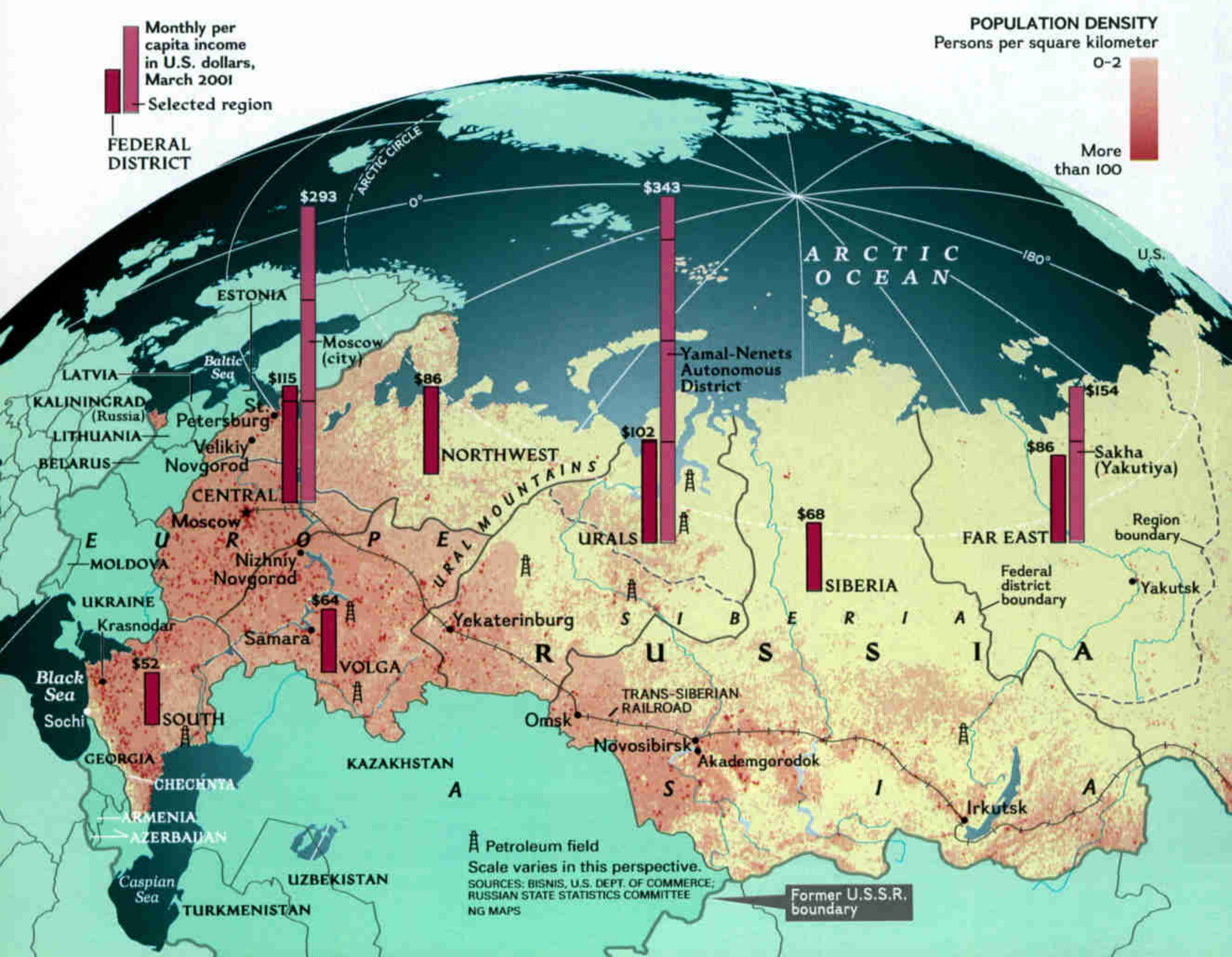
workforce, the emerging middle class makes up less than 10 percent of the population. And while he thinks the middle class will continue to expand, he is mindful that, given Russia's history, much could still undermine the country's excruciatingly slow climb out of the post-communist economic morass.

"If 15 years from now Russia is in the same state as today, I may feel there is no hope for the future of the country," he said.

A decade has passed since the U.S.S.R. ceased to exist, and during that time the Russian people have been subjected to nothing less than an economic and social revolution. Three-quarters of state enterprises have been fully or partly transferred to individual owners in a corrupt privatization drive. The Soviet social safety net has been shredded, and articles about the woes and impoverishment of the Russian people could fill volumes. But as a seven-week trip around Russia earlier this year showed, shoots of new life are springing up throughout the country.

Most of Russia's economic activity is centered in Moscow, where a sizable middle class has emerged. Yet vibrant businesses also have taken root in many other cities, including Novosibirsk, Nizhniy Novgorod, St. Petersburg, Samara, and Yekaterinburg. Often the most successful enterprises are in spheres of activity that scarcely existed in the Soviet Union, such as computer software, sophisticated food processing and packaging, restaurants, and advertising. Ironically, the collapse of the ruble in 1998—which made imports prohibitively expensive—boosted domestic production. That increase, coupled with higher prices for Russian oil and gas, has at last halted the country's economic slide; the economy grew by

RUSSIA TODAY Most of the population of the planet's largest country is packed into its west and along the Trans-Siberian Railroad. The government divides the country into seven districts (below). Many of Russia's valuable natural resources are in the remote north, creating rare islands of relative prosperity such as Yamal-Nenets, rich in oil and gas, and Sakha, source of 98 percent of Russia's diamonds.



5 percent in 1999 and by 8 percent in 2000.

That said, the financial success stories—and the middle-class workers affiliated with them—are still islands in a sea of stagnation. The official salaries of most Russian workers hover around a hundred dollars a month, although many earn some undeclared income on the side. An estimated 20 million of Russia's 145 million people live below the official poverty line of $31 a person a month. Tax evasion is epidemic, and an estimated 25 to 40 percent of the economy is conducted underground. And every year a tiny layer of super-rich Russians—fearful of general instability and a shaky banking system—ships an estimated 20 to 25 billion dollars out of the country to foreign banks, much of it from the sale of Russia's abundant natural resources.

Still, to focus solely on the myriad problems is to ignore what has been accomplished in a mere decade. And, as I have discovered after a dozen years of writing about the former U.S.S.R. and being whipsawed by bouts of optimism and pessimism, you must be able to hold in your mind the dichotomy of the two Russias. One is a place of well-educated, hard-working people slowly building a humane society and the other a land where a worn-out populace endures corruption and a lack of decent civil institutions. The question is, will the second Russia overwhelm the first, or will the new Russia ultimately prevail?

One thing is certain: What is happening from the bottom up in Russia is far more encouraging than what is happening from the top down. At the top the crony capitalism that enabled a small number of oligarchs to become fabulously wealthy during privatization in the mid-1990s still continues under President Vladimir Putin, only with a somewhat different cast of characters. Putin is extremely popular with most Russians, enjoying a 70 percent approval rating. But many reformers view the president—a former KGB colonel—as a cautious man with little commitment to democracy or a free press and little stomach for tackling critical problems like endemic corruption and the creation of a viable legal system. He also continues a war in Chechnya that is draining the country's treasury and spilling the blood of its citizens.

"Russia's like a rusty ship," said Boris Nemtsov, leader of a liberal party in the Duma, or lower house of parliament. "It's barely floating, and instead of trying to repair the ship, Putin just grabs a bucket of paint and starts painting it in patriotic colors. That's the essence of Putin—he won't do anything fundamental. The security services, the police, the prosecutors—he won't touch these elements of the Soviet system."

Despite the lack of reform in Russia's woeful institutions, such as the courts, many individuals are engaged in building a more stable society. Small businesses are slowly increasing, larger businesses are becoming more efficient, and students are pouring into colleges and universities. And these days in Russia youth is everything. In few countries is the generation gap as wide or are people under 35 playing such an important role in transforming society. Unencumbered by communist thinking and work habits, unaccustomed to the Soviet Union's cradle-to-grave security, young Russians more readily accept the challenges and uncertainty of a market economy.

"Your prediction for the future mostly depends on your age," said Novosoft's Vaschenko. "People our age have more hope. Most people still managing the institutes in Akademgorodok are older than 50, and they still rely on the government to help them. We rely on ourselves. We know how to earn money, and what I'm waiting for is the time when these old people will be replaced by us. When we do that, I think Russia will be a better place."

Vaschenko is right to think in terms of generations, for the transformation of Russia will take far longer than most people imagined. The euphoria of a decade ago has been replaced with a cold-eyed realism and an understanding that turning Russia into a civil society, with an effective market economy, is a herculean task—and not just a matter of grafting Western models on this unruly land.

"All this will take a long time, at least three generations," said Dmitri Trenin, deputy director of the Carnegie Moscow Center, a think tank. "Well, we're halfway through the first one. Just two-and-a-half more generations to go."

Kirill Dmitriev and Peter Panov don't have

FAMILY

A family toasts the dead in the Black Sea resort town of Sochi. Showy graves are more common these days—particularly in what one local cheerfully calls "the mobsters' part of the cemetery."

that kind of patience. Born and raised in Ukraine and Moscow, respectively, they graduated from top American universities and worked in some of the United States' most prestigious companies—such as Goldman Sachs and Qualcomm—before deciding to return home and cast their lot with a reborn Russia. Dmitriev, 26, graduated Phi Beta Kappa from Stanford University and Harvard Business School. Panov, 31, attended the University of Pennsylvania's Wharton School on full scholarship, receiving his M.B.A. in 1996. Though these two men could have stayed in the U.S. and earned loads of money, they returned to Russia in 2000 for two reasons. The first was the sense that they had an important role to play in shaping Russia's new economy. The second was Anatoly Karachinsky.

A low-key, bearded, 41-year-old partial to wearing khakis and cowboy boots, Karachinsky is the president and CEO of Information Business Systems (IBS) Group, one of the country's most successful information technology companies. A computer whiz during the waning days of the Soviet Union, Karachinsky founded his own firm in 1992 and quickly became a master at designing and selling the sophisticated computer systems

Brainpower: Physicists gather for a daily roundtable meeting in Akademgorodok,

that integrate the operations of large businesses, such as Sberbank, the state savings bank. Karachinsky's IBS Group now employs close to 2,000 people and adds another few hundred every year. Its revenues increased by 50 percent in 1997 and in 1999.

Seeking good managers, Karachinsky made Dmitriev and Panov an alluring offer that included the opportunity to link some of Russia's industrial giants through an Internet supply-and-sales network.

"Peter and I had tremendous possibilities in the U.S.," said Dmitriev, a tall, exuberant man with light brown hair. "But we came back because we feel it's our home, and there's a certain responsibility that goes with it. We're playing a real role in this country as it grows. The level of influence we have is so much greater than we'd have in the U.S."

I met the pair in IBS's Moscow headquarters, a modern, glass-and-concrete building set back from the capital's grimy Dmitrovskoye Highway. Like some other young Russian business people, Panov and Dmitriev believe that the robber baron phase of Russian capitalism is gradually fading as oligarchs seek legitimacy.

"Up to now, money has been made by people dividing up different pieces of the old

or Academic City, a utopian Soviet-era community in Siberia built to gather the nation's top scientists. Now that state support for research is drying up, their ideas help run their own fleet of business enterprises.

state pie," said Dmitriev. "The oligarchs were thinking, 'How can I take away this guy's piece of the pie?' Now the pie has been more or less divided up, and the oligarchs are thinking, 'I can't take this guy's pie because he's too powerful.' So they want to grow their piece of the pie, they want good managers running their businesses, and they want respect, because in Russia it's all about respect."

Panov interjected, "Their horizon used to be really short. During privatization they wanted to take what they could and get out. Now their horizon is way, way longer."

And that, Dmitriev and Panov say, is where they and IBS come in. Karachinsky is banking on it, and one afternoon as I talked with him in his office, he served up the most cogent analysis I'd heard of the Russian economy:

"There is the old economy of the U.S.S.R., and it has a much tougher road. Many enterprises will first have to die to be reborn. Then there's the resource economy—oil, gas, aluminum—a large part of the gross domestic product. It's making a good profit and moving ahead. Then there's the new economy, the economy that didn't exist ten years ago, and we're part of that.

"If you just focus on the old economy, the country looks in terrible shape," said Karachinsky. "But something entirely new is being born here. Russia is just at the beginning of an economic climb. Overall, I'm pretty optimistic."

It's easy to be *(Continued on page 18)*

"We rely on ourselves. We know how to earn money, and what I'm waiting

Technicians at the Design and Technological Institute of Monocrystals in Novosibirsk (left) test industrial crystals, one of the growing number of exportable goods made in for-profit ventures by research institutes. Despite losing half its scientists to other countries or professions since 1991, Russia's workforce remains skilled and tech savvy. An oil rig in western Siberia (below) produces another economic underpinning: Russia is the world's second largest exporter of oil.

for is the time when these old people will be replaced by us."

—VLADIMIR VASCHENKO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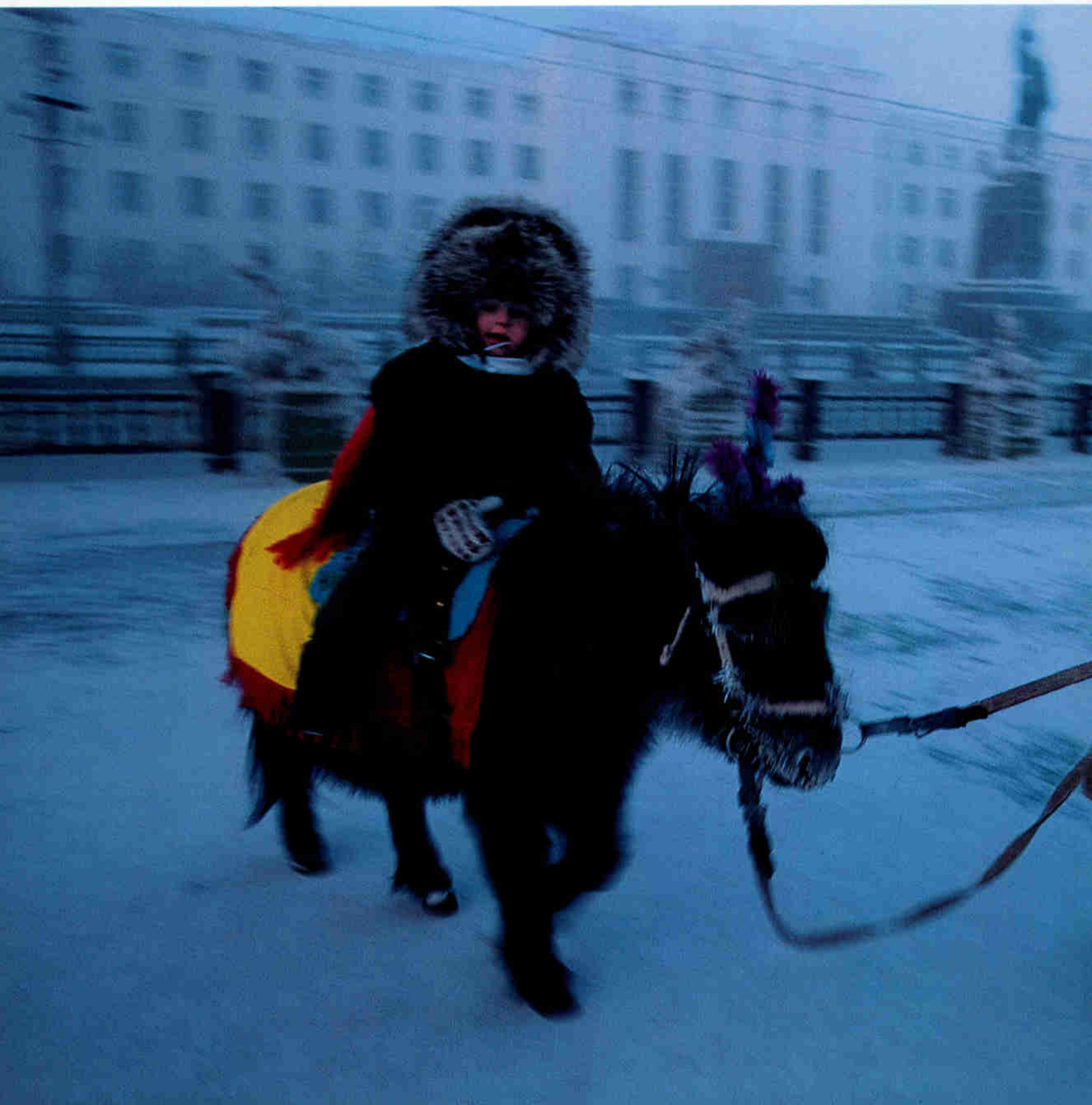
CITIES

Billboards grow as thick as weeds along Nevsky Prospekt in St. Petersburg. The country's new outdoor ad industry has boomed as companies rush to build brand loyalty among Russian consumers.

optimistic in Moscow, where you can move from youthful enterprise to youthful enterprise inside the hip bubble of the new wave Russian economy. I did so for ten days, spending time with the likes of 27-year-old Tatiana Tyutyunnik, a senior copywriter whose advertising firm—BBDO—has played a major role in turning the once nonexistent advertising sector into a billion-dollar-a-year industry. I also visited companies like Wimm-Bill-Dann, which provides about a third of the juice and milk products sold in Russia and epitomizes the rapid growth of food processing.

Today, in the opinion of many sociologists, 20 to 25 percent of Moscow's 8.5 million people are members of a burgeoning middle class, roughly defined as having a monthly household income of at least a thousand dollars and the ability to afford luxuries such as a car, a personal computer, a second home, or an overseas vacation. In the provinces, where bourgeois status comes with an income of only a few hundred dollars a month, probably only 10 percent of the population is middle class. Neither the government nor the market has so far created the conditions to nurture a middle class. In Russia today there is virtually no mortgage banking system, less than 2 percent

Even at 40° below zero, kids can find outdoor entertainment in Yakutsk. The



of the population use credit cards, and only 7 percent have checking accounts.

Still, anyone doubting the existence of a middle class need only take a trip to the Ikea store in northern Moscow. On weekends this enormous yellow-and-blue temple of moderately priced Scandinavian style is mobbed. On a frigid Sunday afternoon I stood in the vast, jammed parking lot and watched as a procession of Ladas and Volgas pulled up to the loading dock. Drivers proceeded to strap to their car roofs the bulky cardboard cartons whose contents, when assembled, would become bookshelves and beds in countless Moscow apartments. Nearly 20,000 Muscovites descended on Ikea that day, helping make it tenth in volume of sales out of 163 Ikeas worldwide. The company plans to open three more stores in Moscow in the next several years.

In Ikea's packed warehouse section I came across a young couple, Andrei Dmitrienkov and Tatiana Dyakonova, hunting for merchandise amid the towering shelves. Andrei, 24, is a product manager for a company that sells computer parts, and Tatiana—30 and nine months pregnant at the time—is a teacher who also operates a food store and a cosmetic shop. Although they have a combined monthly income of several thousand dollars, Andrei and Tatiana displayed an understandable caution about the future, given the economic crises they had experienced in the first decade of Russia's capitalist experiment.

past decade's revolution, like 1917's, took its time spreading east from Russia's biggest cities. Yakutsk hasn't changed the name of Lenin Square or removed his statue, but Benetton has moved in—the city's first Western brand-name shop.

"I feel some optimism, but things are still a mess," said Andrei. "We've been going through a terrible phase of capitalism. Maybe life will be more normal for our grandchildren." Looking around, he told me, "You have to remember that this kind of place is only in Moscow. In the provinces this doesn't exist. In America money is spread all over the country, but here 80 percent of the money is in the capital."

As the Russian provinces go, the Novgorod region, about a two-hour drive south of St. Petersburg, is a relatively prosperous place. Thanks to the region's progressive governor, Mikhail Prusak, Novgorod has attracted about 800 million dollars in foreign investment, including a Cadbury chocolate factory. Some of the region's Russian-owned factories are doing well also, among them an operation called Splav, which employs about 4,000 workers and makes valves for the oil and nuclear power industries. I sat down with the firm's general director, Vladimir Fyodorov, who told me that his growing company now also owns a chain of pharmacies. In the course of our conversation, Fyodorov—a stocky, reserved man of 47—mentioned that the previous general director had died tragically

the year before. I learned the fate of the former executive when I toured the factory: Two assailants had entered his office and beaten him to death. The pair had been hired by the factory's deputy director, who ordered the hit during a dispute over ownership of the profitable Splav group of companies. On the cavernous factory floor, where men in grimy clothes turned steel valve components on lathes, the prevailing opinion was that the assassination exemplified the crooked and murky privatization process that workers said had left them no better off than before.

Ivan Samusenko, who had worked at the factory for 17 years and now earned 7,500 rubles—$250—a month, expressed a widely shared nostalgia for the stability of the Soviet era. "It's a lot worse for us now than it was ten years ago, from any point of view," he said. He had received some shares in the company during privatization but considered them virtually worthless. "What kind of owner am I?" asked Samusenko, 45. "It's just a piece of paper." Nearby, another worker said of privatization, "Someone grabs it all, and we have nothing."

That evening I visited Samusenko, his wife, and their teenage daughters at their apartment

Fog covers Yakutsk, capital of Sakha, a republic that won limited autonomy

in a concrete housing block. Sitting in their small kitchen, eating sausage and the pickled cucumbers and tomatoes that many Russians grow in their garden plots, Samusenko expressed a frustration echoed by low-paid workers throughout Russia.

"I don't see the light at the end of the tunnel," said Samusenko, whose friendly manner belied his bitterness. "We used to be able to go on vacation to the Caspian Sea, and now I can't even afford that. I think that if I work soberly and conscientiously, if I do everything I can, I should be able to go on vacation once a year, to buy nice things for the apartment and for our children. I should be able to live a worthy life."

The country's pensioners subsist on far less than $250 a month, getting by on legendary Russian resilience and ingrained stoicism. The elderly have suffered two shocks in the past decade—the dissolution of the communist system in which they were steeped and the hardship of surviving in an inflationary economy on miserly pensions. Strangely, for many, the latter has been easier to endure. This generation, which suffered Stalin's terror and the loss of more than 20 million countrymen in World War II, has learned to live on very little.

As a teenager, Anna Kovalevskaya survived the 900-day Nazi siege of Leningrad, during which nearly a million civilians—including her father, mother, and brother—perished from starvation, cold, disease, and bombardment. Now 72, Kovalevskaya lives on $70 a month. "I survived the blockade, and compared with that we live in heaven on earth now," she told me as we sat in her apartment in St. Petersburg, formerly Leningrad.

What most concerns her is the fate of her son, who is a businessman, and grandson, for she sees as much peril as opportunity in the new society. "I look with a certain nostalgia on the Soviet period," said Kovalevskaya, a decorous woman with short white hair and blue eyes. "It was easier. I could predict things."

when Moscow's authority weakened. Sakha (Yakutiya)—its official name, including parentheses—makes up a fifth of Russian territory. Its governor refuses to rewrite local laws that conflict with Russia's, and Putin is losing patience.

For those who depend on the government for their salaries—army officers, teachers, health-care workers—the situation is indeed dismal, as they are expected to subsist on monthly salaries of roughly $50 to $100. Nowhere is the situation more acute than in the nation's hospitals, where doctors and nurses face a systemic shortage of funds and modern equipment and where patients are experiencing the shock of having to pay for part of their treatment.

In the western Siberian city of Omsk, I spent several days at three hospitals, all beset by problems whose root cause is the minuscule amount Russia spends on health care: $250 per capita as compared with $4,000 per capita in

Handouts of tea comfort a homeless family in St. Petersburg. One-third of the city's 50,000 homeless were victims of real estate fraud. Swindlers find easy prey among those left vulnerable and confused by economic reforms. Few Russians have become rich; 20 million earn less than $31 a month, the official poverty line. An emergent middle class is rebounding from 1998's currency crisis, enjoying simple pleasures like live music at Novosibirsk's New York Times club (right).

"All this will take a long time, at least three generations. Well, we're

halfway through the first one. Just two-and-a-half more generations to go."

—DMITRI TRENIN

the U.S. In Omsk the situation has forced doctors and nurses to take heroic measures. At the Regional Children's Hospital the head of the Department of Hematology, Natalya Osmulskaya, 34, spends much of her time pleading with the governor and regional parliament for money to treat children with leukemia. Because the needs of these children are so compelling, Osmulskaya persuaded the government to dedicate $350,000 to purchase medicines for dozens of patients.

Touring the sunny, threadbare hematology wards with me, Dr. Osmulskaya—a tall, trim, energetic woman with light brown hair piled atop her head—briefed me on the status of the wan, bald children undergoing chemotherapy. The doctors' efforts, coupled with new Western medicines unavailable in Omsk a decade ago, have helped raise the cure rate for a severe form of pediatric leukemia from less than 5 percent to 50 percent, she said.

"If I weren't running around getting money for these children, we'd be treating them with methods from the Stone Age," said Osmulskaya, who officially earns $70 a month.

In City Hospital No. 1, surgeons rely on skill to overcome the lack of top-flight technology. Although the hospital does have contemporary endoscopic equipment, it lacks up-to-date ultrasound and echocardiogram machines. Sophisticated procedures such as heart-bypass operations are rare in Omsk, and only about 40 percent of the patients needing kidney dialysis receive it. Life expectancy has fallen in the post-Soviet period, dropping for men from a peak of 65 in 1987 to a low of 58 in 1994. Today it stands at 59, still 15 years below that of American men. This low life expectancy, coupled with a drop in the birthrate as Russian women have fewer children in hard times, has created one of the fastest shrinking populations on Earth. Now at 145 million, Russia's population is projected to fall to 137 million in 2025 and 128 million by 2050.

In an antiquated operating room with mint green walls and a composite stone floor, I observed Vladimir Papulov, a 50-year-old surgeon and professor of medicine, remove three-quarters of a patient's ulcerated stomach. After the four-hour operation I asked him what effect the lack of good equipment had on him and his colleagues. The lean, dark-haired Papulov replied, "It's like the difference between a woodcutter and a watchmaker."

Russia's future looks bleakest when you contemplate the massive institutional problems facing the country. On this score the courts are in as critical condition as the health-care system. Russia's criminal court system still relies on an old Soviet procedural code, generally lacks trial by jury, and systematically tramples on the rights of the accused. The country is only just developing a civil court system to resolve disputes, and both civil and criminal procedures are sometimes tainted by bribing of underpaid judges.

Sergei Pashin, the head of judicial reform in Boris Yeltsin's administration, said the criminal court system is so stacked against defendants that 99.6 percent are convicted. "It's an inquisition," said Pashin, 38, noting that some defendants sit in jail for several years before their cases come to trial.

I spent a day in the Moscow criminal courts, where lawyers have to supply their own paper if they want copies of motions or opinions, defendants are kept in cages, and the accused's fate is in the hands of a judge and two citizens, usually pensioners, who are known as nodders because they always concur with the judge's ruling. In eastern Moscow, in the Preobrazhensky district court—a three-story, redbrick, pre-Revolutionary structure—Judge Angelika V. Matushenko acted as both judge and prosecutor, aggressively questioning defendants.

One of those who came before her that February day was Yuri N. Khrupenkov, a 47-year-old drug addict who had already served 15 years in jail on theft and other charges. Dressed in a blue track suit, Khrupenkov—a short, black-haired man with dark circles under his eyes—stood in the seven-foot cage and admitted taking about $300 in property from an acquaintance's apartment, half of which he eventually returned. After a short break the defendant returned to the tiny courtroom, his hands cuffed behind his back, his shoulders hunched, his head lowered. The defense attorney wasn't even present as Judge Matushenko—flanked by the two silent citizens of the troika—pronounced Khrupenkov guilty and sentenced him to 20 months in a high-security penal colony. A guard let him out of the cage, and he shuffled silently out of the courtroom.

Far to the south of Moscow, in the rich agricultural region of Krasnodar, a different drama is unfolding, but in this case change is coming more swiftly to an old Soviet system. The advent of market economics is gradually imposing a new way of life on the countryside. Under privatization government subsidies for the former collective farms have all but disappeared, leaving many bankrupt and able to pay their workers only in grain or sugar. In the Krasnodar region 19,000 private farmers are working 12 percent of the region's arable land, and large corporations are investing in former state farms. But surpassing everyone in production are the villagers, who raise copious quantities of produce in their backyard plots. In Krasnodar they produce 98 percent of all the potatoes, 73 percent of the vegetables, 50 percent of the meat, and 46 percent of the eggs—testimony to how the Russian countryside has returned to a subsistence, almost pre-industrial way of life.

To visit the terminally ill in Russian agriculture, you need go no farther than the Red Star farm in central Krasnodar. On an overcast April afternoon I drove through Nezaymanovskiy, a nearby village of 3,000 with stucco cottages surrounded by white flowering pear trees and plastic-covered greenhouses. Soon I came to the former collective farm, its off-white stucco buildings in disrepair and old tractors scattered about equipment yards. Since the fall of communism the farm has acquired 50 million rubles of debt (1.7 million dollars), cut its workforce from 1,200 workers to 500, and slashed grain production from 47,000 tons a year to 11,000.

As I stood in a muddy equipment yard, workers—who said they had not been paid in cash in six years—complained that the thievery of former farm bosses had nearly driven the Red Star into oblivion. The head of village administration, Alexander Stupak, put it this way: "The private farmers live well because they started their farms with equipment taken from the collective farm, and they hide their income." Stupak, 59, a short man dressed in a tie and black leather jacket, continued, "Wherever there are stronger farmers, there are weaker collective farms. Former directors stole the production and sold it on their own. People stole from top to bottom."

Even Krasnodar's stronger collective farms face daunting problems. They are still saddled with Soviet-era responsibilities like running their own schools and maintaining roads, but without government funds.

In northern Krasnodar, the Ilyich farm—named for Lenin's patronymic—is a well-run collective with 10,000 pigs, 6,000 beef cattle, and 1,300 milk cows. But unable to afford tractors, fertilizer, or building materials, the farm agreed to acquire them from a subsidiary of the oil and gas giant, Gazprom, and pay it back with meat, oil, grain, and sugar. The Gazprom subsidiary now has a 20 percent stake in the farm. It also has similar arrangements with four other farms in Krasnodar and eight in other parts of Russia.

Elsewhere, the giant Sibneft oil company recently acquired one of Siberia's largest pig farms and sausage factories—Omsk Bacon, with 270,000 hogs. The huge juice and milk products company, Wimm-Bill-Dann, is giving dairy farmers credits to increase production. Russian sunflower oil wholesalers and other food processors, as well as international grain companies, all are investing in farms.

Some people believe that corporate involvement in farming could be a powerful agent of change. Others are less sanguine.

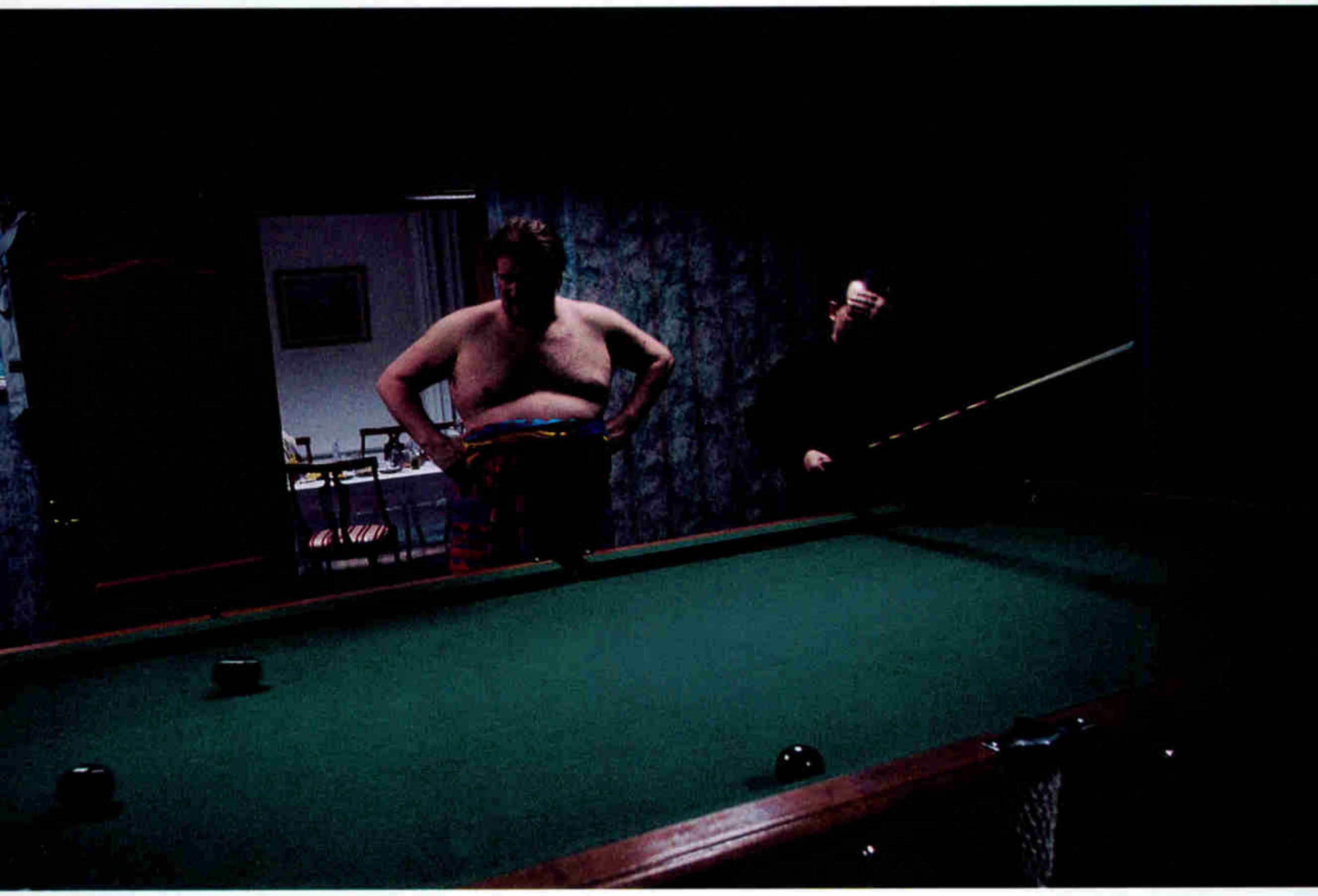
"If we just go from big collective farms to big farms owned by Gazprom, then nothing will change—people will still have the same old attitude," said Ivan Svidrak, a representative of the Russian Farmer's Association in the nearby Timashevsk region.

Alexander Chaika, a private farmer in Timashevsk, has other things to worry about. I found him one cool spring morning ankle-deep in mud in front of his half-finished, aluminum equipment shed. It had rained the night before, and the rich black earth of his 865-acre farm was too gummy for his tractors. The beet planting would have to wait.

Chaika's brother and his three hired hands were repairing an old tractor. Chaika himself was on the cell phone, inquiring about fertilizer, the purchase of a new tractor, and the endless papers he had to file with local authorities. I soon learned that Chaika, like most of Russia's successful farmers, rarely gets behind the wheel of a tractor; he's too tangled up in red tape and errands.

Chaika is one of *(Continued on page 30)*

For American-born entrepreneur Eric Shogren (below, left), doing business in Novosibirsk means doing banya *with partners—a ritual marathon of sauna, games, eating, and drinking. "If you're not willing to drink vodka with Russians, you're not going to succeed here," he says. Alcohol lubricates business but also contributes to Russia's high mortality rate—and to the stream of vagrants and arrestees brought to Moscow's Disinfection Centers for a bath and delousing (right).*



The transformation of Russia will take far longer than most imagined.

The euphoria of a decade ago has been replaced with a cold-eyed realism.

WEALTH

Moscow's Café Pushkin proves that great service, fine food, and kitchens that offer every item on the menu have arrived—if you can afford it. The bigger surprise: Most patrons are Russians.

Russia's 265,000 private farmers, who work 8 percent of the nation's farmland. A decade ago the country had big hopes for private farming, but that romance has been replaced by hard realities. High-interest loans, the reluctance of collective farms to part with more land, and the lack of government subsidies have taken a heavy toll.

Typical of Russia's larger farmers, Chaika got his start ten years ago when land and credits were easier to secure. Quitting his job as foreman at a nearby collective farm, he started with 173 acres of land and a leased tractor. "I didn't want anyone over my head, ordering me around," said Chaika. "I wanted to count on myself."

The first half dozen years were a struggle, as interest rates skyrocketed and prices for agricultural commodities remained low. But the financial crisis of 1998—during which the ruble's value against the dollar dropped fourfold—made food imports too expensive for Russians, eventually giving a boost to the country's farmers and food processors. With prices for wheat and other products rising, Chaika has begun rapidly expanding, renting 700 more acres from neighboring collective farm members. He now owns two combines,

Teenagers tank up on computer games at Internet Club, one of Novosibirsk's

seven tractors, two heavy trucks, two light trucks, and a $28,000 American planting machine from Kinze Manufacturing in Iowa. This year he is raising wheat, rye, beets, and 270 acres of popping corn, which he has contracted to sell to an American broker. He expects revenues of $70,000, including a profit of $35,000. He is putting nearly all the money back into his business.

"Farming is a style of life," said Chaika, who has a wife and two grown daughters. "Your whole life is tied to the land. I'm used to it now, and there's no other way for me. After ten years I've got something to show for all this work. We grow what we want, sell it, and if we make a mistake, we are guilty ourselves. I feel bad for those people who have remained on the collective farm. Now they've just thrown up their hands."

As I spent time with Chaika—watching him supervise the beet planting or round up a hoist to help reassemble his dilapidated tractor—I came to admire this man and his straight talk. One evening before leaving, I reflected on his outlook, how it differed from mine, and how profoundly my view of Russia had changed in the dozen years since I had first set foot on Russian soil. As a correspondent during the

busiest cybercafés. There are only about five personal computers for every hundred Russians, but PC sales are on the rise. A decade after the Big Change, Russia has new toys, new promise, new vices, and plenty of growing pains.

Gorbachev and Yeltsin years, I always seemed to be looking at Russia with either optimism or pessimism, to be cheering on the forces of reform in their struggle with Communist reactionaries. I believed you could more or less graft a Western-style system of capitalism and democracy onto Russia, and I rooted for that system to take hold.

Now I realize how naive I was and that the worst prism through which to observe Russia's struggle is one of optimism or pessimism. These days I accept Russia for what it is—an enormous nation, with little tradition of democracy or capitalism, undergoing a peaceful revolution in a very short time. There is ample reason both for hope and for despair, and what you find often depends on where you look. Chaika and his countrymen have an intuitive understanding of what has taken me years to grasp. They also possess something I never will: an almost genetic comprehension, based on centuries of wildly swinging fortunes, that things in Russia can easily go awry.

"You put all this sweat and energy into this farm and then you worry that all of a sudden, one fine day, someone is going to come along and sweep it all away," he told me. "I don't think it's going to happen, but you have to worry about it. In the depths of my soul I worry about it." □

MORE ON OUR WEBSITE

Hate hassling with red tape? Try doing photojournalism in Russia, says Gerd Ludwig in an interview at **nationalgeographic.com/ngm/0111.**

Curious, or perhaps oblivious, a young hippo eyes a camera through crystalline water. Images from remote cameras monitored for two years reveal new behaviors of hippos, creatures that enable life to thrive in this African spring.

KENYA'S MZIMA SPRING COMES

ALIVE

ARTICLE AND PHOTOGRAPHS BY
MARK DEEBLE AND VICTORIA STONE

Mzima. The word means "alive." Yet the life of Kenya's Mzima Springs is largely born of ash and dung. In the neighboring Chyulu Range (right) stand porous peaks of volcanic ash, whose youngest cones formed about 500 years ago. Rising 7,000 feet above an arid plain, these hills trap up to three feet of rain each year from moisture-laden winds. All that rain soaks into the sponge-like ash and percolates down until it hits impervious bedrock and begins its underground journey to Mzima Springs, some 25 miles away. Filtered over many years, the pure water gushes forth at a steady pace of more than 50 million gallons a day, creating an oasis at the heart of Kenya's Tsavo West National Park. We camped there for two years with our two young sons, studying Mzima's hippos, whose copious deposits of dung nurture a pyramid of life.

Cool and shallow, a shaded spring offers buoyant relief to a herd of ponderous hippos, one of four groups that loll all day in the protected waters of Mzima's three main pools. By night the hippos graze on nearby grasslands. When they return, their yellowish waste fertilizes the water with vital organic matter.

FERTILE WATERS

Nostrils pinched to block out water, an adult hippo stands in a wreath of dung stirred by its footsteps. The consistency of chopped wet hay, the dung provides a hiding place for predatory insects and food for snails and fish. Insects, fish, birds—one feeds the next in an intricate chain anchored by the bulky herbivores that can eat more than a hundred pounds of grass a night. After death, hippos themselves provide food for scavengers like turtles, which lay their eggs on Mzima's shore. There, in wet-season puddles, shaggy coats of algae sprout on the shells of juveniles. When the turtles later enter the springs, tiny *Garra* fish mow the shells clean (below left).

One *Garra* became a meal for a water scorpion (above). The insect hid in hippo dung, then ambushed the fish, snatching it with raptorial forelegs. Larger fish are the favored quarry of the rare African darter, or snakebird (below), which cocks its neck and strikes like a serpent to spear prey.

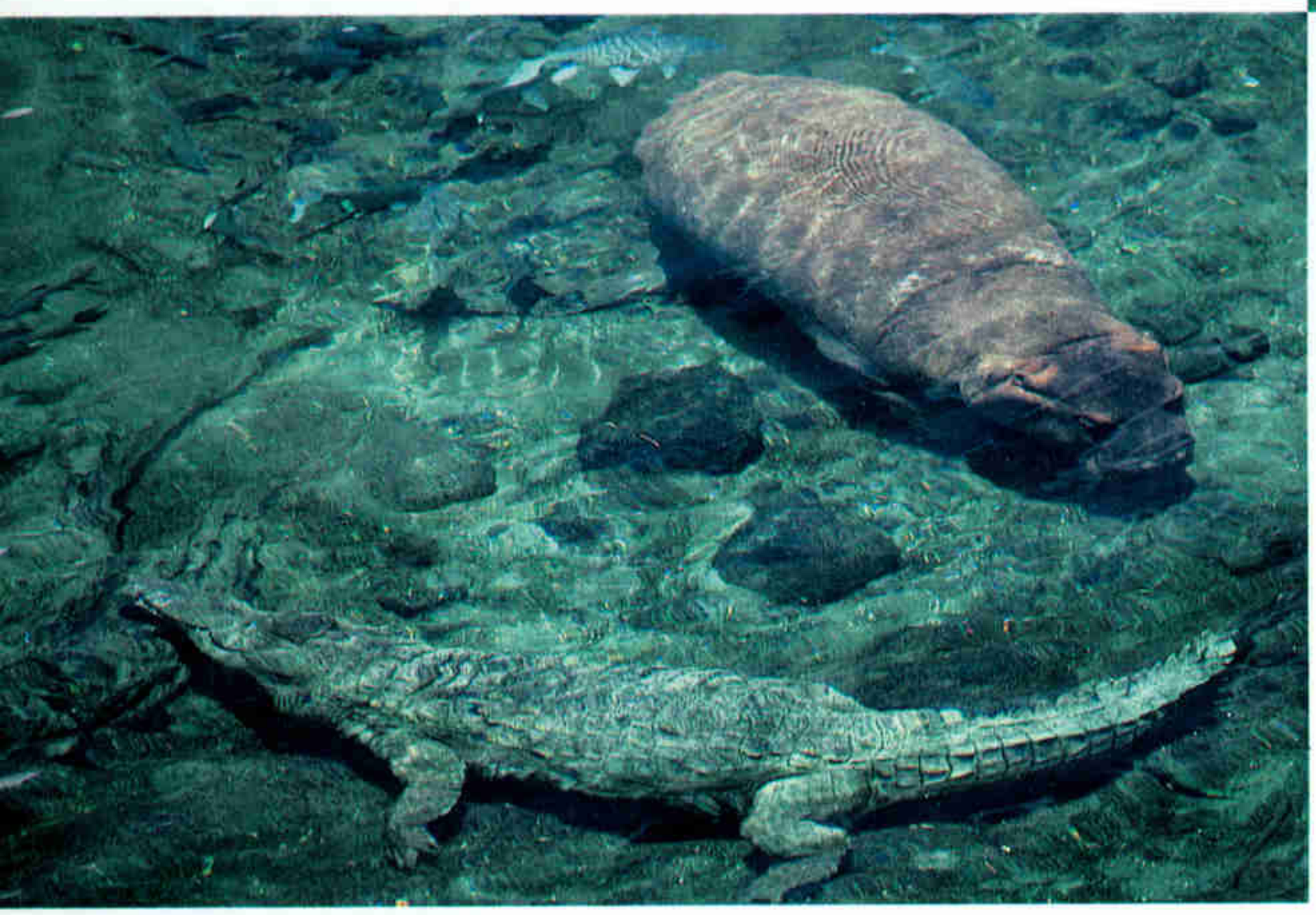
It took nearly a year of trial and error with various gear to begin to capture our own quarry—photographs of rarely seen behaviors among Mzima's wildlife.

Death trap in roiling waters, a Nile crocodile hunts obscured by Mzima's rapids. The touch of a passing fish will trigger these jaws to slam shut. Reaching lengths of 16 feet, Mzima's largest carnivores can't easily sneak up on prey in calm transparent pools.

In the vulnerable first months of life young hippos rely solely on their mothers for defense against crocodiles, virtually the only predatory threat at Mzima. Once a hippo reaches one year, it is robust enough to stand its ground (below) and is rarely bothered.

Hippos display almost whalelike adaptation to life in the water. Infants may be born in water and will even suckle there (right), raising their heads from time to time to breathe. After a secluded period of bonding, mother and calf will return to the herd, usually composed of a dominant male, cows, and calves of both sexes.

For decades the number of hippos at Mzima Springs has remained constant at 60 to 70 animals. Blessed with a steady flow of water, the springs are spared seasonal fluctuations that can stress populations and prompt crowding and fights at drying pools. We saw no fights, but we did see an infanticide, one of only a handful documented. It was doubly rare because the attacker was not the dominant male but a young hippo, which repeatedly bit and dunked a newborn male until it died. The distressed mother carried off the carcass (below right). It's possible the aggressor was a male trying to eliminate a future rival.



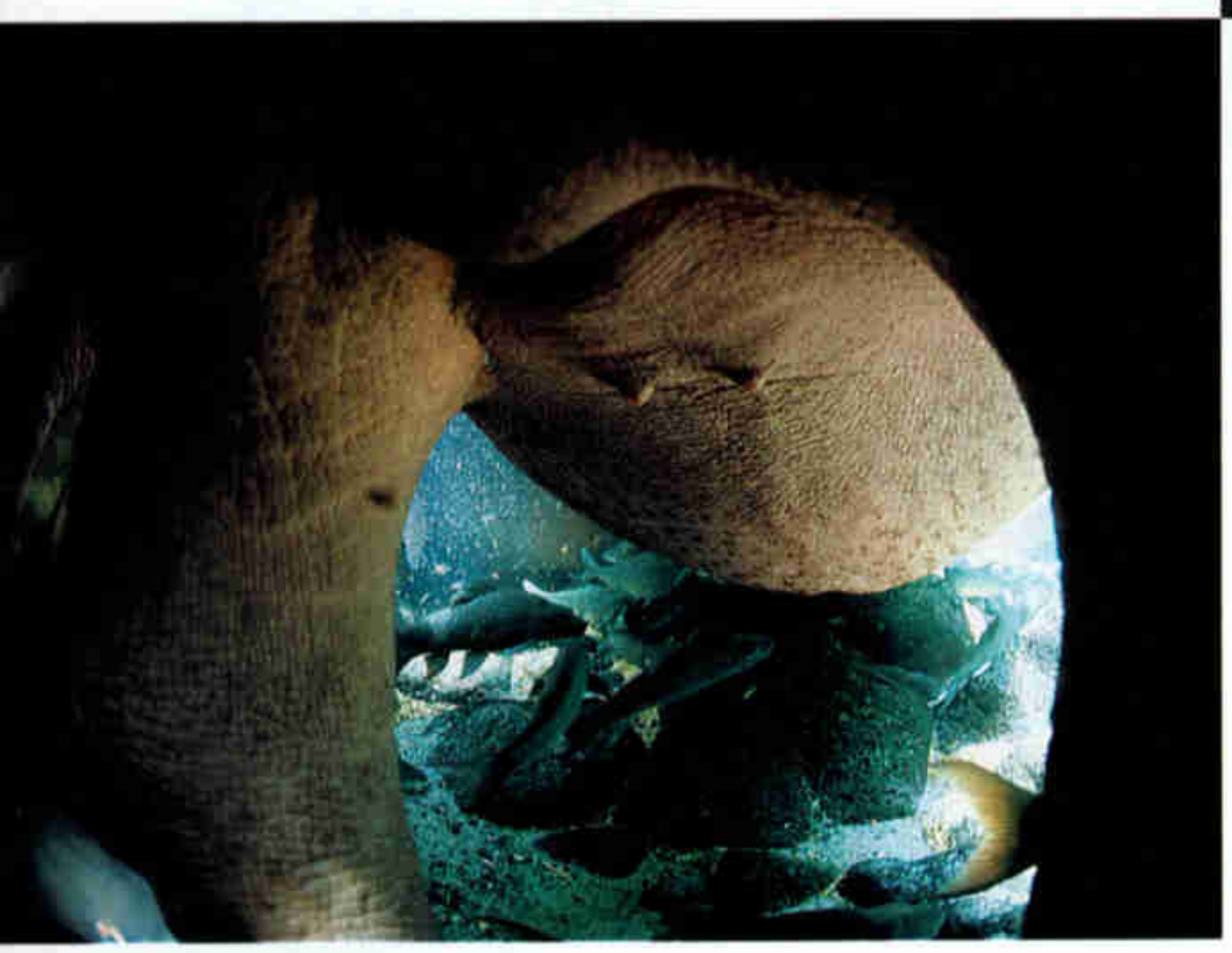
CRADLE OF LIFE AND LOSS

ORAL FIXATIONS

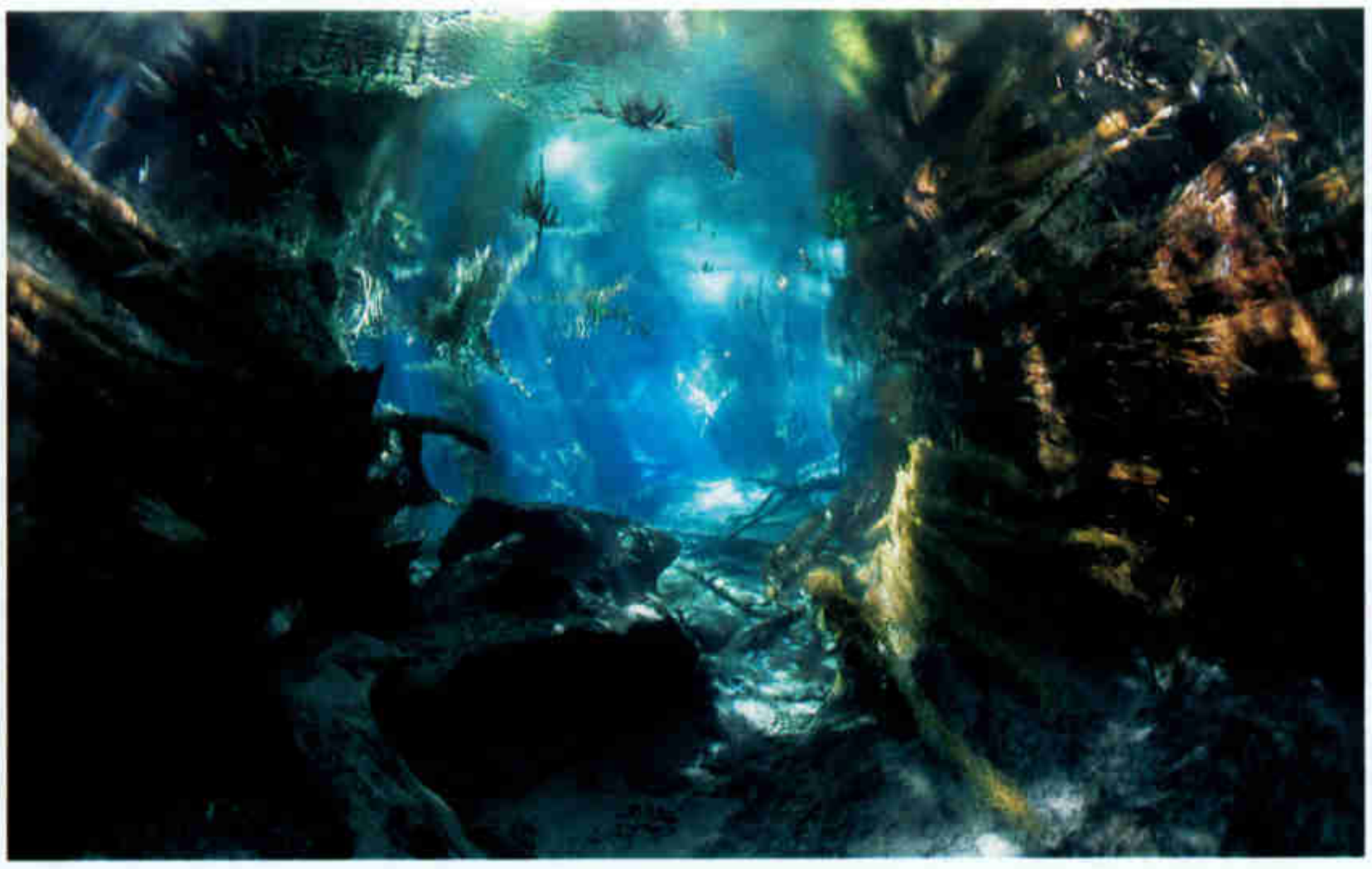
Like a jowly king at ease with his attendants, a hippo passes with a retinue of fish (facing page). It has long been known that hippos and fish are constant symbiotic companions. Fish clean hippos and are in turn nourished by the algae, parasites, and dead skin scraped from hippos' hides. What wasn't known—and what we photographed for the first time via remote submerged cameras at Mzima—amazed us.

We discovered that certain fish specialize in cleaning specific body parts. The ubiquitous *Labeo,* in the carp family, is the main cleaner, using its wide rasping mouth to scour a hippo's hide (right). *Barbus* feeds directly on dung and cleans the cracks in the soles of the feet. Small cichlids graze around the tail bristles. And tiny *Garra* cleans out wounds.

Hippos are far from passive recipients of these services. We saw them deliberately splay their toes (top) and spread their legs (left) to provide easy access or to solicit cleanings. They would even visit "cleaning stations" where fish congregate—much like pampered clients going for a massage or manicure at a spa.



Eager to oblige a pestering swarm of *Labeo,* a hippo proffers its palate for scrubbing. The animal repeatedly opens its jaws until its mouth is clean. Saber-like canines, used for defense or attack, pose no threat to the fish. Hippos get so relaxed during cleanings that they often doze off.



Gloriously clear and inviting, this nameless spring about 50 miles west of Mzima lured us for a dive. We discovered and entered a narrow cave opening. Inside a labyrinth of blind tunnels we found scores of jumbled hippo, crocodile, and turtle bones (below), some so old they crumbled at our touch. Clearly the

A WATERY GRAVE

spring once held hippos and all their attendant life, but today its waters are nearly lifeless.

Clues to the cause of this sterility can be found just beyond the spring's steep banks. The surrounding landscape, which lies outside a national park, is crowded with small subsistence farms. Hippos likely would have eaten or trampled crops during nightly grazing forays. We assume that farmers chased off the hippos or killed them for meat. Without hippos and their dung, the spring died. As for the bones, we speculate that hippos occasionally blundered into the cave, became disoriented, and drowned. Attracted by the smell, crocs followed and met the same fate.

Safely ensconced in a national park, Mzima should be spared the starkness so apparent just beyond its borders. □

MORE ON OUR WEBSITE

Find more photos of the hippos of Mzima plus field notes and reference sources at **nationalgeographic.com/ngm/0111**.

auroras

earth's grand

JAN CURTIS

show of lights

by kenny taylor

THE WHOLE DOME of night sky was awash with color: cascades of yellow-green and blushes of crimson fanning from a darker point high overhead. As they fell in broad rays, they shifted and changed in brightness, sometimes intense in one place, then cool, then hot. It was like looking up into the heart of a flower of glorious light whose petals rippled in a breeze that could not be felt—a breath from beyond this planet.

That aurora (Latin for "dawn") lit up the night at my home in the Scottish Highlands more than a decade ago, but to this day I can picture its colors, shapes, and movements. The show peaked for less than an hour, but its tonal themes lingered longer. It seemed an act of magic, but I knew that science had unveiled this magic act: Electrically charged particles from the sun were making gases glow in the upper atmosphere.

Thousands of miles away, in Alaska, the aurora also caught the attention of Charles Deehr, a physicist at the Geophysical Institute of the University of Alaska Fairbanks. "That display on March 13-14, 1989, was one of the best in the last 50 years," he said.

I visited Deehr in March 2001 during the current phase of intense auroral activity. Deehr is a wiry man who retains, in his sixties, a youthful zest for new research ventures. His work in auroral forecasting mixes science and divination as he searches for patterns in the latest information sent from near-Earth satellites in hopes of predicting auroral activity a day or so in advance. Such forewarning makes it possible to prepare electrical systems on Earth and in space for disturbances.

Scientists use satellites to gauge an aurora's power, but it was the 1989 aurora's extreme reach that demonstrated to most of us how unusual it was. Most auroras are visible only in the higher latitudes (above 60 degrees), but that one showed up as far south as Key West in

NORBERT ROSING

Pictures of satisfied aurora tourists hang in the visitors center in Yellowknife, Northwest Territories. On clear winter nights the aurora reliably lights the sky here in the extreme north, attracting some 12,000 visitors a year to the town.

Florida and the Yucatán Peninsula in Mexico. People unnerved by the fiery tint in the sky phoned the police; others watched in awe. Within 90 seconds of the aurora's reaching the skies above Quebec, magnetic storms associated with it caused a province-wide collapse of the power grid, leaving six million Canadians without electricity for hours. At the same time, compass readings became unreliable, and there were reports of automatic garage doors opening and closing on their own. Radio transmissions and coastal navigation systems were disrupted, and information feeds from some satellites were temporarily lost.

These troubles were a clear illustration of the need to predict auroras. In the Middle Ages a glowing red aurora over middle latitudes was seen by some Europeans as an omen of bloody battle or other impending doom. The superstition may have faded, but in a time of increasing reliance on high-tech links, discovering what auroras might actually signify has taken on practical relevance and a new urgency.

Charles Deehr arrived in Fairbanks with several other graduate students in physics in 1958. They were participating in the International Geophysical Year (IGY), which brought together scientists from 67 countries to study Earth's surface, interior, and atmosphere. The great red aurora of February 1958—perhaps the most extraordinary of the century—had just occurred. This indicated explosive activity on the sun, ideal conditions for auroral research. "The preceding year had the most sunspot activity ever recorded, and we had fancy big auroras every night," Deehr said.

Since the mid-1800s it has been known that the number of sunspots—dark, cooler patches of intense magnetic activity that are often accompanied by major eruptions on the solar disc—peaks roughly every 11 years. Sunspot numbers are usually high for a couple of years or so before and after the crest of this wave, known as the solar maximum. Auroras are hooked in to that roller coaster. So when the sun is restless, as it was in the late 1950s, Earth's night skies may dance.

With a view that's out of this world, the space shuttle *Endeavour* cruises through the aurora australis, or southern lights, a simultaneous and almost identical counterpart of the aurora borealis, or northern lights (preceding pages). Each of these heavenly spectacles has mesmerized

earthbound humans from time out of mind. Born of the effects of solar wind on our planet's atmosphere, auroral activity is especially intense right now, creating stunning displays and giving scientists insights into events in space that can devastate electronic systems here on Earth.

NASA/CORBIS

Deehr's group contributed to the discovery that there are two great ovals of auroral activity encircling the geomagnetic poles—one for the aurora borealis in the Northern Hemisphere, one for the mirroring aurora australis in the Southern. These typically bulge farther toward the Equator on Earth's night side and change shape a bit in the course of a single day. During a big aurora they may move even farther, giving people beyond the normal limits a glimpse of the lights.

The aurora of 1958 also coincided with the dawn of the space age. Our understanding of auroras comes in huge measure from linking insights gained through manned space missions to data and images from satellites, rockets, and observatories on the ground. The current research armory includes various craft in the International Solar-Terrestrial Physics (ISTP) program. Largely under the command of NASA, the European Space Agency, and Japan's Institute of Space and Astronautical Science, this international endeavor uses spacecraft to study the sun—including sunspot activity—and its effects on the Earth. The ISTP missions have roughly coincided with the present solar cycle, which reached solar maximum in 2000 and is likely to produce atmospheric fireworks for the next couple of years.

DURING my time with Charles Deehr, there had been a lull in auroral activity. "Things are picking up again," he said, pointing to a diagram on his laptop. Red lines spiraled from a central point like water jets from a garden sprinkler. "The sprinkler is the sun," Deehr explained. "There are sources on the sun that give off charged particles—electrons and positive ions—at different speeds." This spray of superhot ionized gas, known as plasma, blows across interplanetary space in what is termed the solar wind.

There is always auroral activity somewhere over the Earth. But its strength and extent vary hugely, according to what the sun has been hurling at us in preceding days. Flares that release energy bursts as powerful as millions of volcanic eruptions and coronal mass ejections that send hurricane blasts of ten billion tons of plasma into space figure more often during active parts of the solar cycle.

The sun, like the Earth and most of the planets, is a huge magnet, with its own force field stretching far beyond it. This gets twisted into a spiral by the sun's rotation, and within it the solar wind particles course along magnetic field lines that channel their movements. The eye-catching computer graphics Deehr showed me were an attempt to model the path of that energy from the sun to beyond the Earth.

As they zoom toward near-Earth space, the particle streams hit the edge of our planet's own magnetic sheath—the magnetosphere. Deflected by the magnetosphere, like water meeting a rock, the solar wind swirls past Earth and then pushes in again on the night side, squeezing the magnetosphere and elongating it into a comet-shaped tail. On the day side, the magnetosphere grows when the solar breeze is light and shrinks in a solar gale.

Charged particles that get trapped in the "magnetotail," which may stretch millions of miles, can be sent hurtling back toward Earth. Then, in a variety of possible ways not yet fully understood, some eventually rain down into the upper atmosphere over the polar regions—the places where our protective magnetic envelope is most open to space.

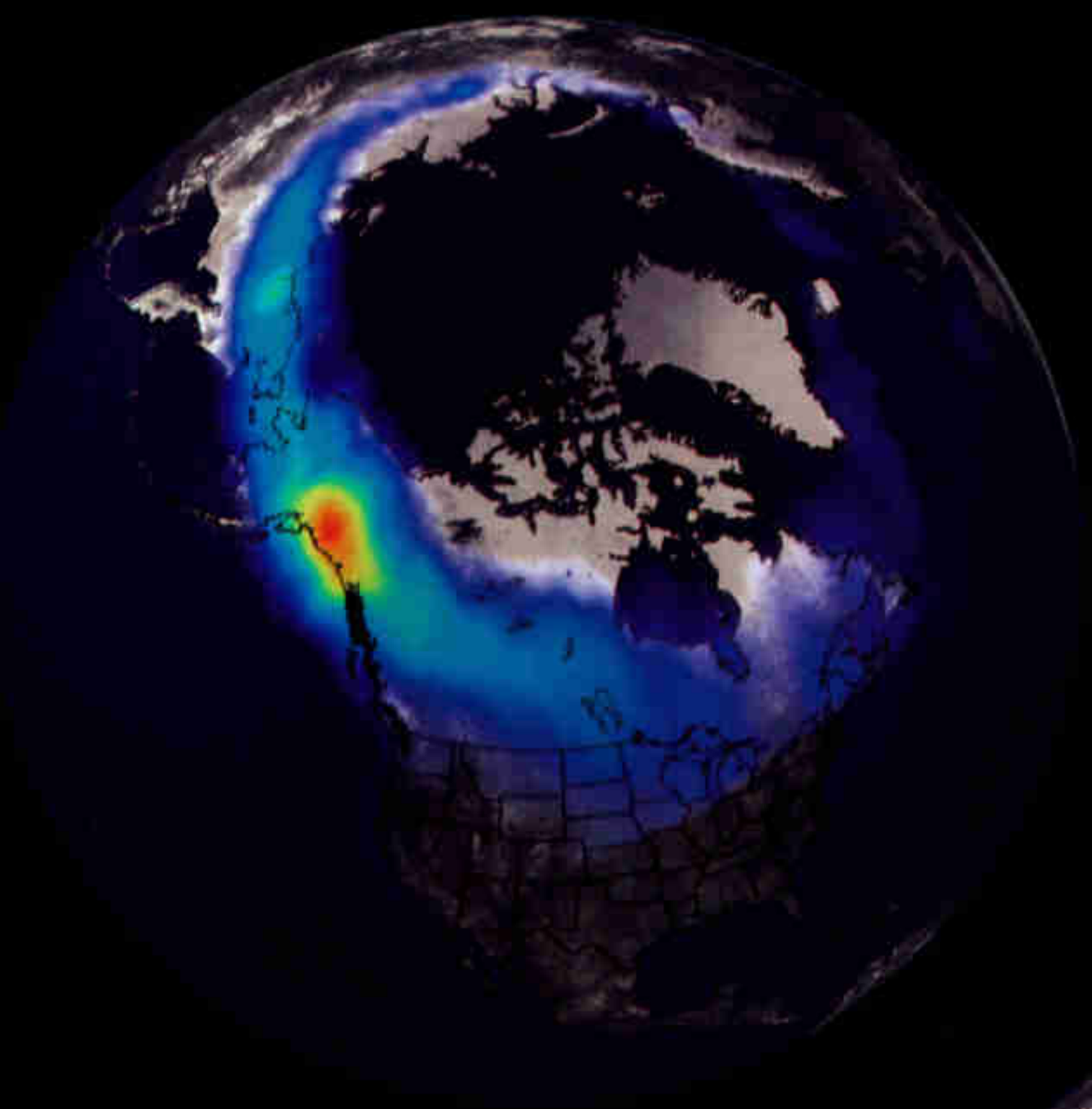
Auroral light comes largely from electrons hitting oxygen and nitrogen atoms and molecules in the upper atmosphere, the same phenomenon that produces the glow in a neon lighting tube. But in the aurora the illumination can be 600 miles high, stretch for thousands of miles, and be linked to a magnetospheric power generator churning out three million megawatts or more—about four times the electricity the United States uses at peak summer demand.

I asked Deehr what my chances were for an aurora that night, my last in Fairbanks. He clicked a couple of keys. "Here's where we're seeing a piling up of fast and slow particles. When we plot out what we think is going to happen, our model says we could get some increase in auroral activity later today."

But my departure was not to be graced by an aurora. I was reminded of what he had said about forecasting them. "There are no guarantees. We're still about a hundred years behind the meteorologists—it's that bad, or good."

In the past few years the term space weather has become a catchall to include eruptions from the sun, variations in the solar wind, and changes in the magnetosphere, which can in turn affect the Earth's atmosphere, producing auroras. Part of the uncertainty in making

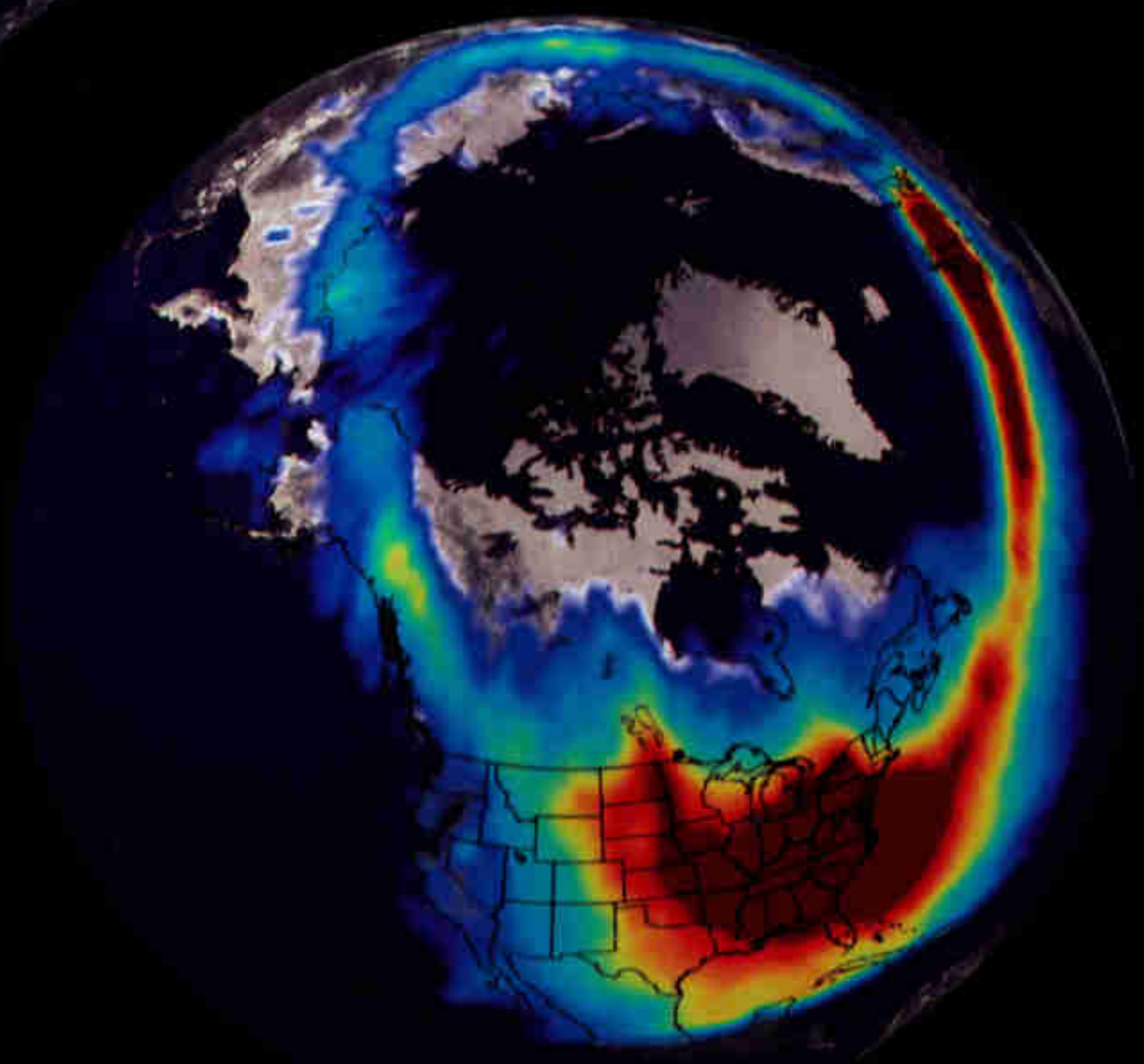
the effects of space weather



minimum activity

Shining in ovals around Earth's Poles, auroras depend on the solar wind, a stream of charged particles from the sun. Near the low point in an 11-year cycle of solar weather, the wind's interaction with Earth's magnetic field produces an aurora borealis over a small northern area (left).

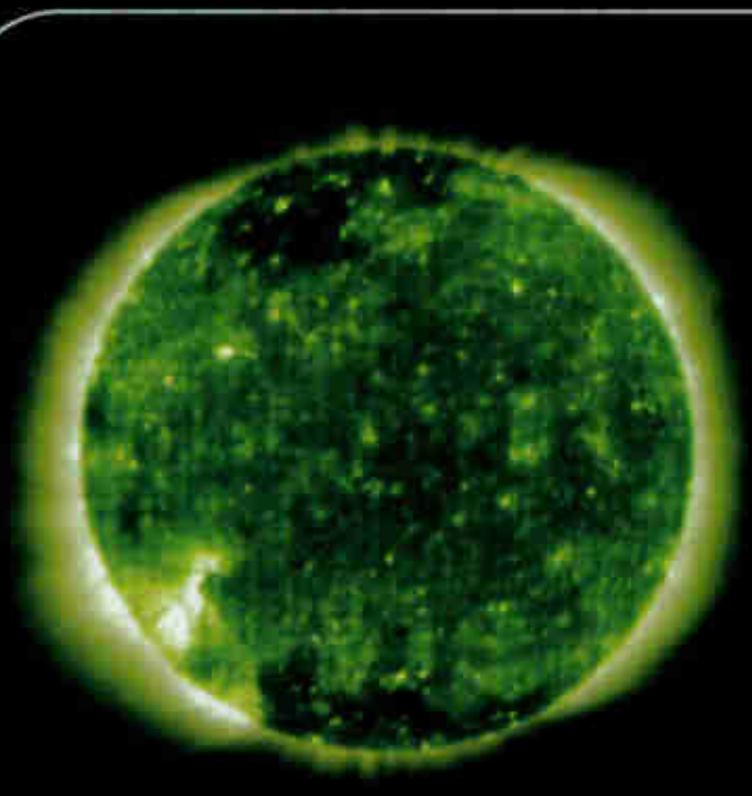
anuary 10, 1997



July 16, 2000

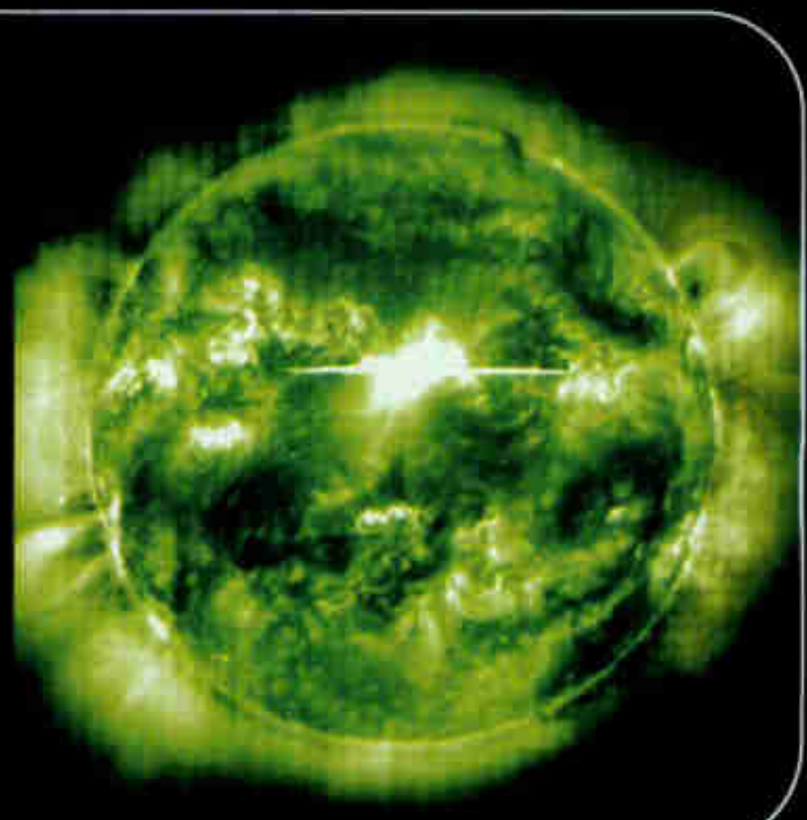
maximum activity

High in the cycle, a strong solar wind can push the auroral ovals far from the Poles. Last year an extraordinary blast produced an aurora over the whole eastern United States (right), but summer twilight and a full moon kept the sky so bright the event was all but invisible.



the sun's extremes

Ultraviolet images show a quiet sun near its low point of activity (left) and a violently restless sun near its high point (right). Greater activity throws more particles into the solar wind, which can create bigger, brighter auroras.



anuary 2, 1997

July 14, 2000

AURORAL IMAGES AND EARTH MODEL: NASA POLAR/VIS; L. A. FRANK AND J. B. SIGWARTH, UNIVERSITY OF IOWA
SOLAR IMAGES: NASA AND THE EUROPEAN SPACE AGENCY SOHO/EIT

A magical variety of shapes and colors dance in the sky as the solar wind buffets the Earth's magnetic field. When the aurora last peaked, in the late 1980s, shows over Churchill, Manitoba, included a green ribbon (above) and a rosy curtain (below). On the downward side of the cycle, a column towers above lava erupting from the volcano Hekla in Iceland (right).

NORBERT ROSING (LEFT, BOTH); SIGURDUR H. STEFNISSON

space-weather predictions is the difficulty of relating an event in one part of this vast system—such as in the sun—to a later event on Earth, such as an auroral display. "A lot can happen in 93 million miles," was how one space physicist put it. Scientists at NASA's Goddard Space Flight Center in Greenbelt, Maryland, are part of an international team at the forefront of research into auroras and connections between the sun and the Earth.

"One of the most important aspects of auroras is that the polar regions are where the magnetic field lines concentrate," said Mario Acuña as we stood on a walkway overlooking a huge space-hardware testing floor. Acuña, who was born in Argentina and still speaks in a warm, accented baritone, is a veteran of NASA science missions from the early satellite days. "So over a small region you can observe what is happening over a gigantic volume in space. The complexity lies in how we can relate this auroral picture to phenomena that are happening elsewhere in the magnetosphere."

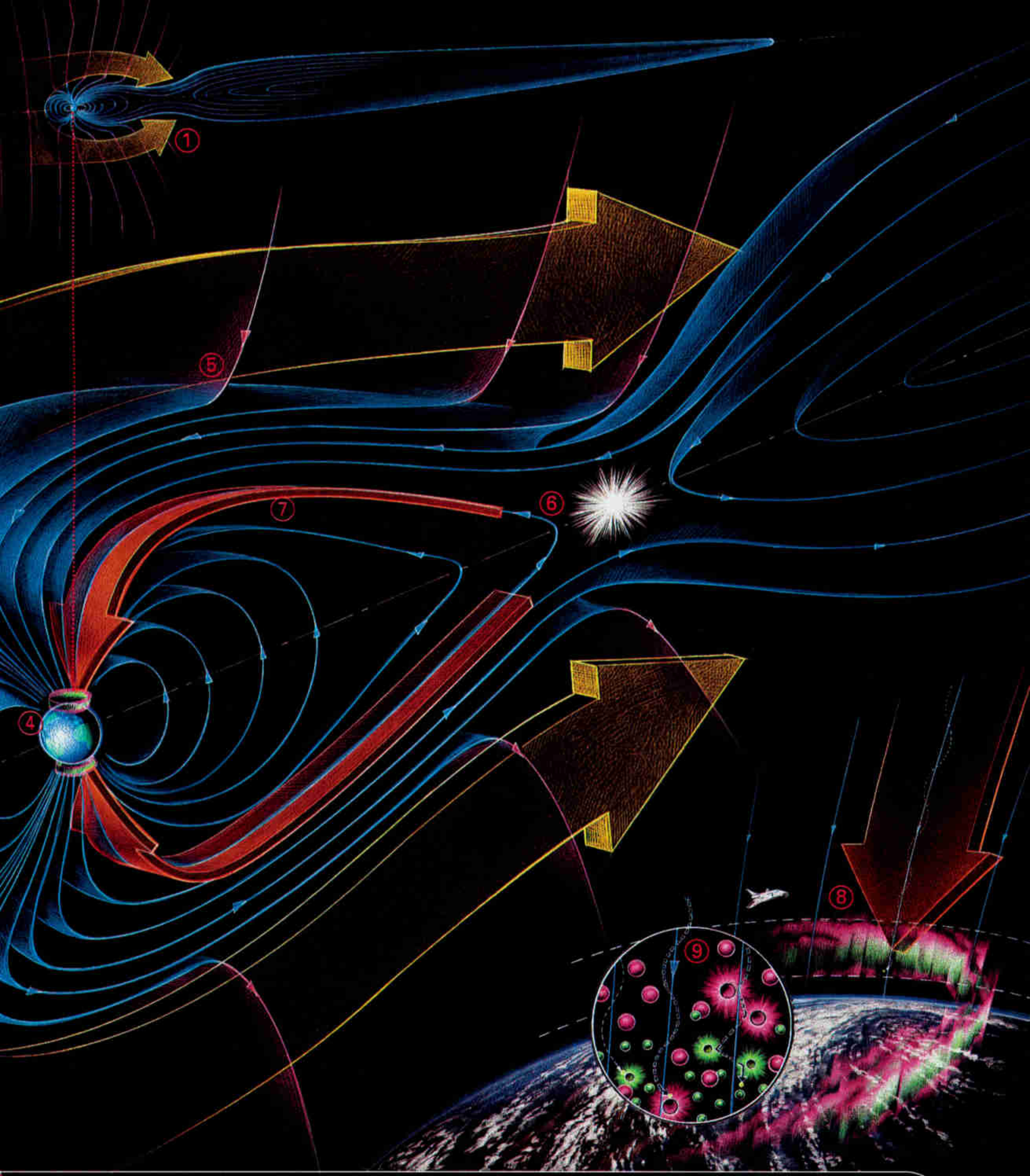
To make sense of the system, he explained, we need, as in weather forecasting, to have enough instruments in key places to understand cause and effect—where the energy comes from, how it gets transformed, and where it ends up. "That's the strategy behind the multiplicity of craft flying today," he said. "They are operating in four key regions. There have been some major changes in thinking because of the results."

One accomplishment was when the ISTP's Polar spacecraft (under NASA control and working on the sunward side of Earth) and Japan's Geotail craft (working in the magnetotail on the night side) made the very first direct observations of a crucial hookup between the magnetic fields of the sun and the Earth. Called reconnection, this linkage is an important aspect of the transformation that allows the solar wind's energy to penetrate Earth's magnetic cocoon, leading to auroras.

Another recent breakthrough from Polar is the finding that waves of energy flowing along magnetic field lines at more than 6,000 miles a second become more intense as the lines converge near Earth. These Alfvén waves (named for Hannes Alfvén, the Swedish physicist and Nobel laureate who first proposed their existence) appear to be what power an auroral display, by accelerating particles down

how the light show works

The Earth's magnetic field forms a protective envelope called the magnetosphere. Arriving with great force, the solar wind compresses the front end of the magnetosphere and elongates the back end into a tail 1. At the point of impact, if properly aligned, the solar wind's magnetic field 2 links up with magnetic field lines from Earth 3. This connection produces the auroras seen on dark winter days in the extreme north and south latitudes 4.



As it blows by the Earth, the solar wind peels back the planet's field lines now linked to it 5. When those lines reach the tail of the magnetosphere, they break away from the solar wind and reconnect 6. Scientists still do not fully understand how, but this process of reconnection transforms magnetic energy into kinetic energy, which then propels electrons and positive ions into Earth's atmosphere along the newly reconnected field lines 7.

These speeding particles, especially the electrons, create the nighttime aurora. Crashing into the atmosphere 8, electrons hit the atoms and molecules of gases such as oxygen and nitrogen. In each collision the atom or molecule absorbs energy from the electron, then releases it as light 9. Color depends on which gas is hit and at what altitude.

To see an animated aurora, go to *national geographic.com/ngm/0111/feature3*.

ART BY BRUCE MORSER

from space. That's the big picture. But what shapes the finer detail of the classic auroral patterns—the curtains, folds, and rays—still awaits explanation.

HEAD REELING with ideas from space physics, I needed to reconnect with the visible aurora and the feelings it can stir. Yellowknife is the capital of Canada's Northwest Territories and the top global destination for aurora tourism. Last year some 12,000 people came here to see auroras—a pursuit of the truly dedicated in this frostbitten location.

Raven Tours, the oldest of the aurora enterprises, was founded by Bill Tait in 1981. Tait was away in Japan drumming up business, but Jared Minty, an eager young co-director, gave me the essential information. "In our current aurora tour season, which runs from mid-November through mid-April, we'll have more than 9,000 clients," he said happily. "The other main operators will also have a few thousand. Almost all these clients are Japanese."

I observed the Japanese enthusiasm for auroras that night at Prelude Lake, some miles from town. With each burst of celestial choreography, groups of people cheered and clapped, some of the women ululating in high-pitched tones. Japanese passion for auroras intensified during the 1990s. Ask the average Yellowknife resident, as I did over a beer in the Raven Bar, and many will say that the Japanese believe that conceiving a child under a good aurora increases the chances of having a gifted offspring. This urban myth may have started in April 1992 with an episode of *Northern Exposure,* a TV series set in small-town Alaska and filmed in Washington State. In it an aurora begins while a group of Japanese visitors are in a guesthouse, and they all run upstairs to try their luck under the northern lights.

"How can they say that about us?" asked Yukiko Suzuki. Yukiko, who is from Tokuyama in western Japan, had found aurora work in Yellowknife for the winter. "In Japan we cannot watch the northern lights, but we know how it's beautiful and great," she said. "That's why they're coming."

Don Morin, part Chipewyan, part Cree, and a former Northwest Territories premier, gave me another perspective on the aurora. "Many of the original peoples of North America have medicine animals," he told me one night as we sat in a huge tepee at Aurora Village, established by his family to give tourists a flavor of tribal life in addition to aurora-viewing opportunities.

"So when you pass on, you're going to go into an animal spirit. That's the next stop." For Morin's people, spirit life after death is a two-stage process. "When you pass on again, you end up in the dancing spirit—that's the aurora spirit. When we were kids, we were told that you have to be quiet when the aurora comes out. You don't want to upset the spirits in the sky by calling them closer."

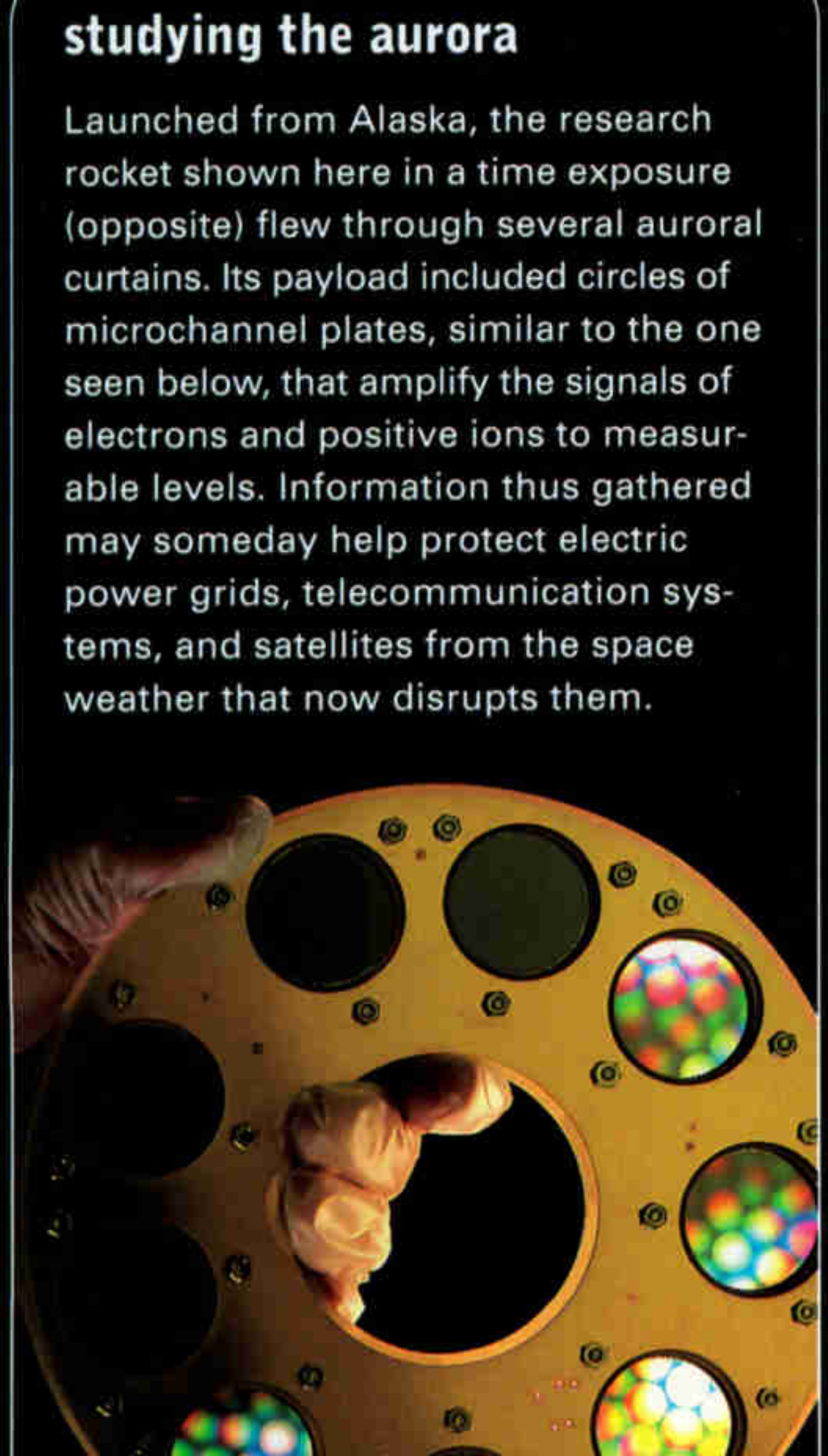
"They've always been sacred to us," said Suzan Marie, a Déné-Chipewyan and Cree woman from the South Slave region. "But of course with elders telling us as children not to whistle at the lights, we had to test to see if it was really true. We knew we shouldn't be doing it, and if they really started to move, we'd get frightened and not stay out too long."

Which, as in many tales, was the down-to-earth practicality that complements the elders' spiritual spin on the world.

In Norway I met a man at Tromsø's Auroral

studying the aurora

Launched from Alaska, the research rocket shown here in a time exposure (opposite) flew through several auroral curtains. Its payload included circles of microchannel plates, similar to the one seen below, that amplify the signals of electrons and positive ions to measurable levels. Information thus gathered may someday help protect electric power grids, telecommunication systems, and satellites from the space weather that now disrupts them.



GEORGE STEINMETZ AT AEROSPACE CORPORATION (LEFT); PAUL NICKLEN

The ghostly glow of an aurora near Iceland's Lake Laugarvatn in 1994 will likely pale in comparison with what is to come. The sun has just cycled into prime time for the most dramatic displays of a phenomenon that has inspired myth, art, and science throughout the ages.

Observatory who bridges the contrasting responses to auroras. Asgeir Brekke is a physicist who has studied the northern lights for more than three decades, but he is also an expert on auroral lore and legend. The walls of his office are hung with an intriguing mix of images, from radar stations to figures from northern mythology. Brekke is a soft-spoken man with a sweep of graying hair, and as we talked, he probed the images of death and life that recur in stories of auroras in different cultures—the links to spirits and battles between supernatural forces in the sky.

"I think for many people the phenomenon was scary, but some brave souls had their own thoughts about it." He mentioned the Norwegian who in about 1250 proposed rational-sounding explanations for the northern lights. One was that Greenland's ice drew in so much power that it could light the beams of the aurora. Along similar lines, he said, other Scandinavians had wondered if the lights were reflections from the sea or even from the glinting scales of huge shoals of herring.

Brekke circled back to science. "The current satellite experiments and those fascinating pictures that show the auroral ring around the Pole are fantastic achievements," he said. "I feel that the northern lights give a linkage between science and art. Even though as a scientist you are supposed to have some sort of objectivity, like an artist, you are inspired by them."

In collaboration with Dagfinn Bakke, an artist in Lofoten, Brekke has produced a book of watercolor paintings, scientific accounts, folktales, and poetry to show how people in Norway have related to auroras over the centuries. As I'd now come to understand, Brekke's enthusiasm for the lights represents a common bond between people who live beneath them and those who study them from afar. When he ended our meeting by reading poems about auroras, it seemed only fitting.

Poetry and space physics? Of course there's a connection. Just look up when the heavens dance. □

MORE ON OUR WEBSITE

Find additional pictures and get the author's inside story on investigating auroras at **nationalgeographic.com/ngm/0111.**

SIGURDUR H. STEFNISSON

EVOLUTION

DOUG PERRINE, INNERSPACE VISIONS

OF WHALES

"Then the whole world was the whale's; and, king of creation, he left his wake...." —Herman Melville, *Moby Dick*

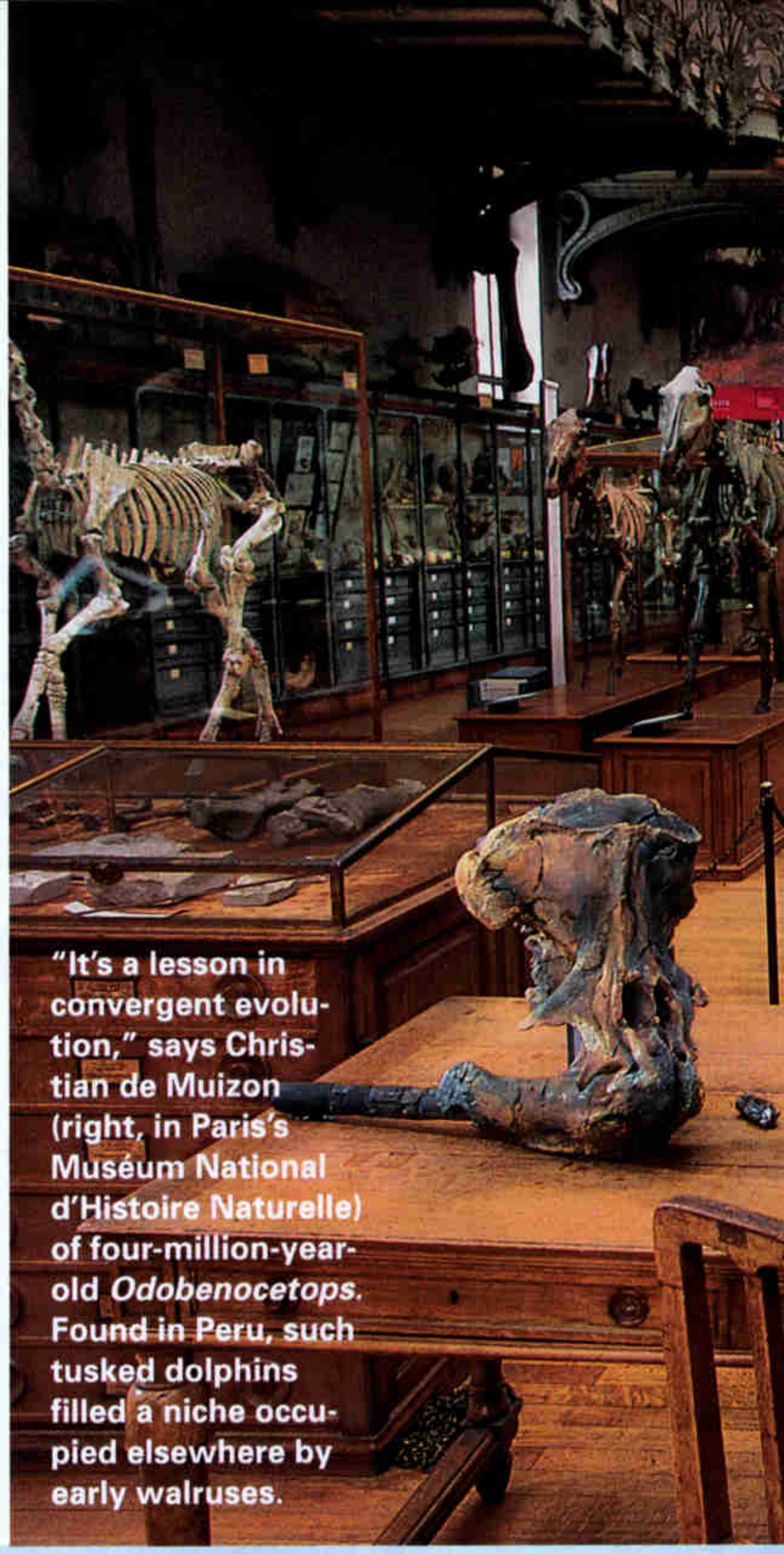
By Douglas H. Chadwick Photographs by Robert Clark

Art by Shawn Gould

The coast of southern Alaska grows glaciers and brooding rain forests. Hot weather is rare, but since sunup the day had brought nothing else. By afternoon everyone was sweltering. The first person to do more than just talk about leaping off the boat into iceberg-chilled Frederick Sound performed a cannonball. Others jackknifed and belly flopped in. This contest to raise the biggest splash was spirited but short. No sooner had the last person shivered back aboard than three humpback whales surfaced exactly where the jumpers had been landing. The whales lingered a while, misting the crew with spray from their blowholes, then eased down out of sight.

We were still exclaiming about the visit minutes later when the sea to starboard erupted. A 45-foot whale went skyborne up to its tail. Then a pair leaped in near synchrony. *Shwaboom! Ker-bloosh!* Others started to breach on all sides. For the next half hour humpbacks were flying and crash-landing, sending out minor tsunamis, floating head down to whap the water with their tail flukes, and lying on their sides to slap the surface with long pectoral fins.

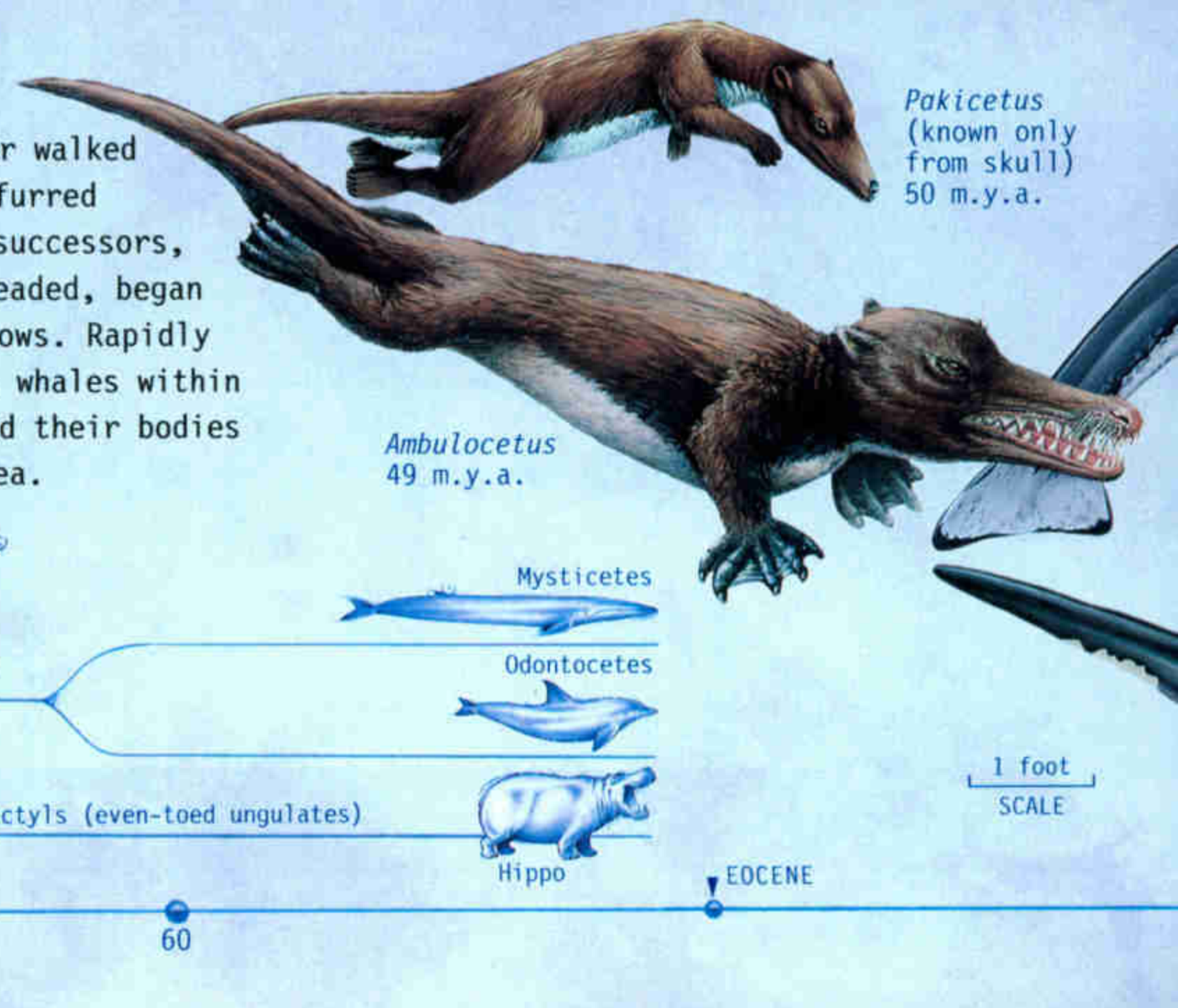
It would be the height of arrogance to think we inspired 40-ton organic submarines to compete with us. But I saw what I saw. Whales have a way of making the incredible real; their very name has become a metaphor for something almost too big to get our minds around. I wondered what the crews on whaling ships thought when they would occasionally haul



"It's a lesson in convergent evolution," says Christian de Muizon (right, in Paris's Muséum National d'Histoire Naturelle) of four-million-year-old *Odobenocetops*. Found in Peru, such tusked dolphins filled a niche occupied elsewhere by early walruses.

BACK TO THE SEA

Whales' earliest known ancestor walked nimbly on land, a hoofed and furred carnivore. In the Eocene its successors, likely gone squat and heavy headed, began amphibious lives in the shallows. Rapidly changing with the environment, whales within ten million years finely adapted their bodies and behavior to life in the sea.



Procetus
45 m.y.a.

Rodhocetus
46.5 m.y.a.

Kutchicetus
43-46 m.y.a.

Durodon
37 m.y.a.

50

40

OLIGOCENE

aboard a fully grown adult with miniature legs sticking out from its flanks. Whether they knew it or not, they were looking at testimony to the origin of these mysterious marine giants.

More than 80 living species of mammals are classified as whales, or, as taxonomists say, cetaceans (from *ketos,* the Greek name for sea monster). They can be divided into two groups. Mysticetes, or baleen whales, use comblike plates hanging from the roofs of their mouths to strain food from seawater. Blue whales, fin whales, bowheads, and most of the other real titans belong to this division along with smaller types such as minke whales and pygmy right whales. Odontocetes, or toothed whales, include belugas, narwhals, sperm whales, pilot whales, and beaked whales—plus all the dolphins and porpoises. We call the largest dolphins killer whales.

But what did the first whales look like? And what gave rise to them? For a long time scientists could only speculate, for the oldest fossils anyone knew of had already assumed the basic appearance of whales. In the absence of intermediate forms, people proposed almost every type of mammal as ancestors.

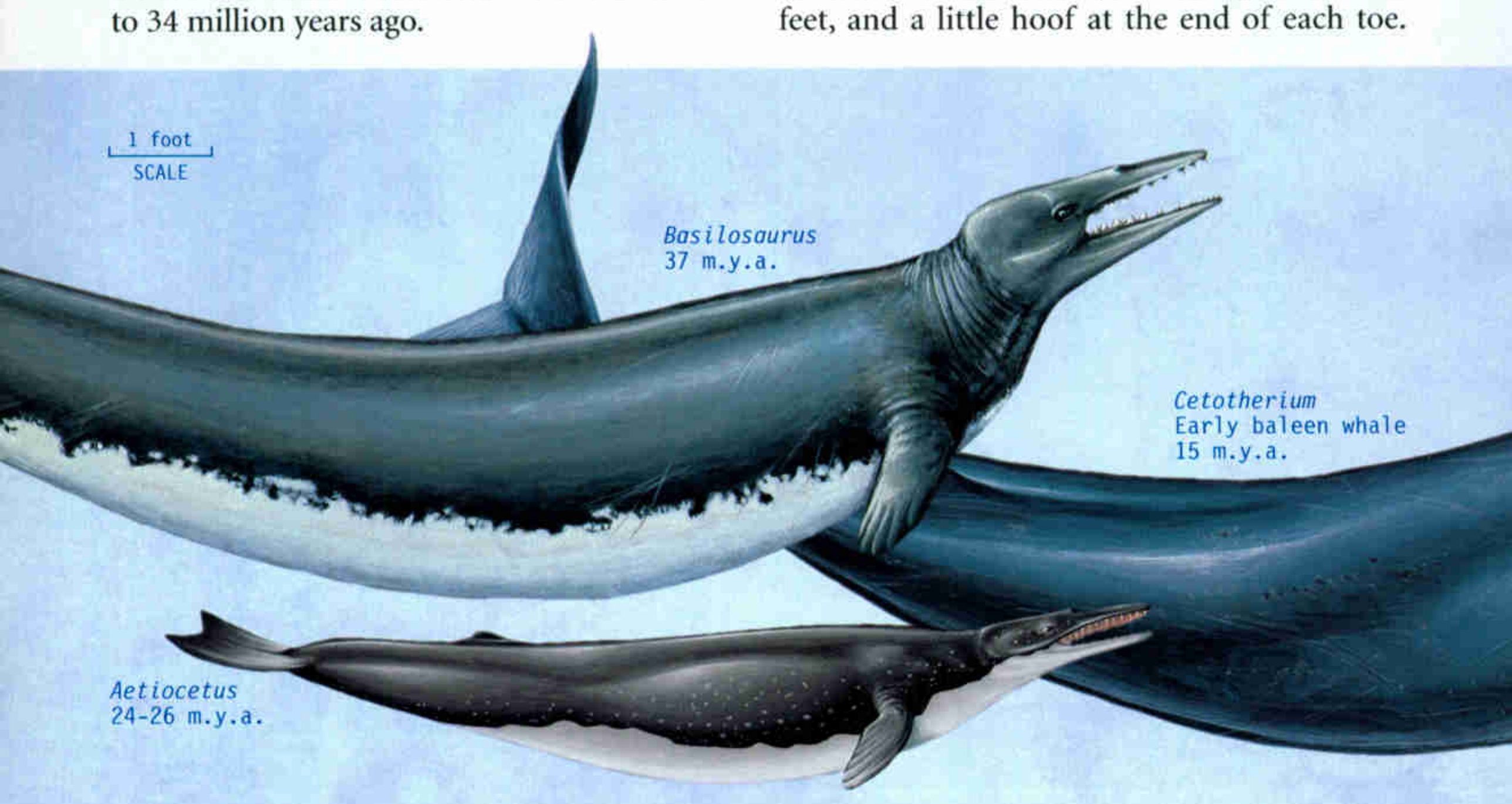
At last a series of fossil discoveries has unveiled whales' distant past. Paleontologists can suddenly trace the most colossal animals ever to appear on Earth step-by-step back to their beginnings early in the Eocene epoch, often referred to as the dawn of the age of mammals, which lasted from about 55 million to 34 million years ago.

The largest cetaceans, blue whales, may span a hundred feet and weigh a third of a million pounds, larger than any dinosaur dimensions; their skulls wouldn't fit into most rooms. When I visited Hans Thewissen at Northeastern Ohio Universities College of Medicine, he showed me one of the oldest known whales by placing its skull in my outstretched hand. At first glance I thought he had handed me the head of a coyote.

The skull belonged to a relatively small, furry, four-legged meat-eater, one that walked on hooves and died around 50 million years ago. The fossil, named *Pakicetus,* was unearthed in the Himalayan foothills from sediments whose other contents tell us that the creature lived with land dwellers that included marsupials and our own very early ancestors, squirrel-size primates.

Its remains are closely linked with river channels, suggesting a life spent partly in the water. What causes scientists to declare the creature a whale? Subtle clues in combination —the arrangement of cusps on the molar teeth, a folding in a bone of the middle ear, and the positioning of the ear bones within the skull—are absent in other land mammals but a signature of later Eocene whales.

A million years after *Pakicetus* a relative took up life at the edge of the sea. Thewissen discovered the fossil in Pakistan in 1994 and named it *Ambulocetus natans,* the walking, swimming whale. It had thick, splayed-out legs, four-toed feet, and a little hoof at the end of each toe.



As soon as I saw the limbs laid out with the rest of the skeleton, I knew I wouldn't have wanted to go wading in *Ambulocetus* territory. Squat, powerful, sharp of tooth, and roughly the size of a large sea lion, this whale-in-progress may have been an ambush hunter, lying submerged like a shaggy crocodile, then leaping forth to snatch passing prey.

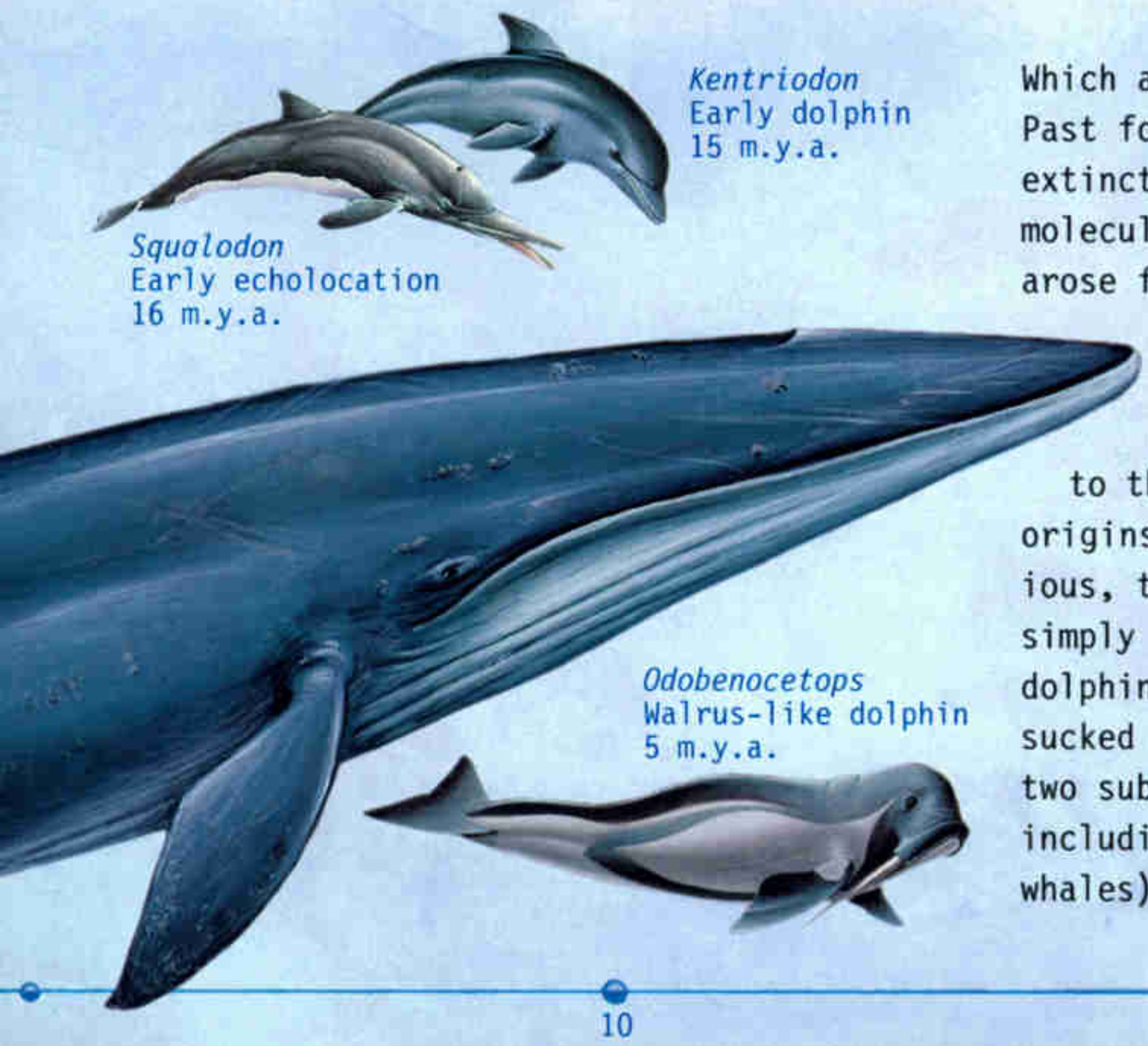
The next time I met Thewissen, it was on a desert plain in western India known as the Rann of Kutch. With Sunil Bajpai, an early-whale expert from the University of Roorkee, we set off into a landscape of camels and goats, where jackals panted in the thornscrub shade. Some 45 million to 42 million years earlier Kutch was a green, shifting border of a river delta, periodically drowned by the ancient Tethys Sea. The place rippled with sharks, rays, bony fish, crocodiles, and turtles, as well as whales experimenting with life in the ocean.

As I dug into the edge of a dry wash, I tried to visualize some of the varieties of whale ancestors that had been found here and nearby: *Indocetus, Rodhocetus, Andrewsiphius,* and *Kutchicetus.* No more than 5 to 15 feet long, they resembled big-headed, snaggle-toothed, web-footed sea lions or walruses and, like them, probably still returned to land to mate and give birth, schlumping along on ever punier hind legs. Yet analyses of oxygen isotopes in their teeth reveal that they no longer needed to drink fresh water as the walking, swimming whale did. These successors to *Ambulocetus* had crossed a crucial metabolic threshold on their way to becoming true marine mammals.

As the rear limbs dwindled, so did the hip bones that supported them. That made the spinal column more flexible to power the developing tail flukes. The neck shortened, turning the leading end of the body into more of a tubular hull to plow through the water with minimum drag, while the arms assumed the shape of rudders. Having little need for outer ears any longer, some whales were receiving waterborne sounds directly through their lower jawbones and transmitting them to the inner ears via special fat pads. Each whale in the sequence was a little more streamlined than earlier models and roamed farther from shore.

The makeover from landlubbers to seafarers happened in less than ten million years—overnight on the geologic time scale. As Thewissen put it, "Whales underwent the most dramatic and complete transformation of any mammal. The early stages were so poorly known 15 years ago that creationists held up whales as proof that species couldn't possibly have come about through natural selection. Now whales are one of the better examples of evolution."

Hoisting a partial skull I had just pried from sunstruck rubble, I trotted over to Bajpai. He said it belonged to an ancient whale named *Remingtonocetus,* identified by its long, narrow jaws. "We assume they were for snapping up fish, like the modern gharial crocodile does with its needle-like snout," he said. "It is a specialization that appears several times among later cetaceans, including modern river dolphins."



Which ancient animals gave rise to whales? Past fossil finds have pointed to long-extinct ungulates called mesonychids, but molecular data indicate that hippos—which arose from artiodactyls, not mesonychids—are whales' closest modern kin.

Ankle bones of two newly discovered early whales lend credence to the artiodactyl link. Whatever their origins, whales evolved into the amphibious, the strangely serpentine, and the simply bizarre. One large-lipped Pliocene dolphin dragged asymmetrical tusks and sucked down mollusks walrus style. Today two suborders, Odontoceti (toothed whales, including dolphins) and Mysticeti (baleen whales), encompass all cetacean types.

An evolutionary fingerprint, a middle-ear bone from a 50-million-year-old pakicetid —a member of the oldest known whale family—"is beautifully intermediate," says paleontologist Hans Thewissen. "Its structure helps answer how a land mammal's ear adapted to underwater sound."

As temperatures shimmered toward 115°F, stories from Hindu mythology came and went in my overcooked brain. I contemplated *siddhas*, those who have the mystical power to assume any shape, fly over mountains, and even defy death. Sleeving sweat from my eyes, I thought: What's so supernatural about that? Life has found ways to flourish in boiling hot springs and on icy mountaintops, to fly, glow in the dark, put forth leaves in a rainless desert, or plumb the ocean, reproducing and adapting, reincarnating itself in new forms in defiance of time and death.

About 40 million years ago, as ancient whales spread out from the Tethys Sea, considered the cradle of whale evolution, a group known as the dorudontines arose. Although they could still bend their flippers at the elbow and their nostrils had moved only partway from the snout toward the top of the head, in most other respects these were full-fledged, fluke-lashing cetaceans that gave birth at sea. They may have been the dynasty that went on to produce modern whales. The giant serpent-like *Basilosaurus*, a contemporary, was surely a hunter to be reckoned with—the fossilized stomach contents I saw contained 13 kinds of fish and sharks up to three feet long.

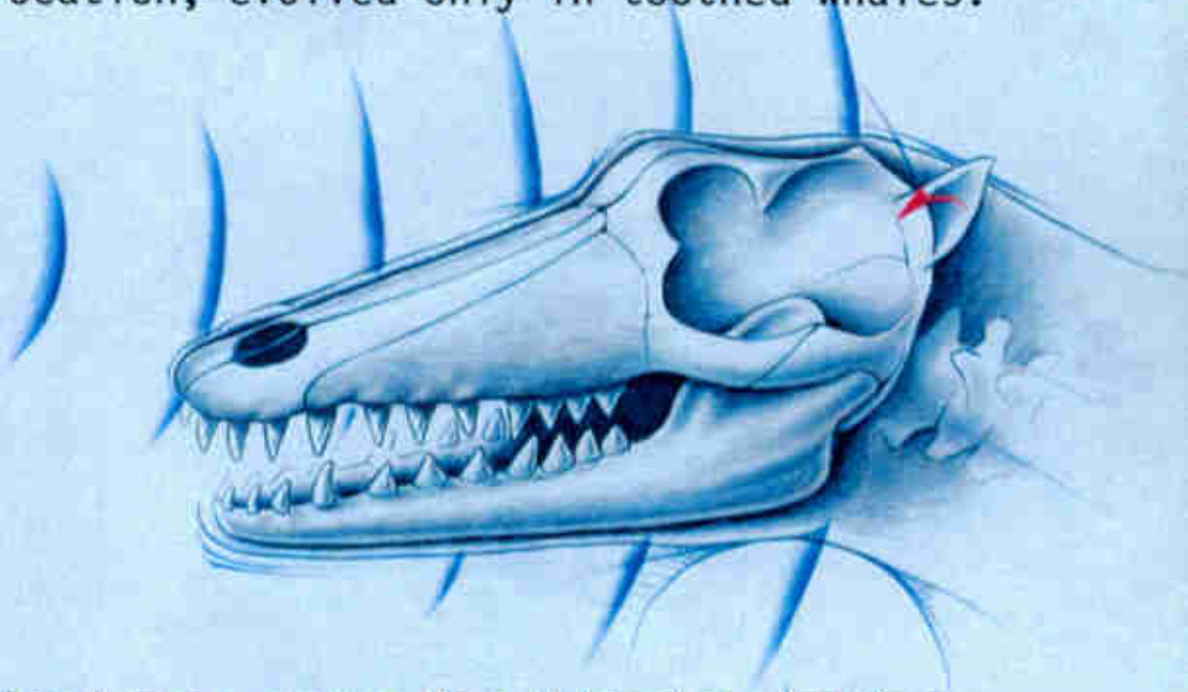
James Goedert knows a lot about how lines diverge or connect. After all, he is a signal inspector for a railroad. Give him a day off and he and his wife, Gail, are questing after extinct whales. They've been at it 20 years, looking mostly in the epoch after the Eocene, the Oligocene, from 34 million to 24 million years ago.

"When we began," said Jim, also a part-time paleontologist for the Burke Museum at the University of Washington, "there were archaeocetes, or ancient whales, and then there were recognizable baleen and toothed whales. What came in between? The Oligocene, and it was pretty much a big blank. If you find a whale from this time period, chances are it's a new species or even a whole new family. And when I do find one, there's no feeling like it."

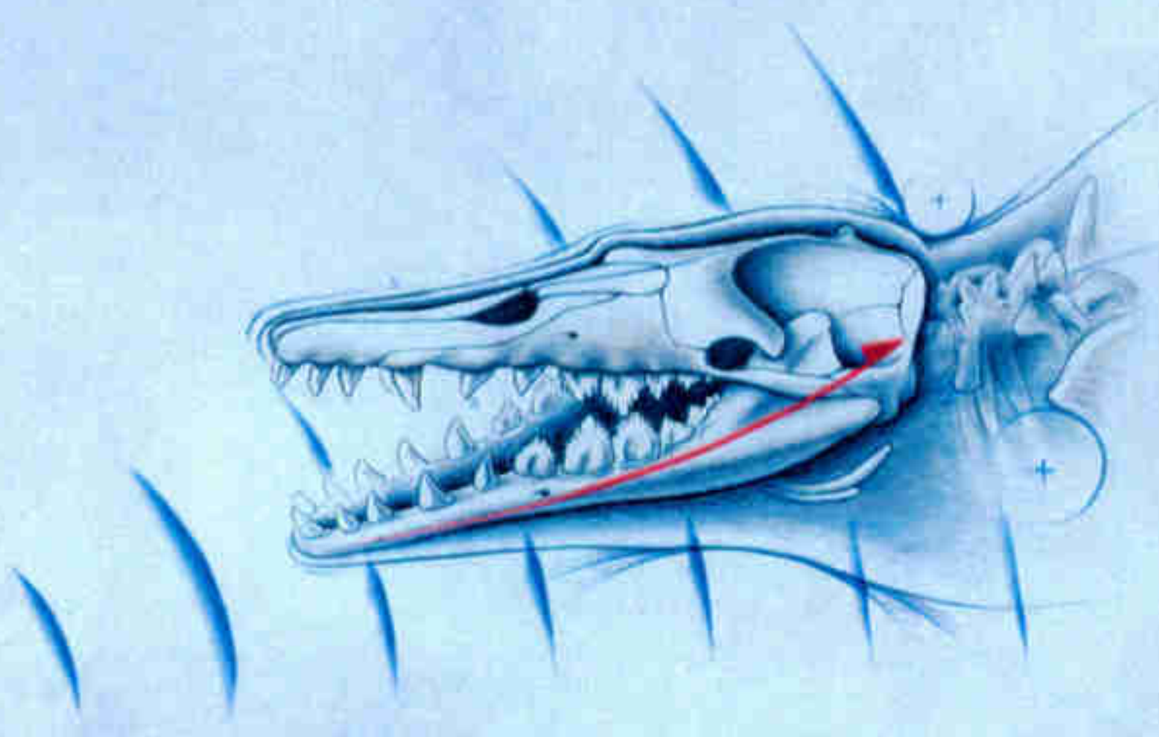
This is a man happy to prospect from dawn 'til dusk and return at night with a lantern, saying the play of shadows can catch hard-to-see bone outlines. The Goederts' efforts have produced the oldest odontocete, several of the earliest *(Continued on page 75)*

HEARING AIDS

Fossil finds illustrate that underwater hearing was acquired—as were other traits—in stages. The ear structure of the semi-aquatic *Pakicetus* makes the case. This walking whale lacked the fat pad extending to the middle ear that modern cetaceans have, a clue that it had kept terrestrial attributes. In later whales, the jawbone, with the fat pad, adapted to receive sounds. The melon, used in echolocation, evolved only in toothed whales.



Though more aquatic than *Pakicetus*, *Ambulocetus* still heard directly through its ears.

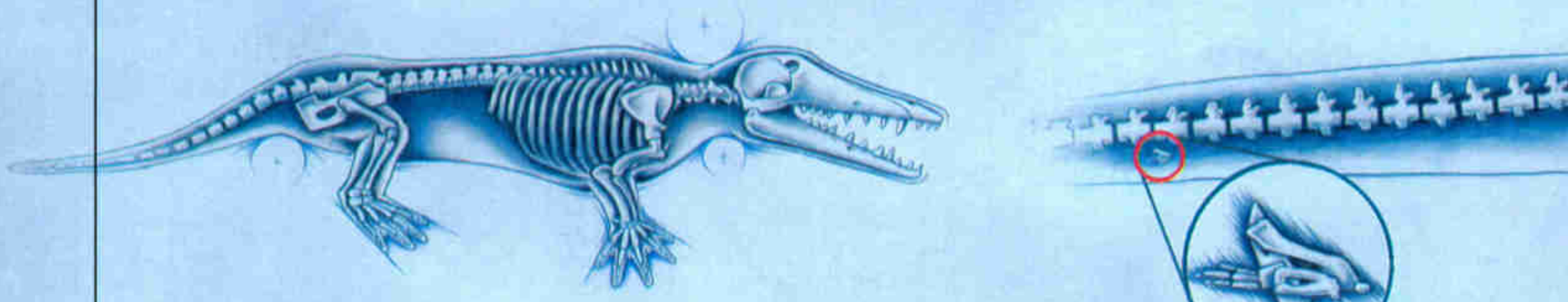


Sounds were transmitted to the middle ears of *Basilosaurus* as vibrations from the lower jaw.

Modern toothed whales echolocate: The melon directs sound at an object, and the lower jaw receives the echoing reply.

LOSING THEIR LEGS

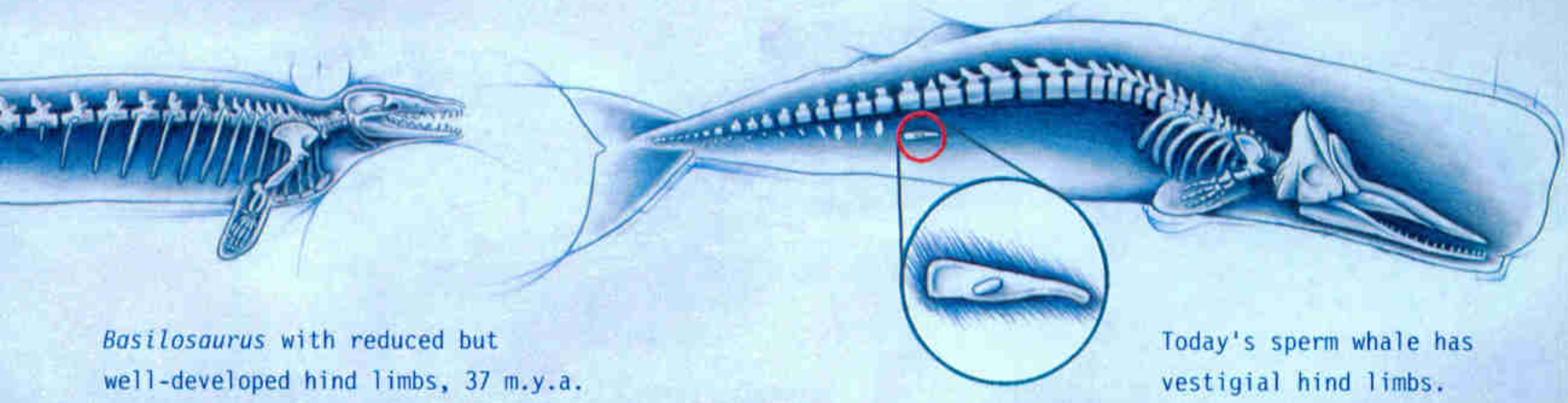
Going . . . going . . . but not quite gone. The hind legs that helped propel whales' four-footed land-dwelling ancestors have become just nubs of their former selves. *Pakicetus* walked, but *Ambulocetus* was more versatile. With its pelvis fused to its backbone, it could support its weight on land, while webbed feet gave it added power underwater as it swam, perhaps by undulating its spine otter-style. Ten million years later, the



Four-legged *Ambulocetus*, 49 m.y.a.

The 49-million-year-old walking, swimming whale from Pakistan—*Ambulocetus natans*—is the most primitive known saltwater cetacean. "With long hind legs and hands, but the teeth and ears of a more modern whale," says Hans Thewissen (right), "this animal was on the fence between land and sea."

up-to-60-foot-long snakelike *Basilosaurus* emerged with shrunken legs. Some evidence suggests that the diminished limbs—still complete down to jointed knees and toes—functioned as copulatory guides. Today whale hind parts are tiny and internal, acting as an anchor for the muscles of the genitalia. Still, the animals retain the genes that code for longer extremities. Occasionally a modern whale is born having sprouted a leg or two—a genetic throwback known as an atavism.



Basilosaurus with reduced but well-developed hind limbs, 37 m.y.a.

Today's sperm whale has vestigial hind limbs.

Sending up spray, a humpback whale exhales through its blowhole at the sea surface. Whales have evolved to be efficient respirators, exchanging some 90 percent of the air in their lungs with each breath (humans exchange about 15 percent).

mysticetes, and the North Pacific's oldest whale.

We waded among tide pools on Washington's Olympic Peninsula for days. Had I looked out across the Strait of Juan de Fuca, I might have found live gray whales or killer whales. But if a fossil whale lay anywhere among the seaweed underfoot, I couldn't get my eye on it.

Jim's backpack was already loaded with skull remains. What we were doing, he said, was equivalent to traveling back countless lifetimes, proceeding miles out into the ocean, then dropping 6,000 to 9,000 feet below the surface to hike the seafloor until we came across sunken whale carcasses. Luckily, geologic forces had compressed those bottom sediments into stone and thrust them up to be pasted onto the continent's edge, after which rainstorms and waves eroded the seaward slopes, bringing fossils down onto the beaches. In short, the hard work had been done for us; he told me, keep looking.

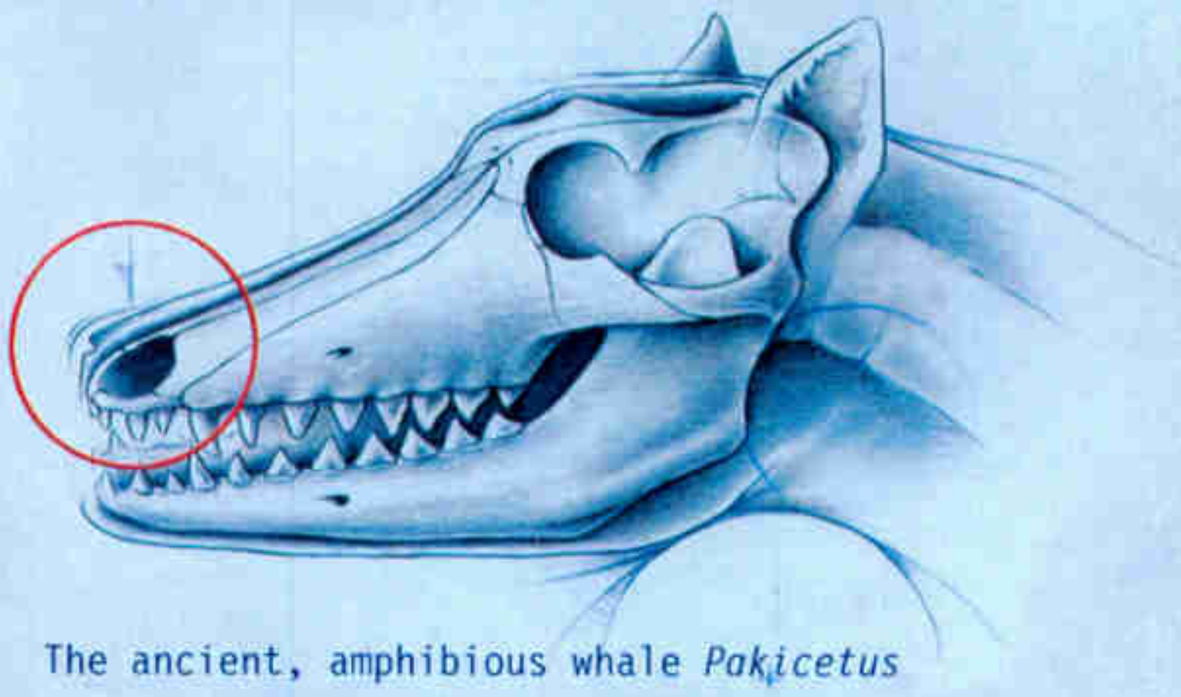
Finally I found a fossil that didn't turn out to be a fish or burly Oligocene seabird. Jim said, "You're looking at a very primitive true toothed whale." Here was a link between the ancient whales, which each carried a mix of different-shaped teeth as a legacy of their days on land, and odontocetes (the division with sperm whales, dolphins, and their kin), whose teeth are more like uniform spear tips or pegs.

Perhaps the most important features in this transitional animal were associated with the skull's architecture: the beginnings of special sacs off the main nasal passage for moving air back and forth to create sound vibrations; a lens of fatty tissue, called the melon, in the forehead for focusing outgoing sounds; and thinned portions of the lower jaw to help catch returning vibrations. Together they added up to the ability to navigate and to find prey through echolocation, a key to the success of the toothed whale group.

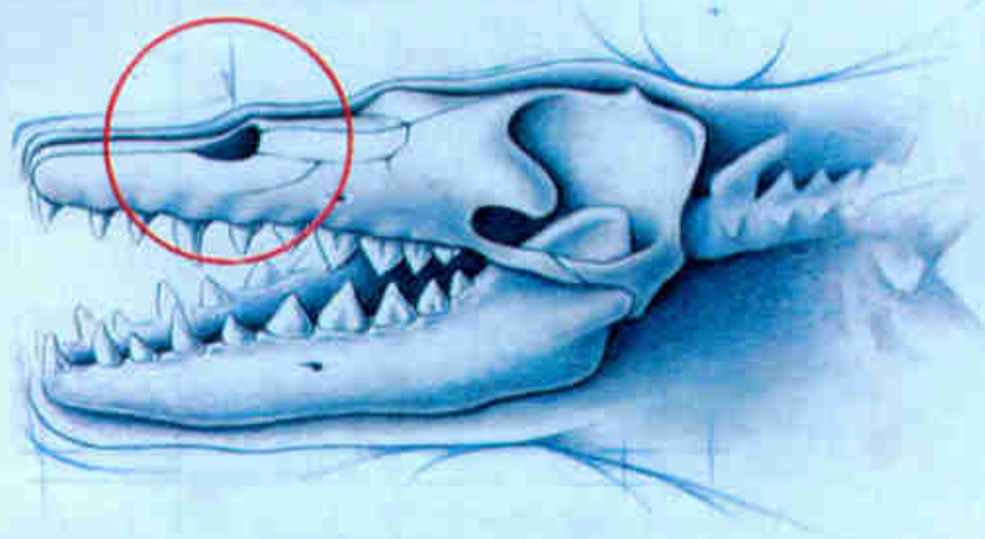
Waving me over to the surf's edge, Jim pointed to a mineralized skeleton of an aetiocetid, a ten-foot-long beast that helped bridge the gap between the ancient whales and baleen whales. Call it one more missing link that is no longer missing, for the animal had teeth yet also showed signs it was developing baleen plates from skin tissue on a widened upper jaw. Modern baleen whales still grow teeth while in the womb but reabsorb them before birth. They don't need chompers

NASAL DRIFT

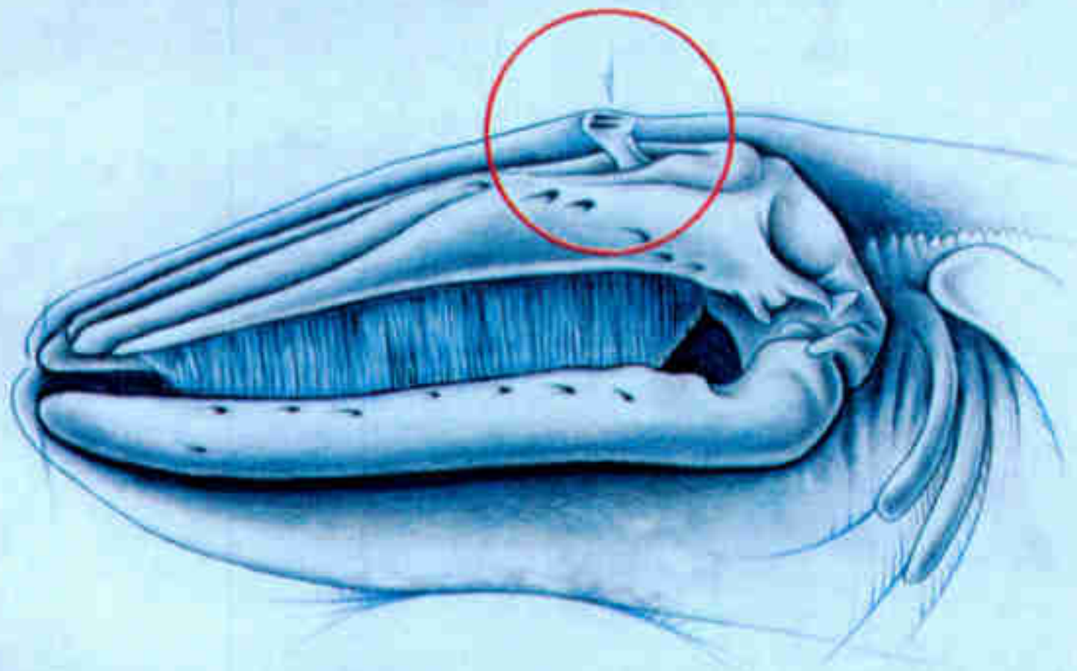
Whales breathed easier once they no longer had to lift a snout above water. As ancient whales spent more time immersed, the nostrils migrated from the tip of the nose to the top of the head, making quick work of a breath of fresh air. Blowholes help distinguish modern forms—toothed whales generally exhibit one, while baleens' are split in two.



The ancient, amphibious whale *Pakicetus* had a land mammal's nostrils at the end of the snout.



Rodhocetus swam the seas; its nostrils were higher on the skull, intermediate to those of its ancestors and modern whales.



A modern gray whale's blowhole allows it to break the surface, inhale, and resubmerge without having to stop or tilt the snout up.

HIROYA MINAKUCHI, *SPHERE* MAGAZINE (LEFT)

anymore; their heads have become, in effect, living nets. The evolution of long strips of baleen did for them what sonar did for the toothed whales; it pushed their effectiveness as predators a quantum leap forward.

Lawrence Barnes, a paleontologist from the Natural History Museum of Los Angeles County, led me into the next epoch, the Miocene, which lasted from 24 to 5 million years ago, at a dig known as Sharktooth Hill near Bakersfield, California. Somebody got the name right; I no sooner sat down for a snack on chalky former seafloor than the fang of a shark lying in wait for eons reached out and bit me on the butt.

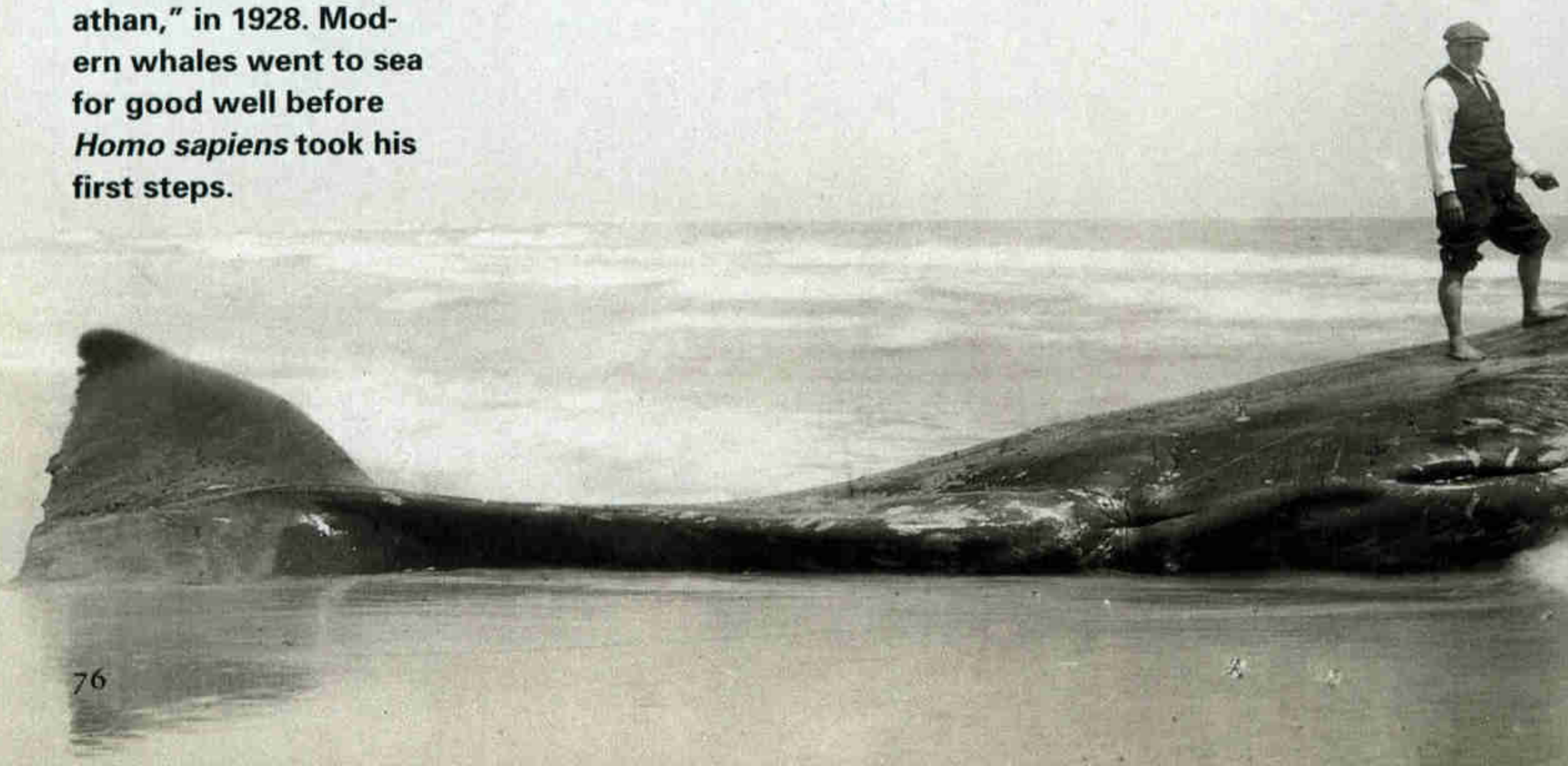
"The site has some 30 kinds of cetaceans, so the cast of characters was about as varied as a similar locale in modern times," Barnes said.

I joined museum volunteers shoveling and screening the sediments. Over the months and years, they had helped unearth eight species of baleen whales called cetotheres. Though relatively primitive, this line survived until three million years ago, coexisting with the modern family of bowheads and right whales, which first appeared 22 million years ago. One reason bowheads and right whales attain weights of 80 tons or more, Barnes explained, is that they have evolved the longest, most elaborate baleen of any whales and use it to comb swarms of abundant plankton from the seawater. Over time cetotheres were replaced by the family of sleek, faster moving rorquals, whose modern members include such behemoths as blue and sei whales. A different kind of feeding efficiency led to their tremendous size; pleats along a rorqual's underside allow its throat to expand like an accordion when gulping seawater teeming with food.

In addition Sharktooth Hill has yielded two kinds of sperm whales and at least half a dozen kinds of primitive dolphins called kentriodontids, plus one of the earliest delphinoids, as members of the major family of modern dolphins are known. Back at the museum, Barnes brought out a dolphin skull to show me how the bones of the snout extend back over the brain case, a move related to the evolution of the fatty melon and air sacs that produce the sounds used in echolocation. In some species the forehead area even has a concavity like a small satellite dish, which may boost the animal's echolocation abilities.

The dolphin skull was a reminder that whale evolution has not necessarily been toward bigness. The sophisticated, talkative whales we label dolphins are the most varied and numerous of the cetaceans today. Fashion models outweigh the four-foot-long porpoises called vaquitas, now endangered in the Gulf of California.

From the Miocene onward, whales could take advantage of prey from tiny crustaceans and sardine schools to sea lions and giant squid, from the surface to the abyss. They had arrived. They had walked, waded, paddled, and fluked their way to dominion over most of the blue planet. At what stage did they come



Land mammals survey a beached sperm whale, Melville's "Leviathan," in 1928. Modern whales went to sea for good well before *Homo sapiens* took his first steps.

up with extra myoglobin in their muscles for storing oxygen on longer dives? When did humpbacks start singing one of the most elaborate, evocative songs ever heard? Because changes in physiology and behavior aren't always associated with obvious shifts in anatomy, they can be harder to track. We only know that when modern whales emerged they continued to refine their adaptations and prosper.

The diagram of the whale family tree remains far from finished. Many branches need to be filled in, and a revision has lately been suggested for the roots. Scientists have known since the 1880s that whales and ruminants both possess multichambered stomachs and a similar pattern of folding on the brain's cortex. Then modern molecular biologists began finding telltale matches of proteins and amino acids between whales and artiodactyls, hoofed animals with an even number of toes, which include ruminants as well as pigs and hippos. Yet, until recently, the hard evidence of fossil teeth and skull features seemed to tie whales to a different group of hoofed creatures, meat-eaters known as mesonychids. Now ankle bones from two new early whale species, discovered by Philip Gingerich of the University of Michigan and colleagues and described in a recent issue of the journal *Science,* point back to artiodactyl origins.

Norihiro Okada of the Tokyo Institute of Technology has no doubt whose picture would hang on the wall if whales kept portraits of their nearest living relatives. "Hippos," he declared at his lab in Japan. Okada and his colleagues have discovered unique genetic markers shared only by whales and hippos, indicating a common ancestor. "It is the solution to a problem that has continued more than a century," he said.

MORE ON OUR WEBSITE

Learn more about the evolution of whales at **nationalgeographic.com/ngm/0111.**

If Okada is right, it could mean that whales descended from a group of primitive artiodactyls called anthracotheres, modest-size beasts with a piggish appearance and four hoofed toes on each foot, as hippos have today. Abundant in Eurasia throughout the early age of mammals, the anthracotheres produced a number of marsh-dwelling forms.

Talking with Lawrence Barnes, I recalled my first sight of a dolphin from the Pliocene whose blunt nose, squarish head, and long tusks resembled a mollusk-eating walrus. The fossil made me wonder aloud how many varieties of whales had taken their turn upon life's stage. Barnes replied, "I've never added them up. Why don't you try?" and left me standing before his drawers of file cards representing the cetacean species identified by science. Hours later I told Barnes I had counted around a thousand. He said, "My guess is that represents 10 percent of what's out there waiting to be dug up." I know what Jim Goedert would say: Keep looking. The world holds more miracles—big, small, new, and old—than we can imagine. □

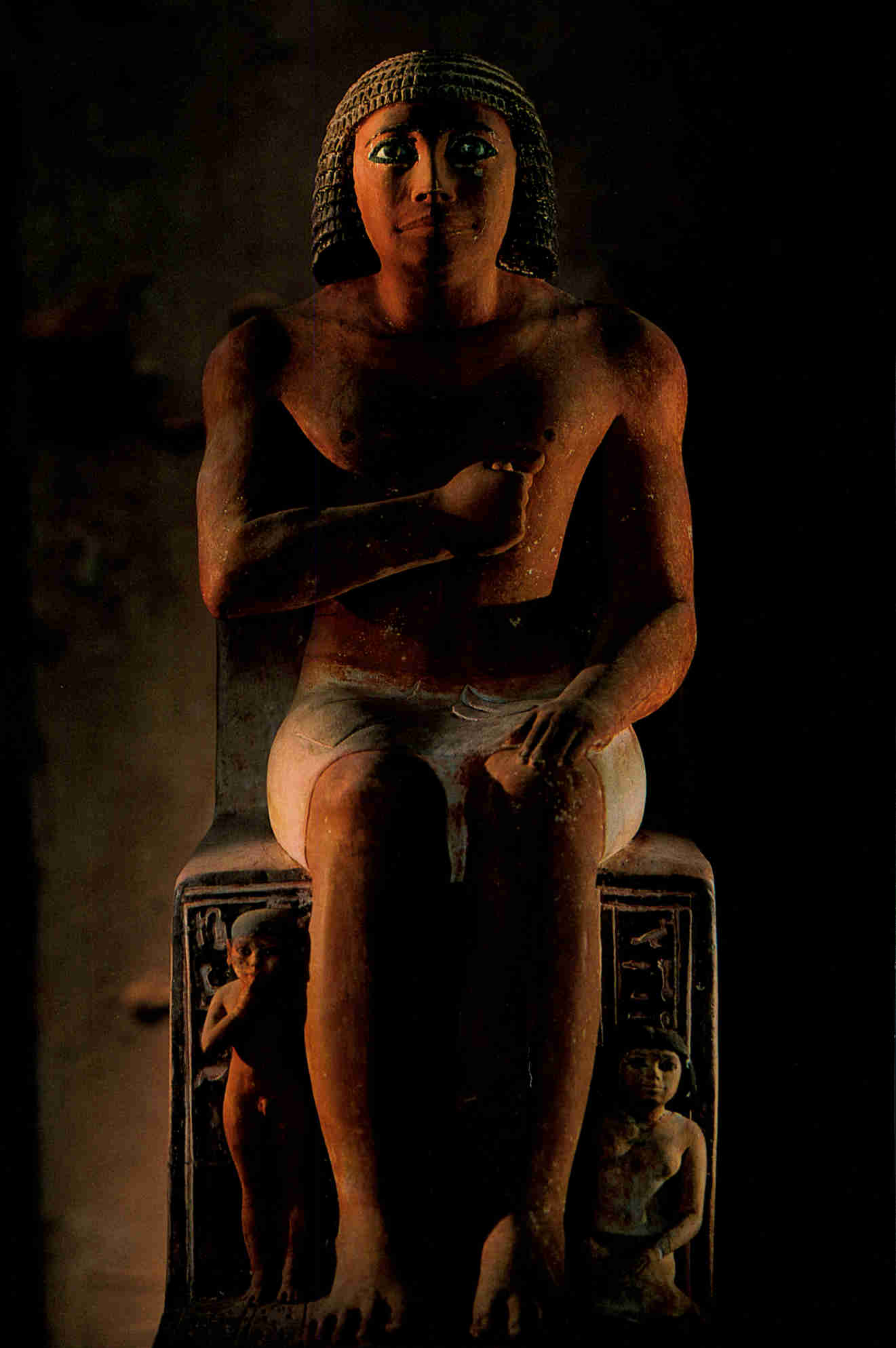
EDGAR D. WILLIAMS, BUCK STUDIO

MORE THAN 4,000 YEARS AGO AT GIZA, THREE GENERATIONS OF EGYPTIANS CONSTRUCTED A SERIES OF MONUMENTS OF UNSURPASSED GRANDEUR. EXCAVATIONS NOW REVEAL THE LIVES OF THE LABORERS AND OVERSEERS WHO RAISED THESE ANCIENT WONDERS.

THE PYRAMID

BY VIRGINIA MORELL
PHOTOGRAPHS BY KENNETH GARRETT

BUILDERS



On a sand-covered hill outside Cairo near the three great pyramids at Giza, Egyptologist Zahi Hawass picks a path among small tombs built of mud and stone. Some of the graves are shaped like beehives; others are rectangular structures carved into the rocky cliffs or constructed of limestone blocks and adorned with hieroglyphics; and still others are little more than small lumps of earth, their tops and sides studded with broken chunks of granite and limestone. Hawass has brought a team of excavators with him, and the men stop beside one of these humble tombs, designated by them as Grave 53. Several similar graves lie to either side, but Hawass has earmarked 53 as his team's morning labor.

"It's something I wondered about for years," Hawass tells me, taking a seat on a nearby rock, while members of his crew dig carefully into the top of the mastaba, as these tombs are called. "Many times when I looked at the pyramids, I would ask myself about the workers who built them. Where were they buried? Who were the men and women behind this great enterprise? Because of these graves, we have some clues."

Contrary to earlier conjectures—and some modern guidebooks—the pyramids were not built by slaves or foreigners, says the silver-haired Hawass. "That idea of the slaves came from Herodotus," the Greek historian and explorer, Hawass continues. Herodotus visited Egypt around 450 B.C., about 2,000 years after the pyramids were constructed, and was told that 100,000 men had been forced to toil as slaves on the Great Pyramid of the pharaoh Khufu.

But Hawass's 1990 discovery of this cemetery, along with archaeologist Mark Lehner's nearby excavations of what appears to be the ancient laborers' city, confirms what Egyptologists had come to suspect: Herodotus was misinformed. Ordinary Egyptian citizens built the pyramids, some working as conscripts on a rotating basis, others as full-time employees. Hawass and Lehner estimate that the feat—quarrying, transporting, and fashioning the seven million cubic yards of stone for the three pyramids and adjoining structures—was accomplished with a workforce of only 20,000 to 30,000 men. Each pyramid complex (a grouping of pyramid, temples, and tombs) was started when a pharaoh assumed the throne and stopped when he died. Thus the Giza monuments, which were constructed during the 4th-dynasty reigns of Kings Khufu, Khafre, and Menkaure (about 2550 to 2470 B.C.), required some 80 years to build.

From my seat beside Grave 53 I can see the pointed summits of the two largest pyramids

"I paid them in beer and bread, and I made them make an oath that they were satisfied." So said Kai (left), a priest and judge, of the builders and craftsmen who created his tomb—and, perhaps, worked on the pyramids. According to Harvard University archaeologist Mark Lehner and Zahi Hawass, director of archaeology at Giza and currently a National Geographic explorer-in-residence, 20,000 to 30,000 workers toiled on Giza's monuments at any one time, quarrying massive blocks of limestone and hauling them by hand up inclined ramps on wooden sleds.

NATIONAL GEOGRAPHIC ARTIST CHRISTOPHER A. KLEIN

COPPER AGE

Aided by lung power, Egyptians smelted copper (above), the only metal available to them, and from it forged tools to build the pyramids of Khufu, Khafre, and Menkaure between about 2550 and 2470 B.C. Workers today (left) have iron that readily cuts stone, and restorers at Giza can dress blocks with sharp iron chisels that shave off pieces of limestone. The softer copper

the workers built: the tombs of Khufu and his son Khafre. The pyramids always take a visitor's breath away, in part because of their size, shape, and beauty but also because of the mind-numbing amount of work they obviously entailed. They were built of blocks of limestone and granite ranging from less than one to more than 40 tons, all hewed, moved, and set in place by human hands. The ancient Egyptians relied on neither complex machines nor animals (nor extraterrestrials) for any of this labor. And after they completed the core of a pyramid (which is primarily what we see today), they covered it with stones precisely fitted together and polished until the pyramids gleamed like jewels in the sun.

"They were proud of their work, yes," says Hawass when I comment on the evident care

tools of antiquity, such as this gad (right), which was driven into fractures to break rock, were frequently reshaped, and chisels had to be continually resharpened. Quarriers and masons cut grooves in hard stone by pulling copper blades back and forth over a layer of abrasive sand. They used stone picks to carve out channels around pieces of rock and fitted wooden levers into sculpted sockets to pry blocks of limestone free.

EGYPTIAN MUSEUM, CAIRO

the pyramid builders took in their craft. "It's because they were not just building the tomb of their king. They were building Egypt. It was a national project, and everyone was a participant. People we're finding in these graves were part of that national project," he adds, nodding toward the one at his feet. "Many of them were cutting, moving, and polishing the stones."

By now Hawass's men have removed the mud bricks and rocks covering the grave, and some of them are carefully spading into the sand below. Others stand in a line above the pit with buckets woven from rubber inner tubes. Most wear long robes and turbans. It's a little after eight o'clock in the morning on an Egyptian spring day, but already the sun is high and hot, the sky a white-blue. I try to find a little

shade behind a mastaba. For the crewmen, however, the heat, dust, and sweat are nothing new, and one by one they move forward to lower their buckets into the grave, where a workman named Said Saleh is digging. He fills each bucket with sandy soil. And one by one the workers hoist up their buckets, then walk down the slope to dump the sand on a pile, which two archaeologists run through a sieve. There's a steady rhythm to their digging, hoisting, and dumping—a smaller version, I imagine, of the crews who pushed, pulled, and set the stones of the pyramids.

NATIONAL GEOGRAPHIC, NOVEMBER 2001

Within minutes the team's efforts reveal the dark, pulverized bits of what had once been a wooden coffin.

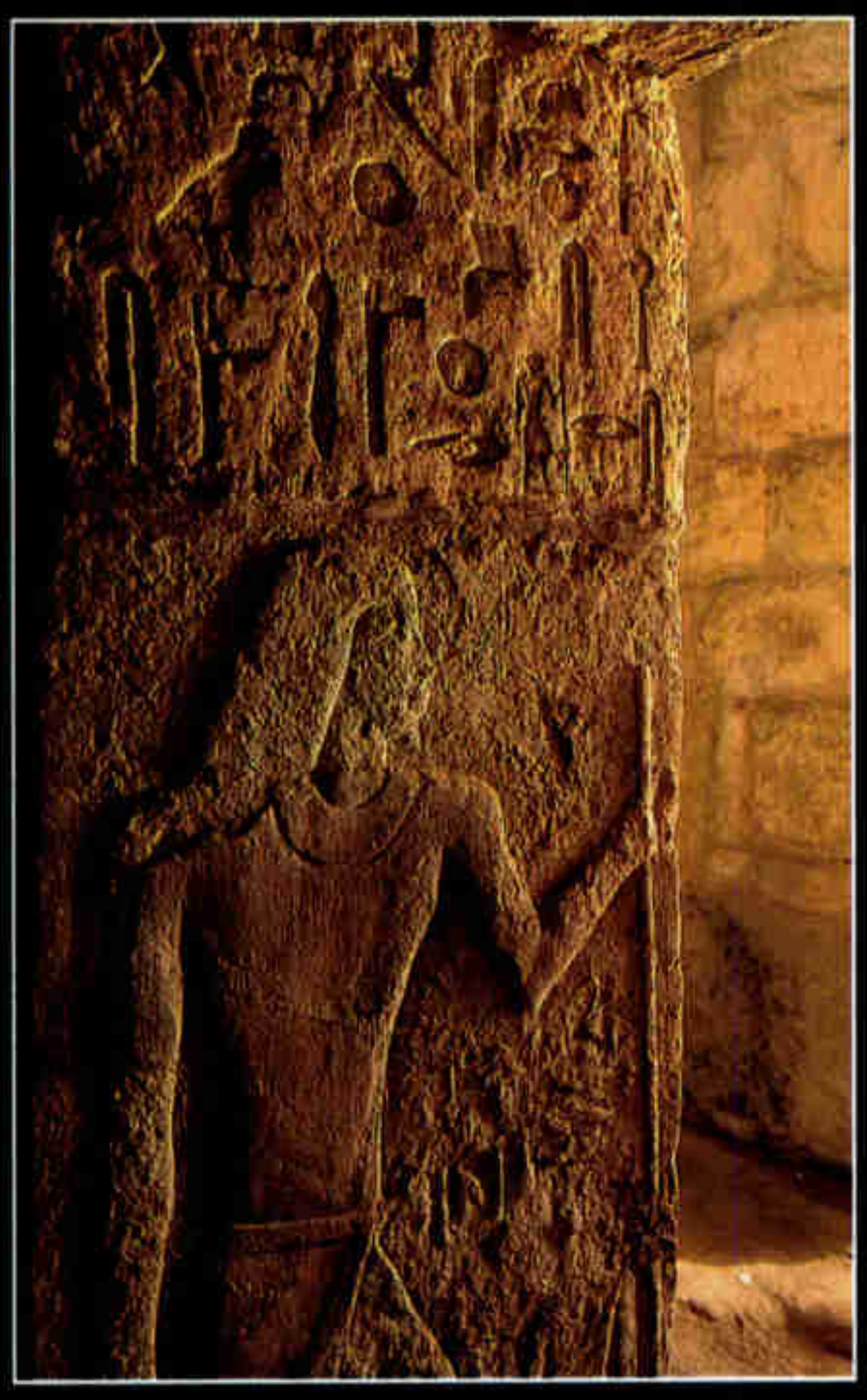
"That's rare," says Hawass. "Usually these people were too poor to afford something like this. Maybe he worked in a carpenter's shop or knew someone who did."

Beneath the bits of wood Saleh uncovers the skull and collarbones, stained a yellowish brown color from the decaying coffin, then the rest of the skeleton. It lies bent in the fetal position, as was the custom, with the face pointing east toward the rising sun and the top of the skull aligned to the north, where the pharaoh's spirit ascended each night to join the "imperishable" circumpolar stars.

Saleh uses a brush to gently sweep away the earth from the bones; later a physical anthropologist will collect them for study. Bits of

Excavations on Cairo's westernmost outskirts have revealed what Lehner calls a "royal production center," at lower right, that fed and equipped workers at Giza. To the left lies a cemetery dug into a cliff containing, Hawass believes, the pyramid builders' tombs.

WALL OF THE CROW



Weser-Petah, described as the one whom the King knows, honored one by the Great God, and overseer of the officials, looks out on eternity from the doorway of his tomb in the upper section of the builders' cemetery. Raising the pyramids was as much a feat of organization as engineering. Administrators such as Weser-Petah had to coordinate the arrival of rotating teams of laborers and shipments of supplies from all over Egypt. A gateway in the Wall of the Crow (right) could have been used to manage the flow of goods and people from the sacred pyramid complex on the north to the royal production center on the south. Lehner and Hawass believe that the wall lay just south of a harbor linked to the Nile by canals and filled by the river's floods. Where excavators walk, carrying dirt from the wall's base, ancient stevedores may have bustled back and forth with loads of copper, fish, grain, wood, and cattle.

linen still cling to some of the bones, suggesting that this person had been wrapped in a cloth before being placed in the coffin.

"The poorer people often did this as a kind of symbolic mummification," Hawass says. "It was expensive to be mummified, so almost no one could afford it. But you could have the idea of being mummified with a cloth like this."

On one side of the skeleton Saleh unearths a curved knife made from yellow flint and hands this to Hawass.

"Even the poorest people were given something to help them in the afterlife," Hawass says. "Maybe this fellow used a knife like this for cutting his meat."

Many workers were also buried with jars of beer, Hawass adds, picking up one such rough red-clay pot lying on top of a nearby grave. "They made a beer from barley, and that was their daily drink. They didn't want to be without it even in the afterlife, so they often put in one of these jars."

Unlike some of the other mastabas Hawass has excavated, Grave 53 isn't equipped for after-death beer drinking. Instead, the sieving team has found a handful of tiny bone and faience beads. One of the men pours them into Hawass's hand.

"Ah!" says Hawass, giving a broad smile. "Well, our worker this morning is a woman. We'll know for sure after her bones are studied. But I think we have a woman here. You see, as I said, all Egyptians—men and women—helped to build the pyramids."

WHEN ARCHAEOLOGISTS first began excavating at Giza some 200 years ago, they naturally turned their attention to the pharaohs' and queens' pyramids, associated temples and tombs, and the Great Sphinx. The ancient Egyptians built all these classic monuments during the 4th dynasty of the Old Kingdom, a veritable golden age of art and architecture.

Ironically, despite their huge and elaborate buildings, relatively little is known about the three key 4th-dynasty pharaohs. If Egyptians of this period recorded the activities of the royal households on papyrus rolls, as they would later, the rolls have not survived. Researchers have only the vaguest idea of what Pharaoh Khufu, who built the Great Pyramid, looked like; one small ivory statue with his name inscribed has survived, and this may have been carved a few centuries after his death. Yet scientists know even less about the common people who toiled on the tombs and temples for the ruling elite.

"It was as if they had vanished," says Mark Lehner, who has spent the past decade searching for the pyramid builders' homes and workshops. "But how do you lose 100,000 people, to use Herodotus's estimate—or even 20,000 or 30,000 people?"

There were a few clues about this workforce, and Lehner leads me to one: the limestone quarries immediately below Menkaure's pyramid. "Here's one of the grooves they made to remove a block of stone," he says, bending down next to a channel five inches wide and three inches deep cut into the rock. "They worked with stone picks and copper chisels to free each block, and they carved out sockets for wooden levers so they could pop the whole block—a 20-ton rock—free."

Each block was delineated with red paint before the workers began to remove it. "Some years ago you could still see traces of that red paint," says Lehner, "and a cartouche," the hieroglyphics that encircle someone's name. "It was probably the mark of the team of workers who had to quarry the block."

Similar team-name inscriptions have been found inside the pyramids. On two blocks in the highest chamber of Khufu's Great Pyramid, for example, a gang of workers painted hieroglyphics that read "Friends of Khufu." And in Menkaure's mortuary temple *another*

group displayed its insignia: "Drunkards of Menkaure."

Those team names alone, I note, suggest something other than a slave mentality.

Lehner nods. A slightly built man in his 50s, he carries the tools of his archaeological trade —pens, trowel, tape measure, paintbrush— jutting from the pockets of his shirt and jeans.

"The workers were organized into competing teams," he explains, "which may have helped them psychologically. You know, 'Let's see whose team can do this job faster.'"

After all, he adds, much of the work the teams had to do was not fun. "Imagine working under the hot Egyptian sun with a stone pick or copper chisel to cut these blocks of stone and then pushing and pulling them to make a pyramid. How do we come to grips with making people work so hard? What motivated them? The most we can say, because we have so few papyrus texts from this period, is that they were deeply religious and believed that by building the tomb for their king, they were assuring his rebirth as well as their own and that of Egypt overall."

To build such monumental structures, the Egyptians needed a highly organized workforce. From tomb inscriptions and from laborers' instructions on walls inside Khufu's pyramid and Menkaure's mortuary temple, researchers can now draw something close to a modern personnel chart for the ancient workers. "Every project like a pyramid had a crew of workers," explains Ann Roth, an Egyptologist who has studied the groups of workers in detail. "And each group was responsible for one part of the pyramid complex. There was one group for building the interior granite roofs and separate groups for raising the chamber walls."

Each crew of workers was divided into four or five smaller units, which Egyptologists call *phyles* (after the Greek for "tribe"). Each phyle carried a name, such as "Great One" or

WATERS OF PLENTY

A fishseller's table in Cairo echoes the bounty of the ancient Nile, which fed the pyramid workers. Archaeologists have recovered the remains of a wide variety of freshwater fish from the royal production center. "They were out there catching everything they could," says Richard Redding, a bone specialist on Lehner's team. One building had benches where workers may have gutted larger fish. Floors were littered with tiny bones of small fish like those the men in a relief (above) pull from the shallows. These were probably dried, salted, and eaten whole. Seal impressions in clay (right) carry parts of the names of Khafre and Menkaure, the pharaohs who built the second and third pyramids at Giza.

"Green One." The phyles too were broken into forces of 10 to 20 men, and these had names like "Endurance" and "Perfection."

"They had to be very organized," says Lehner, "to build these things as quickly as they did." He notes that some researchers have calculated that in order to construct a pyramid in 20 years' time, the workers had to set a stone in place every two minutes. "It's a phenomenal pace."

To keep that kind of workforce functioning at top speed, a highly developed support force was also needed, notes Lehner. "You have to have a place to feed and house all these workers and the other workers—the bakers, brewers, and butchers—who support them."

In other words, you need a city. And Lehner thinks he has found it—or at least the production or industrial part of the city.

On a wide, sandy plain a few hundred yards below Hawass's cemetery, Lehner and his crew have excavated carefully thought-out—and paved—streets and well-designed buildings divided into small chambers and linked by corridors. Along the north side of this site a massive wall of hewn stone, the Heit el-Ghorab (Wall of the Crow), extends for some 600 feet. The wall rises nearly 33 feet, is 33 feet thick at its base, and has a center gate capped with three massive limestone lintels.

"We still aren't sure who passed through that gate or why it was there," says Lehner. We stand just at its portal, close to the area where members of his team are now excavating what he calls South Street.

"It's our third such street here, and it runs parallel to the other two. It was a gridded city and quite unusual for its time." Prior to its discovery some Egyptologists thought that settlements in Old Kingdom days would have been nothing more than expanded villages, with streets and work areas placed in a higgledy-piggledy fashion. "We helped put the kibosh on that idea," says Lehner.

BEEF, BREAD, AND BEER

An ancient Egyptian seizes a calf so another man can milk its mother in a scene from the Old Kingdom (above). To provide meat for workers, officials collected large calves from farmers and received donations from wealthy estates in the lush cattle-raising region of the delta. Herders, such as these

He knows that several buildings were used as bakeries, others as breweries. But Lehner is still unsure about the industrial area's overall purpose. "Was it here solely to feed the workers?" he asks, leaning down to sweep away the sand from a tiny fish spine. "Or did they use buildings like this one, where we've found so many fish bones, to prepare offerings for the temples?"

Again, there are no papyrus texts or wall inscriptions—not even any ancient graffiti—to give an answer. The only textual clues to the site come from tiny scraps of sealing clay that once secured the mouths of jars of wine and oil or sacks of grain.

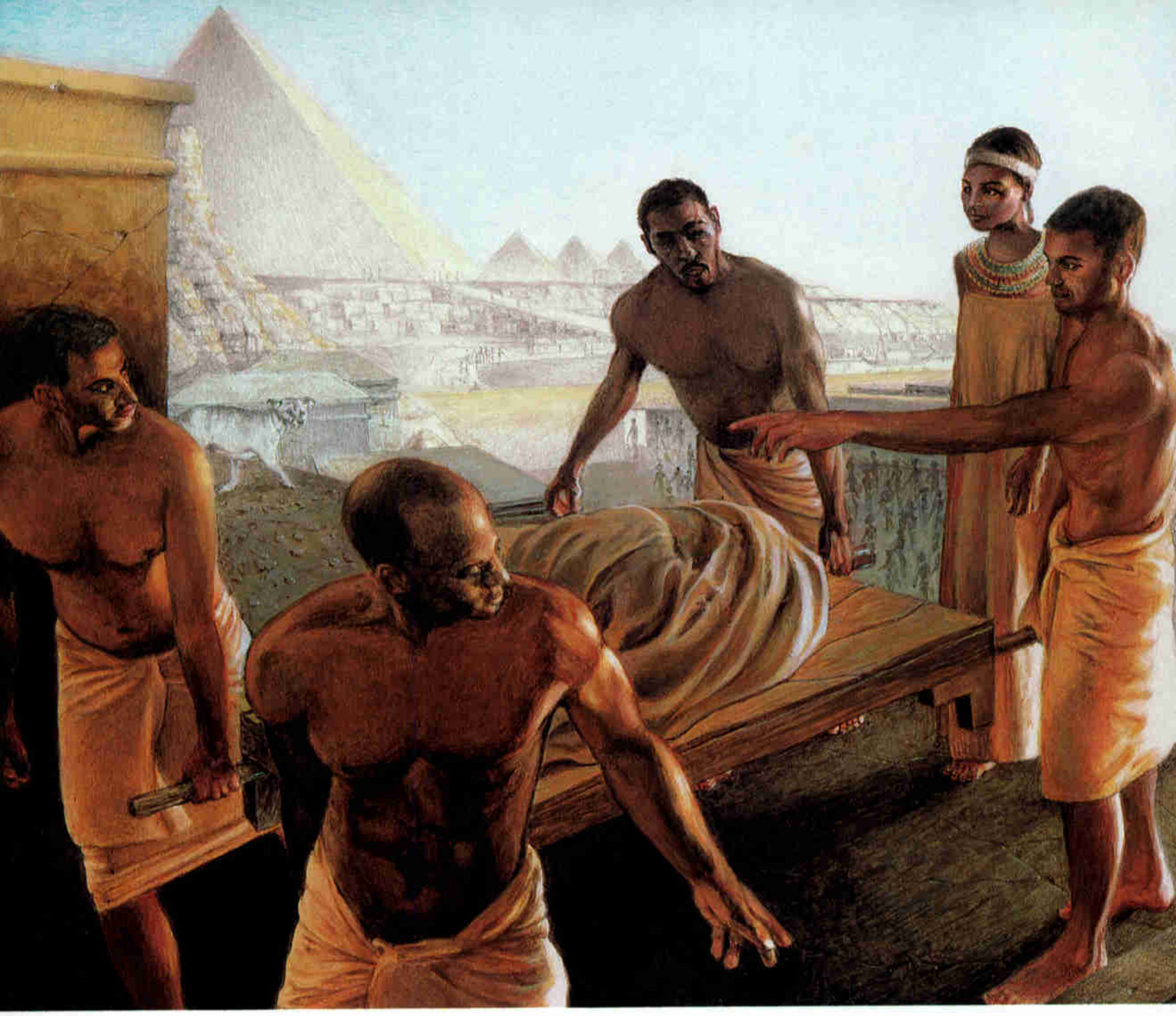
In a lab near Lehner's excavation Egyptologist John Nolan hands me a magnifying lens to take a closer look at one such scrap. It's flat

boys in Dahshur (left), drove cattle along the Nile toward Giza, gathering more animals as they went. At the royal production center cattle were slaughtered in an industrial-scale food-processing operation that left remains scattered across the site (right, top to bottom): charcoal for cooking; emmer wheat for bread and barley for beer; a flint butcher knife; and teeth and bones from cattle, sheep, goats, and fish.

and dark brown, and along the surface it bears the tiny imprints of hieroglyphics—as well as the fine lines of someone's fingerprints. On this one the symbol of a falcon with folded wings clearly stands out. "That's a sign that this is the name of a king, in this case Menkaure," says Nolan. "It implies that the person who made this was a high official."

The imprints were made by rolling a carved seal over a piece of wet clay to create a sealing. After someone had filled a jar, say, with wine, the mouth of the jar was covered with a piece of cloth and tied with a cord, and the moist clay sealing was put in place. The sealings, Nolan adds, were like little tags attached to commodities. "Sealed goods were the closest thing to money these people had. The sealings established a chain of responsibility: There was the

Standing before a false door built for the dead, Momadouh Taha, an archaeologist on Hawass's team, examines inscriptions in Nefer-Theith's tomb, one of the most elaborate in the builders' cemetery. Hieroglyphics identify Nefer-Theith as overseer of a palace, which was probably located nearby. Hawass thinks that he may have had another role: supervisor of bakeries. Tomb reliefs show workers grinding grain and baking bread.



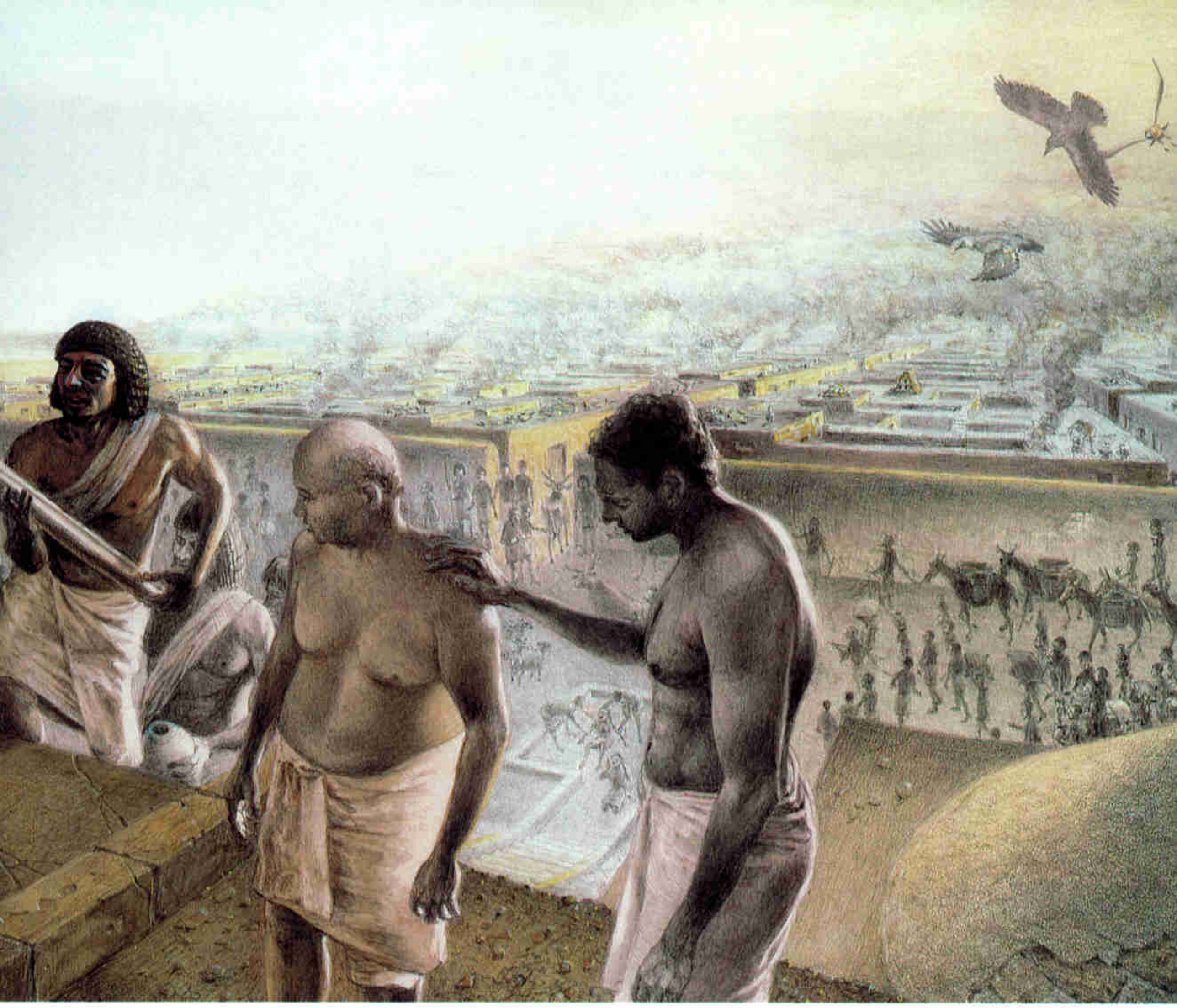
person who put the sealing on and the person with the authority to break it."

Nolan has thousands of these sealing scraps left to read. Stored in plastic bags, they line his desk like micromystery tales. "There's always the chance that I'll find one with a title we recognize—someone besides the king. Maybe there'll be one that ties our site directly to the workers' cemetery."

FINDING SUCH A LINK would clear up a question about how closely Hawass's cemetery and Lehner's city are connected in time. Lehner's site has been dated to the mid to late 4th dynasty, and Hawass thinks his cemetery runs from the mid-4th dynasty into the 5th. Yet even if the two sites are not intimately connected, the workers' tombs have given archaeologists a better understanding of the organization that lay behind the building of the pyramids.

Although most of the graves are those of poor workers, several mark the resting places of more important—and wealthy—officials. Some of these are built like miniature versions of the temples of the kings and queens. They are rectangular and made of limestone blocks, and they have all the key features a tomb should have: carved false doors for the person's spirit to use to exit the tomb each night, stone offering basins, and hieroglyphic inscriptions giving the owner's name and title as well as the names of his wife and children. Two even have ramps leading up to their doorways, like the long causeways outside the three pyramids.

The owners of these two tombs "wanted them to look as much like those of their pharaohs as possible," says Hawass, walking up one of the ramps. "This one is the tomb of Weser-Petah, overseer of the officials." The ramp leads to a small doorway. I bend down and step inside the carved-rock tomb. It is a simple structure, like a narrow but shortened railroad car. Above the false door and on either



CHRISTOPHER A. KLEIN

side of it are bas-reliefs showing Weser-Petah in the classic Egyptian profile and beside and below them hieroglyphics spelling his name and title. Although not as elaborate as the tomb inscriptions of the ruling elite, these carvings still reveal the care and concern the Egyptians had for assuring a good afterlife.

A few steps to the west takes us to the ramp and tomb of Ni-ankh-Petah, overseer of the king's bakeries and cakes, and uphill from his tomb stands that of Nefer-Theith, overseer of the palace and purifier of the king. Other tombs bear such titles as overseer of the rowers, overseer of the side of the pyramid, inspector of the royal gardens, and master of the harbor. So far, Hawass's team has discovered 26 of these titles.

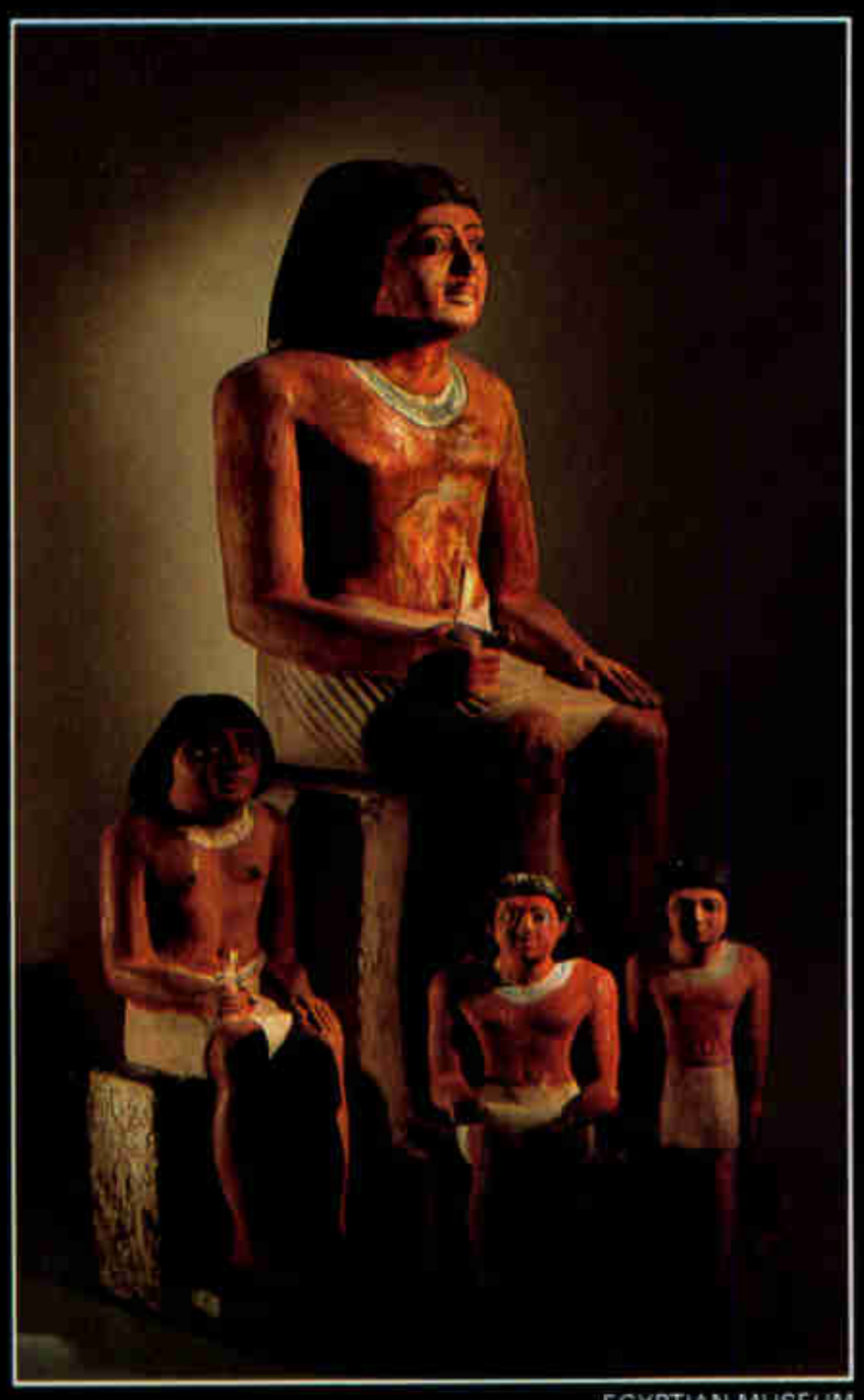
"The titles are those of mid- to high-level managers," notes Hawass, "and further demonstrate the tight organization of the ancient Egyptian workforce."

"That's what really blossomed in the 4th dynasty," says Egyptologist James Allen. "It wasn't the discovery of how to work large blocks of stone; it was the discovery of how to organize a large labor force."

Many elite women were buried in the tombs of their husbands, and often they too had their names and titles inscribed on the lintels of the false doorways, as did the wife of Petty,

Family and friends bear the shrouded body of an official's wife during a funeral in the builders' cemetery. Behind them walk a professional mourner and two white-sashed priests, one holding a prayer scroll, the other a pot of water for libations. As the grieving husband is comforted by his son, servants at the foot of a stairway sink to the ground and pull their hair. Beyond, life continues: Animals are brought to slaughter, and donkey trains carry supplies into the royal production center, which is overhung with smoke from scores of foundry and cooking fires.

FINAL MONUMENTS



EGYPTIAN MUSEUM

Four statues portray aspects of the life of Inty-Shedu, a carpenter who Hawass believes oversaw the manufacture of wooden tools and boats at Giza. The people buried in the builders' cemetery modeled their tombs on those of the pharaohs. Inty-Shedu's group of statues, discovered in the upper part of the cemetery reserved for officials and artisans, is similar to ones found in pyramid temples. In the lower part of the cemetery, Hawass (right, at far right) sits on a mud-and-stone mastaba, or tomb, belonging to one of many workers buried beside their overseers. Some tombs are dome-shaped and, like the pyramids, evoke the mythical mound of creation. Causeways, at top, link the upper and lower cemetery and resemble those connecting the Nile Valley to the pyramids. An Old Kingdom text expresses the builders' hope in the afterlife: "Make good your dwelling in the graveyard; make worthy your station in the west."

inspector of the craftsmen. Her name was Nesy-Sokar, and she was a priestess of Hathor, goddess of love and dance. Two women had their own tombs; one, like Nesy-Sokar, was a priestess of Hathor and the other a priestess of Neith, goddess of war.

Like the pharaohs, these titled officials—men and women—often had various goods placed in their tombs to help them in the afterlife. There might be beer jars as well as miniature offering plates and drinking cups, but these were made of clay and about the size of a child's tea party set. "There was nothing of real value in these tombs," says Hawass, "which is why they were not looted." That did not prevent the tomb owners from worrying about thieves. Below the exquisitely etched portraits of Petty and Nesy-Sokar a row of protective curses was carved, threatening harm to anyone who disturbed their resting place.

"As for any person, male or female, who shall do evil against this tomb and who shall enter therein, the crocodile shall be against him upon water, the hippopotamus shall be against him in the water, and the scorpion shall be against him on land."

Some of the tombs contained small statues of their owners. Most of these, such as the statue of Nefer-ef-Nesu, chief of the sculptors, and his wife Nefer-Menkhes, were carved from limestone, then painted. The statue shows the couple seated side by side on a bench of "pink granite"—the limestone has been painted in trompe l'oeil fashion to resemble that royal rock. She wears a fancy net dress, a beaded necklace, and bracelets, while he is dressed in a simple white kilt. They both face forward, with slight beatific smiles, and she has her right arm around her husband's shoulder. "It is their ideal, how they want to be in the afterlife," says Tarek El-Awady, an archaeologist and assistant to Hawass. "So they want to look their best and wear the best clothes and jewelry."

For most of these fancy tomb owners daily

life in Egypt was probably not too difficult. Surrounded by desert and blessed with fertile land and crops, Old Kingdom Egypt was a rare place: a state marked by sufficient peace and stability so that there was ample leisure and wealth to cultivate a culture devoted to the afterlife. But even the Egyptians faced disease, old age, and death, and for the laborers life was surely hard.

"We can see that in their skeletons," says Azza Mohamed Sarry El-Din, a physical anthropologist who is studying the skeletal remains from the cemetery. "I've looked at 175 skeletons so far, about half men, half women, and nearly all of them suffered from arthritis. Their lumbar vertebrae are badly compressed, as you would expect for a manual workforce. I expected to see that—but I was surprised to see this kind of arthritis in the women too." She lays out the neck and lumbar vertebrae of one woman who died in her early 30s and points to the roughened, eroded edges of the bones. "She must have been carrying heavy loads on her head from the time she was a young girl to get this kind of damage," says Sarry El-Din.

Although there are no records or carvings showing women pushing stones or pulling statues on sleds (as there are of men doing this kind of labor), the condition of the women's bones suggests to her that they were. "There is more damage to their bones than you would expect from simply doing household chores" —or from supporting weight on their heads.

Some of the skeletons also suggest that the workers, despite the hard nature of their occupations, were well treated, although they may not have had the best diet—Sarry El-Din's initial analysis suggests that some individuals were anemic and that most of the laborers ate very little meat. (Curiously, Lehner's team has excavated great quantities of bones from butchered cattle, sheep, and goats—more than enough, he says, to feed several thousand workers some meat each day. Were the

slaughtered animals intended only as offerings for the temple cults? The discrepancy between bones, diet, and quantities of meat remains a mystery.) But the workers did have access to good medical care. One worker suffered a badly injured arm, which a doctor amputated below the elbow; the operation healed as well as a similar amputation performed on the leg of an official. "Both men recovered and lived for many years after their accidents," says Sarry El-Din. "Someone was taking care of these laborers. Workers who are pushing stones around like this are going to be hurt, and it's heartening to see that their overseers knew this and had a clinic for them."

Despite the availability of medical care the workers' lives were short. On average a man lived 40 to 45 years, a woman 30 to 35. "The women's lives were shorter, probably because of problems in childbirth," says Sarry El-Din. "But very few people were living what we think of as a long life."

Yet they wanted to. They loved life, Egyptologists say, and their

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elaborate funeral industry was aimed at one thing: assuring that life never ended.

"You could look at this as a fairly miserable existence," Lehner says, standing on a bluff above his site. "There would have been hundreds of fires burning to bake the bread, to make the pottery and copper chisels, and to keep those chisels sharpened. The air was probably thick with smoke, and there were people moving in long lines to pull the blocks to the pyramid site and people grinding grains, butchering cattle, probably unloading goods in a harbor we think was close to the pyramids. It was all hard, hot, sweaty labor."

Mark Lehner surveys the expanse of Giza, where he believes Egypt crossed a critical threshold. To build the pyramids, Egyptians had to mobilize a nation and create a vital urban center. The monuments they raised to immortality marked the first great flowering of their civilization.

And what did it get you? "It gave you a job, a way of making a living, and it gave you a national purpose. And, for them at least, it gave them life beyond this world." □


KING
C

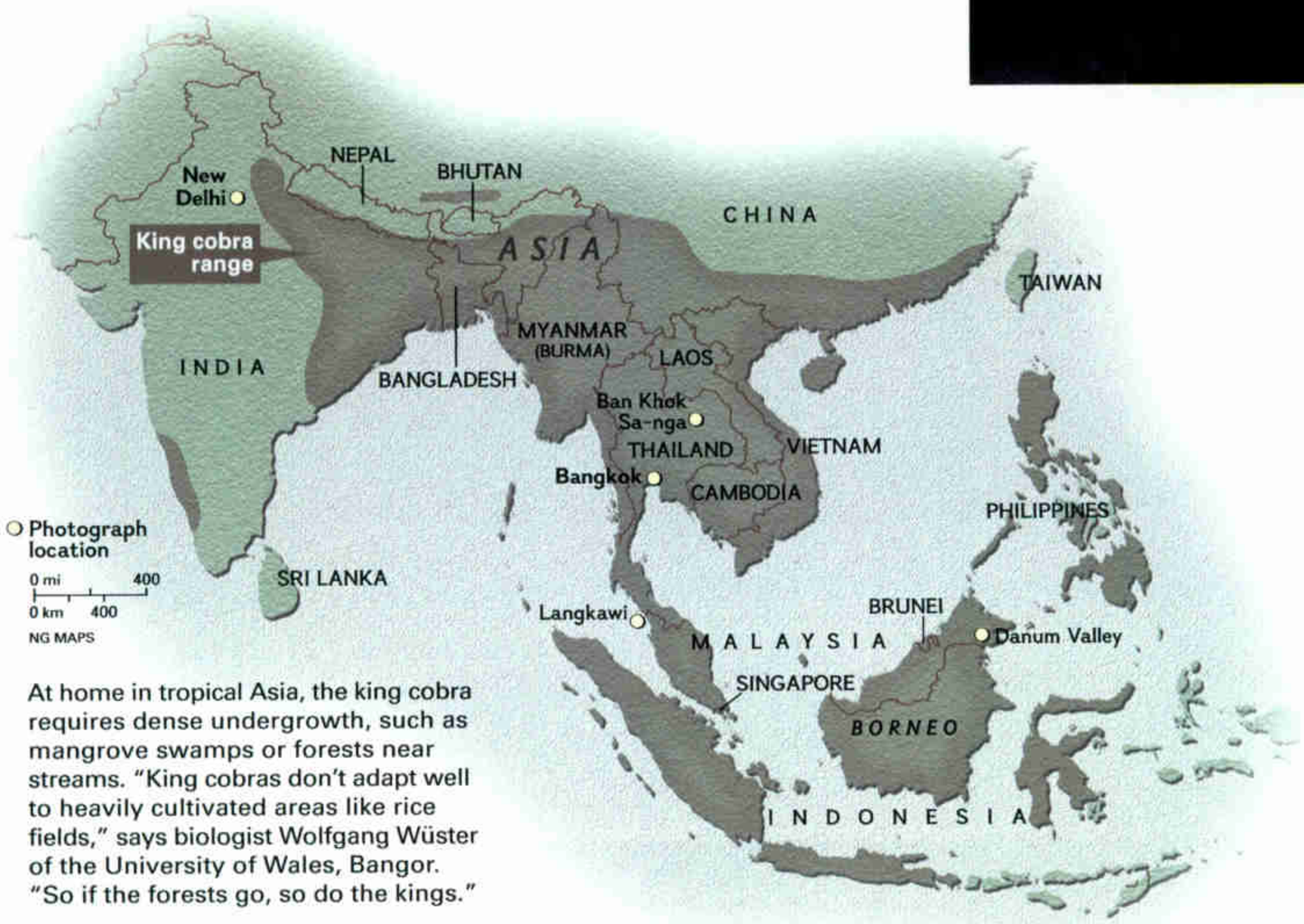
FEARED, REVERED

OBRAS

Lightning fast and just as deadly, an agitated king cobra strikes in self-defense during a "boxing match" between man and serpent (preceding pages). Villagers of Ban Khok Sa-nga in northeastern Thailand perform this perilous dance for coins from visitors and respect from peers. The act began as a way to lure potential buyers of herbal medicines and snakebite cures.

ARTICLE AND PHOTOGRAPHS BY MATTIAS KLUM

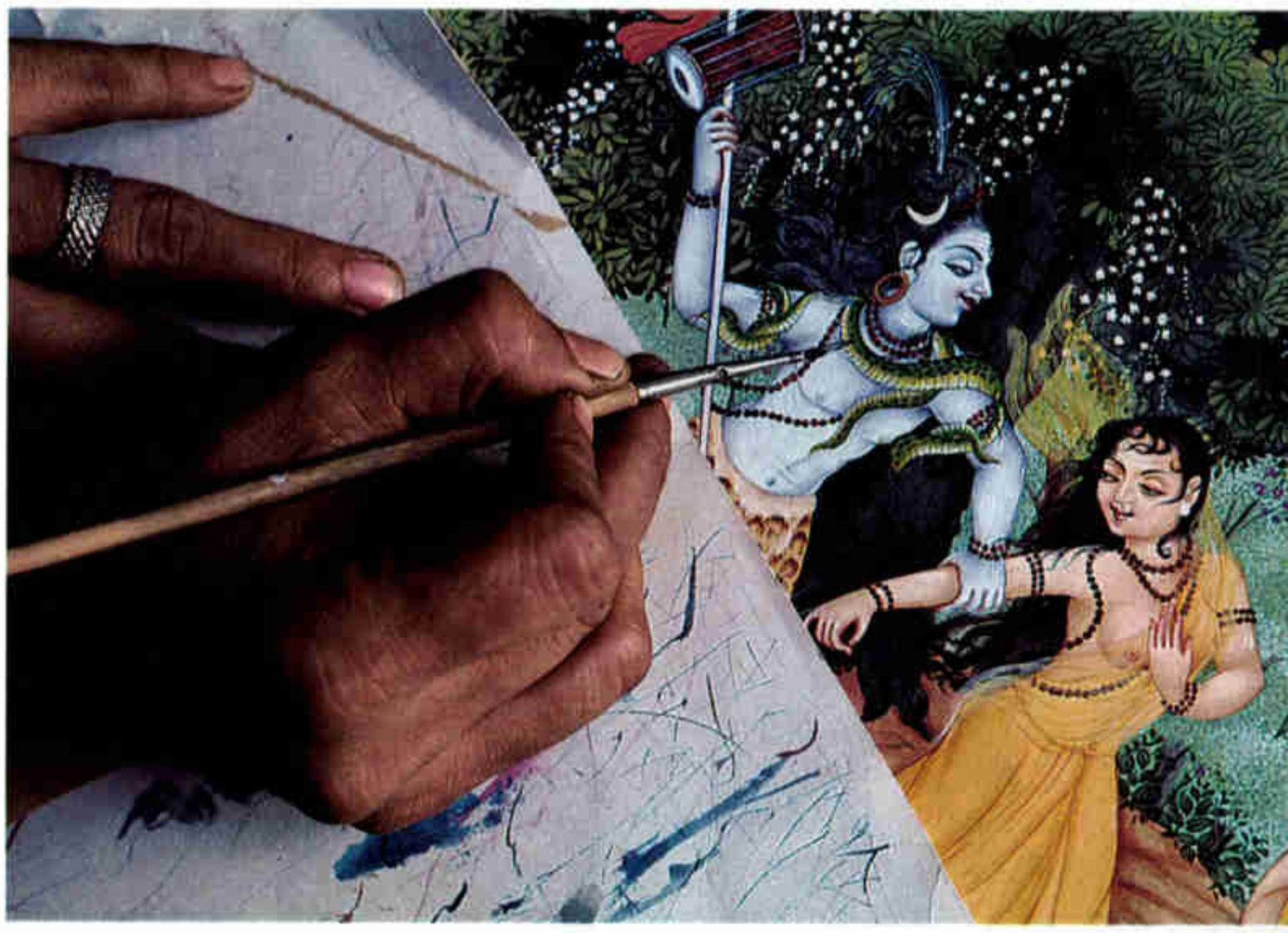
As if lit from within, the mist-drenched rain forest of Borneo's Danum Valley (right) awakens with me before sunrise. Somewhere below stirs the king cobra—the inspiration for my journey to the villages and forests of Southeast Asia. The longest venomous snake, it produces startling amounts of neurotoxin—enough to kill an elephant with a single bite. But this serpent that can stand up like a man in a terrifying pose is shy and retreating, aggressive only if provoked. We know little about its populations, but fragmented forests and illegal wildlife trade may be putting it at risk. Though snakes strike fear in many Westerners, in the East the cobra is often an object of worship and reverence—and, in some places, a part of peoples' livelihoods. So I have come here to pay my respects to *Ophiophagus hannah,* with hopes that I might observe this king of snakes in its natural realm.



At home in tropical Asia, the king cobra requires dense undergrowth, such as mangrove swamps or forests near streams. "King cobras don't adapt well to heavily cultivated areas like rice fields," says biologist Wolfgang Wüster of the University of Wales, Bangor. "So if the forests go, so do the kings."

SERPENT OF THE GODS

Using pigments from stone on handmade paper, New Delhi artist Sneh Gangal adorns the Hindu god Siva with a cobra—in India a sacred being that can symbolize fertility or rebirth. Siva, grasping his consort Parvati, is one of the most complex gods of India—both a great destroyer and a primal life force. He is often portrayed in mythology and art garlanded with the venomous serpent—also both killer and creator.



CLOSE ENCOUNTERS

Once fearful of all that slithered in their wild, brimming forests, the villagers of Ban Khok Sa-nga for decades made use of venomous snakes by killing and eating them. Today locals, who rely on rice cultivation and a diminishing supply of wood, bring in much needed income by entertaining with, rather than stir-frying, the deadly king cobra. Waving and yelling "King cobra!" in Thai and English, roving shills enticed me and other passersby into a small building where, for 10 baht (about 25 cents), we watched the ladies of the King Cobra Club dance holding snakes' heads in their mouths (below). No one could tell me the origins of the performance, but it makes economic sense—and sends chills through an uninitiated crowd.

A man for whom cobras are family, village elder Komchai Pimsaimoon (top, with grandson) has spent years learning the rhythms of the serpent—what calms it and what makes it fighting mad. Mad was in force back at the boxing ring (above), where a now rested king whipped toward me on release from its wooden enclosure. Though I managed to skirt its strike, I took some comfort knowing I had cobra antivenom in my pack. Locals assured me that their herbal remedy was also on hand—just in case mine failed to work.

With no room for error, snake handler Othman Ayib intensely eyes his student, who attempts to calm—and kiss—a wild king cobra. Ayib caught the agitated snake on a Malaysian golf course, where it had strayed from the forest, and later freed it on wilder lands. "Snakes aren't evil or mean," he says. "They just want to be left alone."

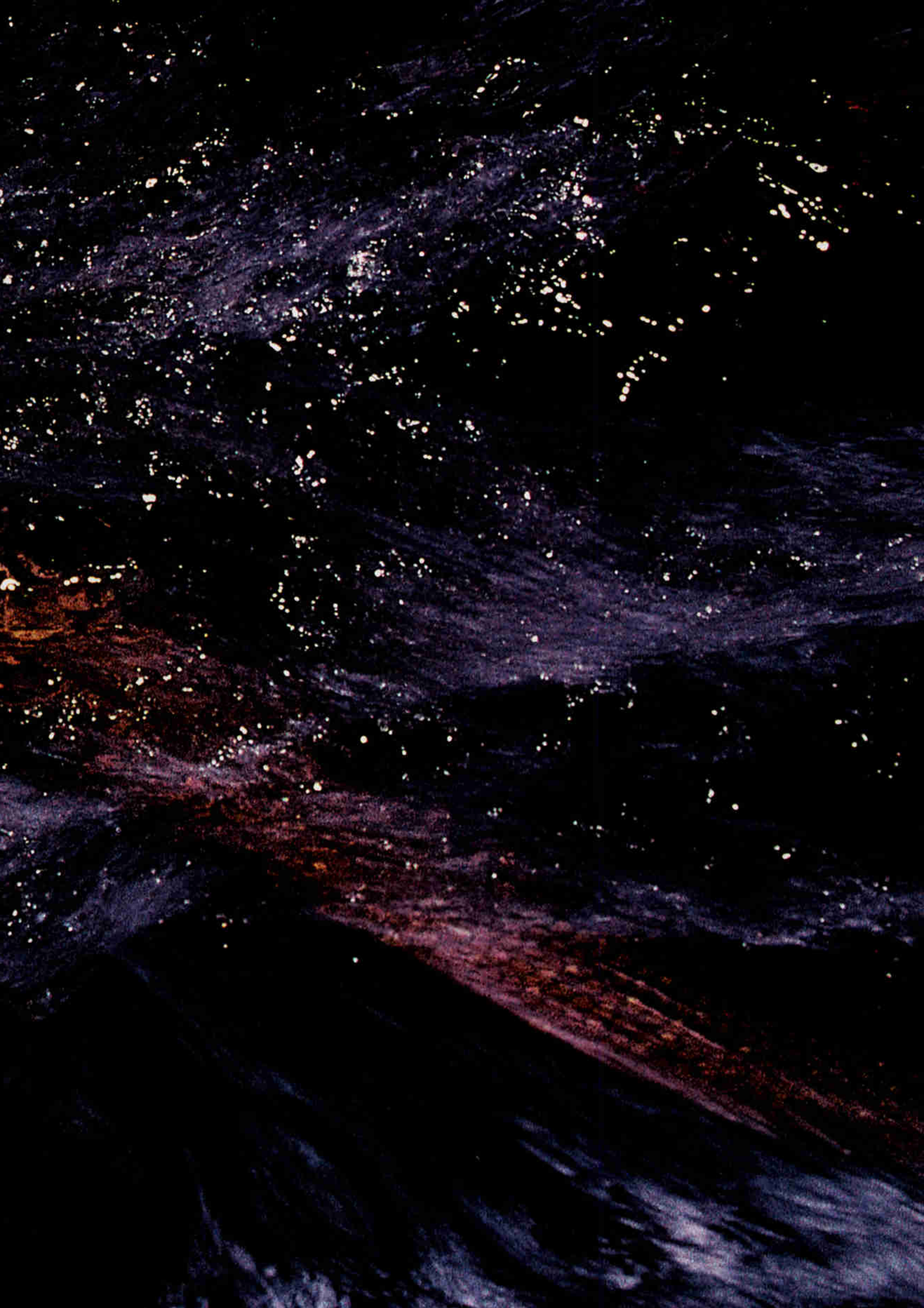
THE FOREST'S DEADLY KING

Where the king cobra resides, no smaller snake of any species is safe. *O. hannah,* a formidable ground hunter, normally feeds on others of its kind. In Langkawi, Malaysia, I witnessed a victim being swallowed (below), the cobra's visible trachea allowing it to breathe despite a mouthful. In a behavior unlike other snakes, a female king rounds up leaf litter with her body to build a nest and may defend a small territory around it. She injects her potent neurotoxin in copious amounts through relatively small fangs (about ten millimeters long). Her hatchlings—usually numbering between 20 and 40—emerge already loaded with poison, which increases in quantity as they attain the great lengths (up to 18 feet) for which the kings are known.

At the Queen Saovabha Memorial Institute's snake farm in Bangkok, antivenom, the modern snakebite remedy, is made. Adult cobras are milked every few weeks (top), and small doses of venom are injected into horses, which develop antibodies to it. Horse plasma is collected (above) and treated to make the final product—which, if given to a victim in time, stops the venom's toxic effects.

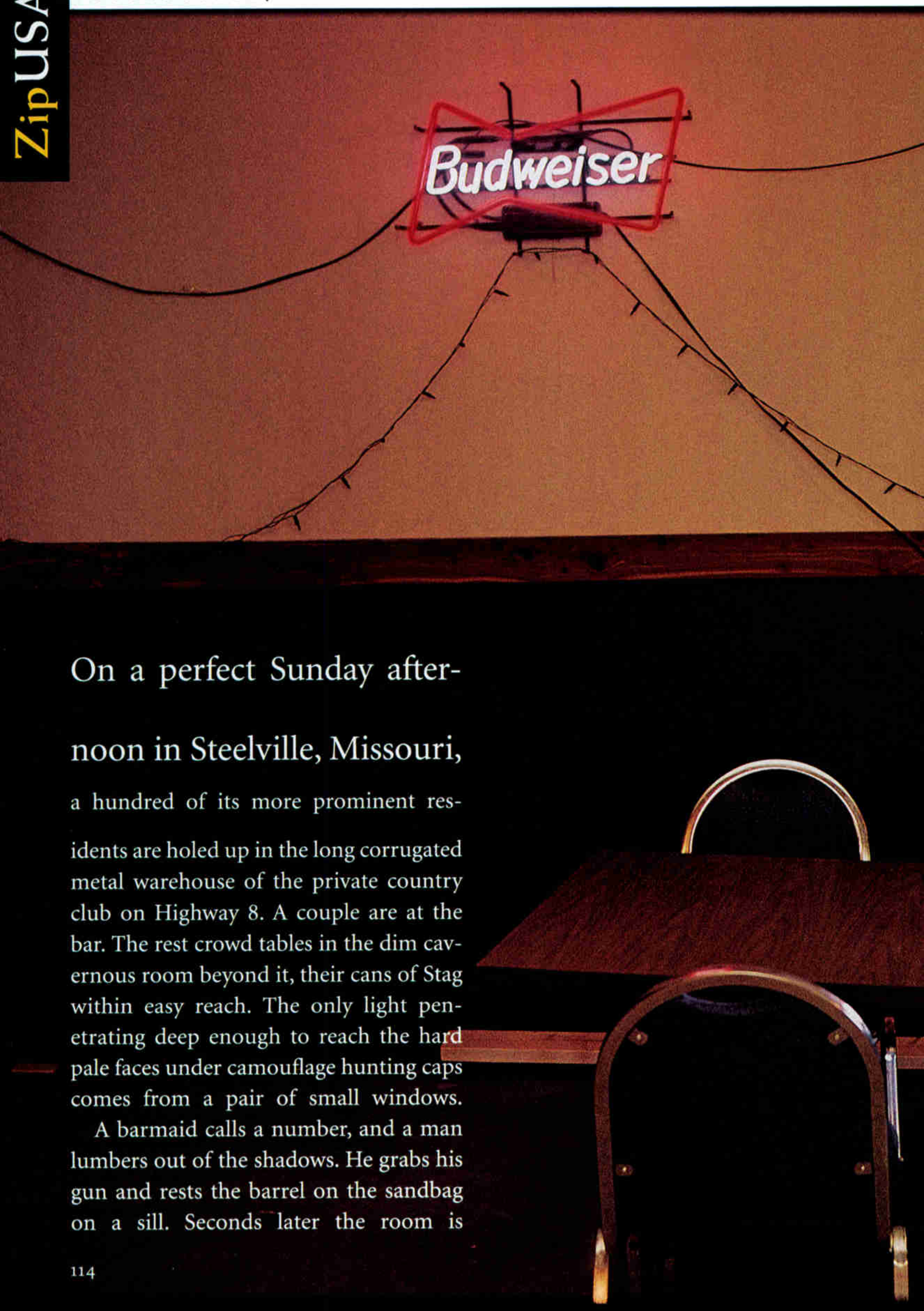
MORE ON OUR WEBSITE

Hear Mattias Klum tell what it is like to come face-to-face with a king cobra at **nationalgeographic.com/ngm/0111.**



After a frantic chase for the ultimate photograph, I at last faced a wild king in a Danum Valley stream. With a growling hiss and flared hood the defensive cobra stood its ground, landed a forceful strike on my camera lens, then dropped flat and fled downstream—14 feet of muscle and scales sweeping my leg as it made its escape. □

STEELVILLE, MISSOURI



On a perfect Sunday afternoon in Steelville, Missouri, a hundred of its more prominent residents are holed up in the long corrugated metal warehouse of the private country club on Highway 8. A couple are at the bar. The rest crowd tables in the dim cavernous room beyond it, their cans of Stag within easy reach. The only light penetrating deep enough to reach the hard pale faces under camouflage hunting caps comes from a pair of small windows.

A barmaid calls a number, and a man lumbers out of the shadows. He grabs his gun and rests the barrel on the sandbag on a sill. Seconds later the room is

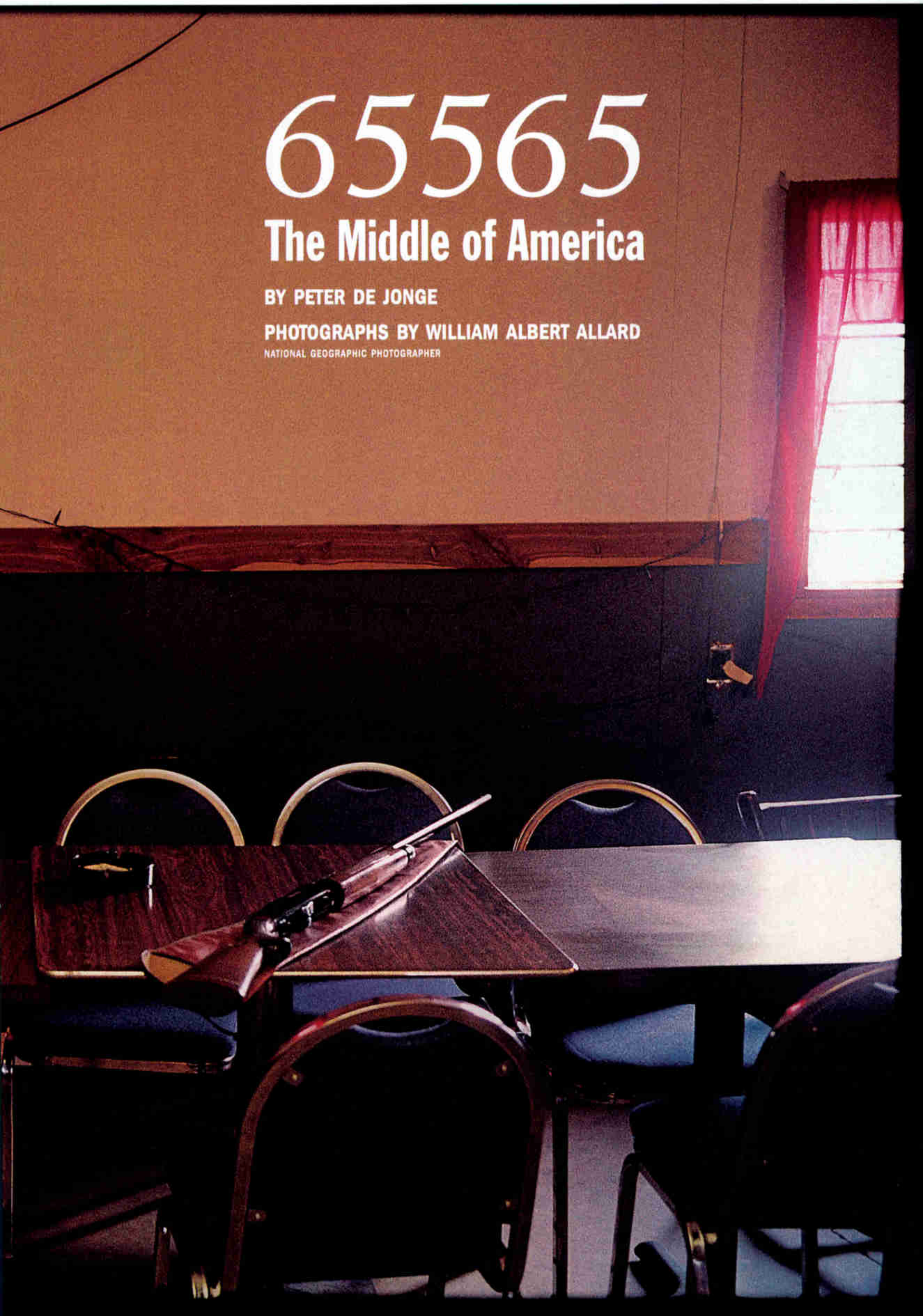
65565

The Middle of America

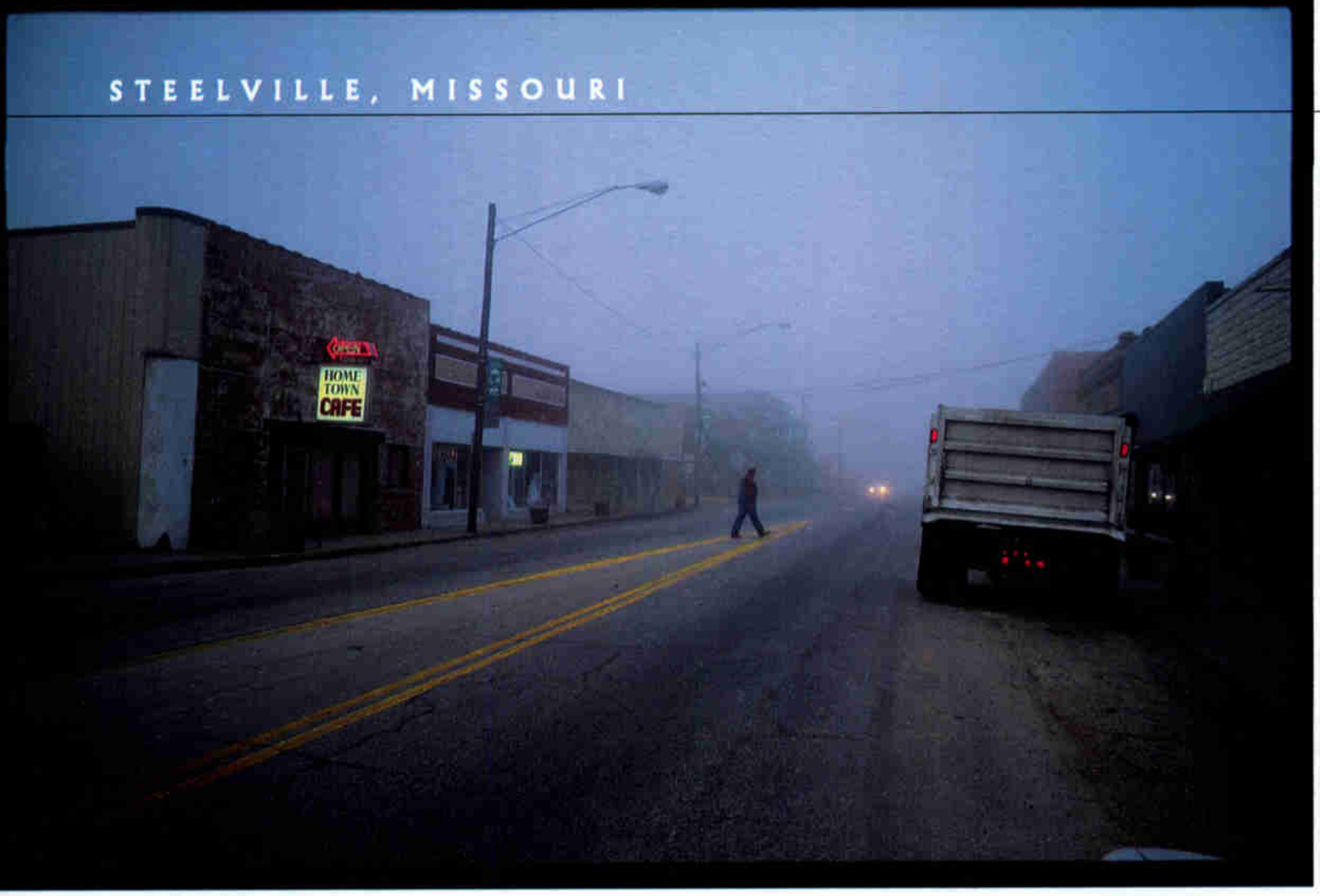
BY PETER DE JONGE

PHOTOGRAPHS BY WILLIAM ALBERT ALLARD

NATIONAL GEOGRAPHIC PHOTOGRAPHER



STEELVILLE, MISSOURI



jolted by a deafening 12-gauge report. Then he pulls the barrel out of the sunlight, ejects the spent shell, and returns to his seat to find out if his aim was true enough to win the pork chops or ham or beefsteaks in this fund-raiser for the high school baseball team.

In Steelville, a hardscrabble town of 1,429 about 80 miles southwest of St. Louis, there has never been a clear line between recreation and nutrition. With spare rolling hills and vistas just big enough to take them in, this portion of the Ozarks foothills seems to have been created to fit the scale of the human eye, but the land isn't good for growing anything but trees. The homesteaders who arrived in the 1830s counted on deer, turkeys, and squirrels to augment their minuscule harvests of beans, taters, and corn, and with more than half the current households taking in less than $15,000 a year, a lot of Steelvillians still do.

Steelville was once the demographic center of the United States (the 2000 census has moved that spot west to Edgar Springs), but the challenges of this beautiful, unbountiful terrain have given the town a character well outside the mainstream. America's culture is about getting rich. Steelville's is about getting by. It's one of the few places left in the continental United States where living on little more than skill and resourcefulness is not a disgrace but a point of pride.

If everyone in the United States were balanced on a map, a trucker crossing Steelville's Main Street would once have straddled the center of gravity. David Helmering (below) doesn't go downtown to be at the center of America. He just likes the food at the Spare Rib Inn.

Earl Halbert, 89, and Eldon Dunlap, 85, are high priests of the old Ozarks lifestyle. Dunlap describes his Depression-era childhood as "a world of trouble," in which his whole family lived on the three dollars he brought in a week, and Halbert recalls how he once quit an aboveground day job for night shift in a bauxite mine because it paid an extra 50 cents a day. Yet both seem more

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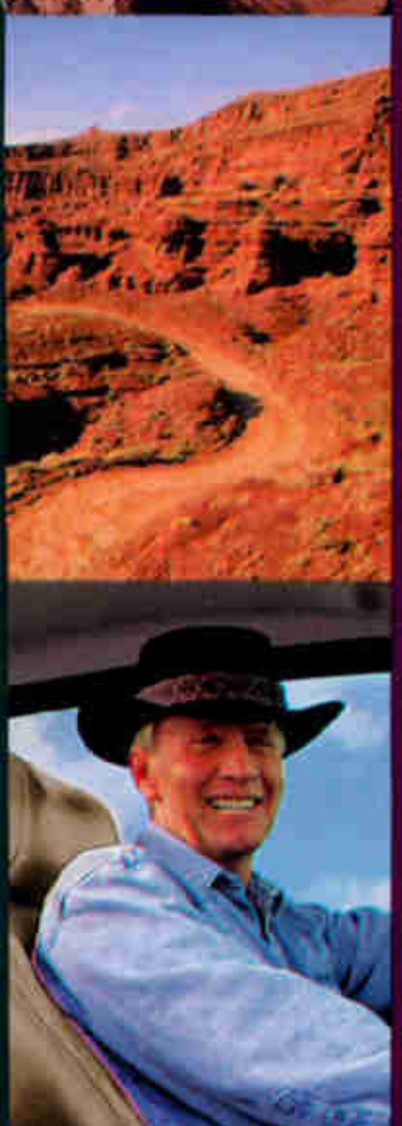

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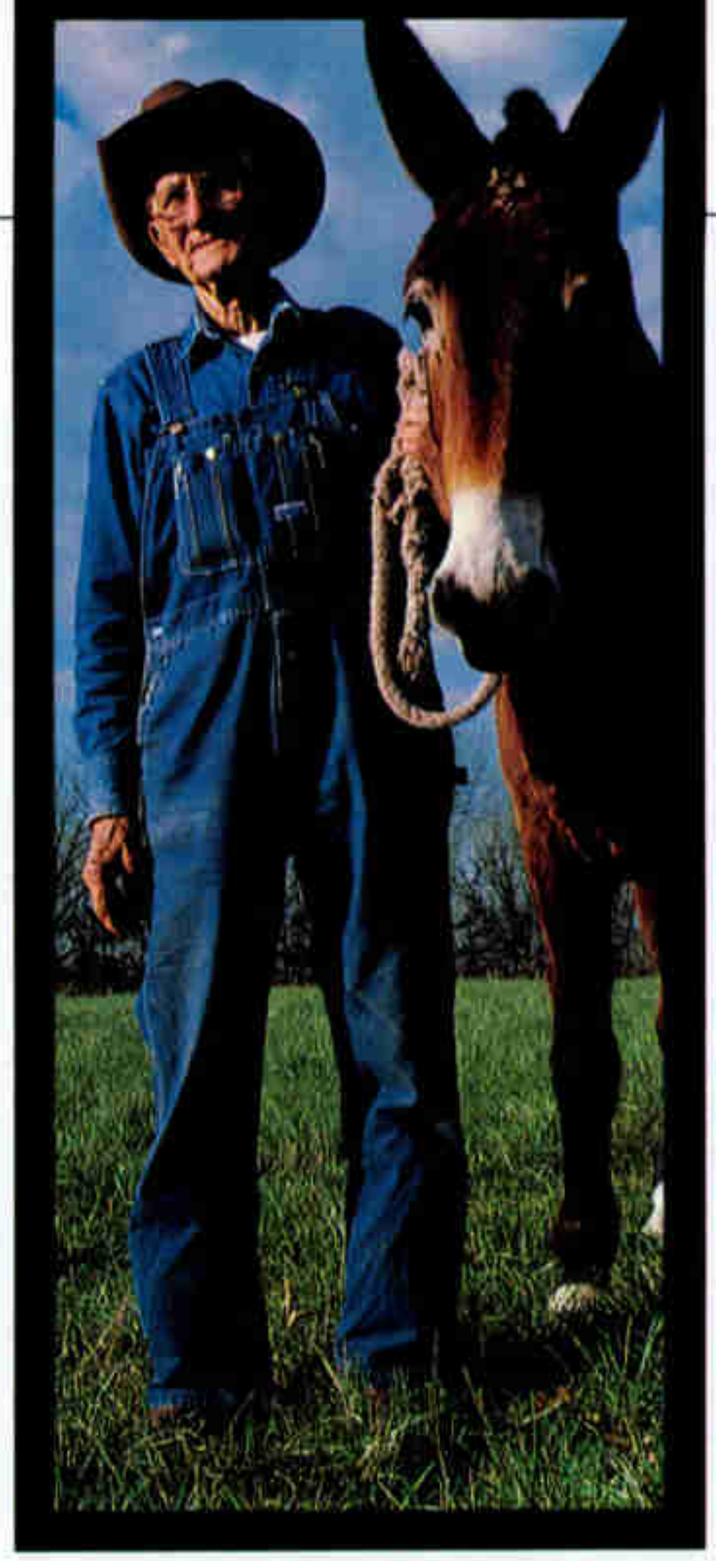

amazed than embittered, and the scripture-quoting Halbert is as upbeat as a TV evangelist.

"Make yourself comfortable," he says at his farm in the holler. "We're just hillbillies here." A red bandanna nattily folded in the back pocket of his overalls, Halbert explains that due to the soil, making money from farming was not in the cards. "You were lucky if you could grow enough to almost feed your family and fatten a few hogs," he says. "But if you knew what you were doing, you could make up the difference in the creeks and woods, and if there was something that absolutely needed buying, you could haul some timber to a mill or cook up some sorghum molasses."

If, like Halbert's legendary late friend Treehouse Brown, you were "tough as a pinewood knot" and so inclined, you could live your whole life quite comfortably outside the official economy. And if you were willing to add a succession of low-paying wage jobs, you could end up like Halbert and Dunlap, sitting pretty in old age on sizable spreads. "It's been a hard life," says Halbert, "but also a pleasant one."

The rough thrill of country life isn't reserved for elders. In the late afternoon I'm welcomed at a birthday party on a scruffy farm at the edge of town, where a couple dozen men and women in their twenties lean against the long bed of a logging truck as if it were a bar. For refreshments there is a cooler of Stag, boxes of charred venison steaks and elk burgers, and a bag of very spicy venison jerky. For entertainment there are horseshoes and the Dixie Chicks coming from the stereo in a flat-bottom fishing boat towed into the yard. Although the sun is dipping fast, there is no talk of moving inside, and in a few hours when it gets really cold, they'll drag the logs off the pickups and build a bonfire. The only other amusements are the lewd novelty items for the birthday boy.

Here I make the acquaintance of a six-foot-three-inch, 220-pound Gen-X logger named Nick Adams, who sports gold Oakleys and a buzz cut and talks about his work with the charisma of a 22-year-old living exactly the life he wants. In high school Adams was a good enough

"Pretty rough sledding, but we made 'er," says Earl Halbert of his 90 years here (above). Riders in the Saddle Tramps Motorcycle Club hit the tavern for karaoke.

65565

POPULATION: 1,429
MEDIAN HOUSEHOLD INCOME, 1990 CENSUS: $14,435
NUMBER OF CANOE/RAFT RENTAL BUSINESSES, CAMPGROUNDS, AND RESORTS: 18
CLAIMS TO FAME: Population center of United States, 1990-2000; "The Floating Capital of Missouri"
PRICE OF AN ADULT TICKET AT THE MERAMEC MUSIC THEATRE ("ALL THE FUN OF A BRANSON *SHOW WITHOUT ALL THE* TRAFFIC"): $12

Here's the dirt on Ms. Pochomis's class.

Her special-needs students are running a dirty little business on the side called "Kidwormco" which provides earthworms to every second grade science class in the state. Because they charge half of what the previous supplier did, these fourth and fifth graders save the school system over a thousand dollars a year.

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bareback rider to attract rodeo scholarships, but seeing no point in deferring the inevitable, he went to work for his even more Bunyanesque six-foot-six-inch old man, Larry Adams.

In the mornings they pull up to a site in two 60-foot logging trucks. When they've dragged out enough oak or pine to fill them both, they're done for the day. They work year round—the cold of winter offset by the lightness of the trees, whose sap has run back into the ground—and they'll keep cutting until one of them gets killed or the woods are gone. "Logging," says Adams, "isn't something you retire from."

America's culture is about getting rich. Steelville's is about getting by.

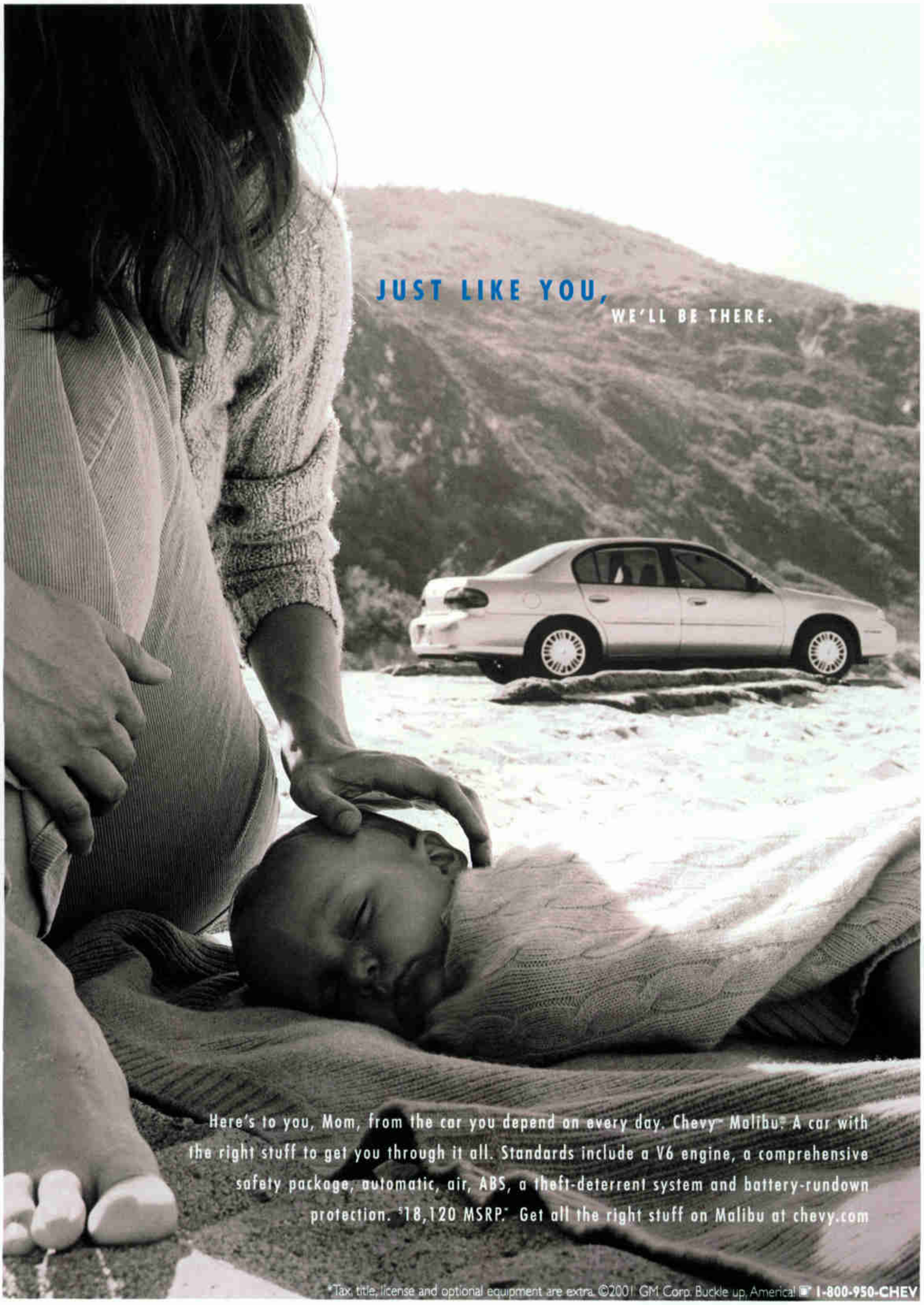
And when Adams isn't cutting, he's still in the woods hunting or fishing. Steelvillians have three beloved ways of plucking fish out of the crystal-clear Huzzah and Courtois (pronounced COAT-a-way) Creeks. There's gigging, a nocturnal winter activity using a flashlight and a spear or gigging pole, and snagging, which involves hanging a heavy hook

Nick Adams logs for a living and lives for fishing, but he'll settle for a can of Stag.

from a rod, throwing it into the creek, and dragging it back across the bottom, hopefully with a fat ugly paddlefish flapping at the end.

Adams's favorite is the spring rite of grabbing. That's where you dangle a hook from an overhanging limb, and when the fish come schooling by, you yank them right out of the water. Adams spits out a sluice of tobacco juice as his pregnant wife stands beside him. "I live for grabbing suckers," he says.

"Steelville's a southern town laid out like a western town," explains Nancy Cole, gazing at the seven-block Main Street on Highway 19 from L & J Package Liquor to the Hometown Café. Having arrived in Steelville only 21 years ago, Cole, a 53-year-old with cropped gray hair who likes to listen to John Prine, realizes she's a long way from shedding her newcomer status. Nevertheless, her droll hospitality has made Willie Mole's, her gift shop/antiques store/old-fashioned ice-cream parlor, one of Main Street's more productive gossip factories.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Sitting at the counter are Bob Hollenbeck, one-sixth of Steelville's police force, and Anyes Stafford, who works the register at the gift shop next door. Both stop in many times throughout the day to help each other and Cole get through the considerable stretches between sales and crimes. The burly, mustached Hollenbeck, who is reputed to make an excellent pâté, often talks recipes with Cole, and, if she follows through with her plan to put in a little restaurant, may moonlight as her chef.

Stafford came from Paris 35 years ago when Robert Bass, the scion of one of the town's handful of well-off families, brought her back after his military stint in Europe, although she has long since divorced him for a variety of reasons Cole sums up as "bad behavior."

Also visiting is Pam Clary, the town's young and restless veterinarian, who recently married an airline pilot. Before the morning is over, I learn how the lesbian who lived up at the vineyard accidentally shot herself while doing laundry and about the teenage busboy who got busted for manufacturing amphetamines in his kitchen.

In Steelville, town and country exist in opposition. You live in the "country" and you come to "town," and while the country is a male preserve, the proprietors of Main Street are mostly women. Every place I frequent, from the Spare Rib Inn to Meramec Wedding Creations, where a girl getting fitted for a gown tells me about borrowing her cousin's boyfriend for the high school prom, is run by women, and they have proved as adept as Ozarks trailblazers at living off the gristle of the land.

But while the rugged outdoor pleasures of Steelville maintain a strong pull on its men, for women Steelville seems like a posting in a foreign land, something you make the best of. You join the Liquored Up Ladies Literary League or maybe, like Vicki Manzotti, open the Cinnamon Stix Tea Room and offer the first menu in town that isn't slathered with gravy. Or if, like Clary, you're young and marketable enough to have real options, you sell your practice and get the hell out of town. □

For women Steelville seems like a posting in a foreign land, something you make the best of.

Girls come from as far as St. Louis for Sandi Martin's custom-made prom dresses.

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BRIEF SUMMARY Before prescribing NEXIUM, please see full Prescribing Information. **INDICATIONS AND USAGE** NEXIUM is indicated for the short-term treatment (4 to 8 weeks) in the healing and symptomatic resolution of diagnostically confirmed erosive esophagitis. **CONTRAINDICATIONS** NEXIUM is contraindicated in patients with known hypersensitivity to any component of the formulation or to substituted benzimidazoles. **PRECAUTIONS** Symptomatic response to therapy with NEXIUM does not preclude the presence of gastric malignancy. Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole, of which NEXIUM is an enantiomer. **Information for Patients:** NEXIUM Delayed-Release Capsules should be taken at least one hour before meals. For patients who have difficulty swallowing capsules, one tablespoon of applesauce can be added to an empty bowl and the capsule opened, and the pellets carefully emptied onto the applesauce. The pellets should be mixed with the applesauce and then swallowed immediately. The applesauce used should not be hot and should be soft enough to be swallowed without chewing. The pellets should not be chewed or crushed. The pellet/applesauce mixture should not be stored for future use. Antacids may be used while taking NEXIUM. **DRUG INTERACTIONS** Esomeprazole is extensively metabolized in the liver by CYP2C19 and CYP3A4. *In vitro* and *in vivo* studies have shown that esomeprazole is not likely to inhibit CYPs 1A2, 2A6, 2C9, 2D6, 2E1 and 3A4. No clinically relevant interactions with drugs metabolized by these CYP enzymes would be expected. Drug interaction studies have shown that esomeprazole does not have any clinically significant interactions with phenytoin, warfarin, quinidine, clarithromycin or amoxicillin. Esomeprazole may potentially interfere with CYP2C19, the major esomeprazole-metabolizing enzyme. Coadministration of esomeprazole 30 mg and diazepam, a CYP2C19 substrate, resulted in a 45% decrease in clearance of diazepam. Increased plasma levels of diazepam were observed 12 hours after dosing and onwards. However, at that time, the plasma levels of diazepam were below the therapeutic interval, and thus this interaction is unlikely to be of clinical relevance. Coadministration of oral contraceptives, diazepam, phenytoin, or quinidine did not seem to change the pharmacokinetic profile of esomeprazole. Esomeprazole inhibits gastric acid secretion, therefore, it is theoretically possible that esomeprazole and omeprazole may interfere with absorption of drugs where gastric pH is an important determinant of their bioavailability (eg, ketoconazole, ampicillin esters, digoxin, and iron salts). **Carcinogenesis, Mutagenesis, Impairment of Fertility:** The carcinogenic potential of esomeprazole was assessed using omeprazole studies. In two 24-month carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (about 0.7 to 57 times the human dose of 20 mg/day expressed on a body surface area basis) produced gastric ECL cell carcinoids in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinoids seldom occur in the untreated rat. In addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg omeprazole/kg/day (about 5.6 times the human dose on a body surface area basis) for 1 year, then followed for an additional year without the drug. No carcinoids were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of 1 year (94% treated vs 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs 26%) but still showed more hyperplasia in the treated group. Gastric adenocarcinoma was seen in one rat (2%). No similar tumor was seen in male or female rats treated for 2 years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. Esomeprazole was negative in the Ames mutation test, in the *in vivo* rat bone marrow cell chromosome aberration test, and the *in vivo* mouse micronucleus test. Esomeprazole, however, was positive in the *in vitro* human lymphocyte chromosome aberration test. Omeprazole was positive in the *in vitro* human lymphocyte chromosome aberration test, the *in vivo* mouse bone marrow cell chromosome aberration test, and the *in vivo* mouse micronucleus test. The potential effects of esomeprazole on fertility and reproductive performance were assessed using omeprazole studies. Omeprazole at oral doses up to 138 mg/kg/day in rats (about 56 times the human dose on a body surface area basis) was found to have no effect on reproductive performance of parental animals. **Pregnancy:** *Teratogenic Effects. Pregnancy Category B* - Teratology studies have been performed in rats at oral doses up to 280 mg/kg/day (about 57 times the human dose on a body surface area basis) and in rabbits at oral doses up to 86 mg/kg/day (about 35 times the human dose on a body surface area basis) and have revealed no evidence of impaired fertility or harm to the fetus due to esomeprazole. There are, however, no adequate and well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, this drug should be used during pregnancy only if clearly needed. Teratology studies conducted with omeprazole in rats at oral doses up to 138 mg/kg/day (about 56 times the human dose on a body surface area basis) and in rabbits at doses up to 69 mg/kg/day (about 56 times the human dose on a body surface area basis) did not disclose any evidence for a teratogenic potential of omeprazole. In rabbits, omeprazole in a dose range of 6.9 to 69.1 mg/kg/day (about 5.5 to 56 times the human dose on a body surface area basis) produced dose-related increases in embryo-lethality, fetal resorptions, and pregnancy disruptions. In rats, dose-related embryo/fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole at 13.8 to 138.0 mg/kg/day (about 5.6 to 56 times the human doses on a body surface area basis). There are no adequate and well-controlled studies in pregnant women. Sporadic reports have been received of congenital abnormalities occurring in infants born to women who have received omeprazole during pregnancy. **Nursing Mothers:** The excretion of esomeprazole in milk has not been studied. However, omeprazole concentrations have been measured in breast milk of a woman following oral administration of 20 mg. Because esomeprazole and omeprazole are likely to be excreted in human milk, and because of the potential for serious adverse reactions in nursing infants from esomeprazole and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be made to discontinue the drug, taking into account the importance of the drug to the mother. **Pediatric Use:** Safety and effectiveness in pediatric patients have not been established. **Geriatric Use:** Of the total number of patients who received NEXIUM in clinical trials, 778 were 65 to 74 years of age and 124 patients were ≥ 75 years of age. No overall differences in safety and efficacy were observed between the elderly and younger individuals, and other reported clinical experience has not identified differences in responses between the elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out. **ADVERSE REACTIONS** The safety of NEXIUM was evaluated in over 10,000 patients (aged 18-84 years) in clinical trials worldwide including over 7,400 patients in the United States and over 2,600 patients in Europe and Canada. Over 2,900 patients were treated in long-term studies for up to 6-12 months. In general, NEXIUM was well tolerated in both short- and long-term clinical trials. The safety in the treatment of healing of erosive esophagitis was assessed in four randomized comparative clinical trials, which included 1,240 patients on NEXIUM 20 mg, 2,434 patients on NEXIUM 40 mg, and 3,008 patients on omeprazole 20 mg daily. The most frequently occurring adverse events (≥1%) in all three groups was headache (5.5, 5.0, and 3.8, respectively) and diarrhea (no difference among the three groups). Nausea, flatulence, abdominal pain, constipation, and dry mouth occurred at similar rates among patients taking NEXIUM or omeprazole. Additional adverse events that were reported as possibly or probably related to NEXIUM with an incidence < 1% are listed below by body system: ***Body as a Whole:*** abdomen enlarged, allergic reaction, asthenia, back pain, chest pain, chest pain substernal, facial edema, peripheral edema, hot flushes, fatigue, fever, flu-like disorder, generalized edema, leg edema, malaise, pain, rigors; ***Cardiovascular:*** flushing, hypertension, tachycardia; ***Endocrine:*** goiter; ***Gastrointestinal:*** bowel irregularity, constipation aggravated, dyspepsia, dysphagia, dysplasia GI, epigastric pain, eructation, esophageal disorder, frequent stools, gastroenteritis, GI hemorrhage, GI symptoms NOS, hiccup, melena, mouth disorder, pharynx disorder, rectal disorder, serum gastrin increased, tongue disorder, tongue edema, ulcerative stomatitis, vomiting; ***Hearing:*** earache, tinnitus; ***Hematologic:*** anemia, anemia hypochromic, cervical lymphoadenopathy, epistaxis, leukocytosis, leukopenia, thrombocytopenia; ***Hepatic:*** bilirubinemia, hepatic function abnormal, SGOT increased, SGPT increased; ***Metabolic/Nutritional:*** glycosuria, hyperuricemia, hyponatremia, increased alkaline phosphatase, thirst, vitamin B12 deficiency, weight increase, weight decrease; ***Musculoskeletal:*** arthralgia, arthritis aggravated, arthropathy, cramps, fibromyalgia syndrome, hernia, polymyalgia rheumatica; ***Nervous System/Psychiatric:*** anorexia, apathy, appetite increased, confusion, depression aggravated, dizziness, hypertonia, nervousness, hypoesthesia, impotence, insomnia, migraine, migraine aggravated, paresthesia, sleep disorder, somnolence, tremor, vertigo, visual field defect; ***Reproductive:*** dysmenorrhea, menstrual disorder, vaginitis; ***Respiratory:*** asthma aggravated, coughing, dyspnea, larynx edema, pharyngitis, rhinitis, sinusitis; ***Skin and Appendages:*** acne, angioedema, dermatitis, pruritus, pruritus ani, rash, rash erythematous, rash maculo-papular, skin inflammation, sweating increased, urticaria; ***Special Senses:*** otitis media, parosmia, taste loss, taste perversion; ***Urogenital:*** abnormal urine, albuminuria, cystitis, dysuria, fungal infection, hematuria, micturition frequency, moniliasis, genital moniliasis, polyuria; ***Visual:*** conjunctivitis, vision abnormal. Endoscopic findings that were reported as adverse events include: duodenitis, esophagitis, esophageal stricture, esophageal ulceration, esophageal varices, gastric ulcer, gastritis, hernia, benign polyps or nodules, Barrett's esophagus, and mucosal discoloration. Other adverse events not observed with NEXIUM, but occurring with omeprazole can be found in the omeprazole package insert. **OVERDOSAGE** A single oral dose of esomeprazole at 510 mg/kg (about 103 times the human dose on a body surface area basis), was lethal to rats. The major signs of acute toxicity were reduced motor activity, changes in respiratory frequency, tremor, ataxia, and intermittent clonic convulsions. There have been no reports of overdose with esomeprazole. Reports have been received of overdosage with omeprazole in humans. Doses ranged up to 2,400 mg (120 times the usual recommended clinical dose). Manifestations were variable, but included confusion, drowsiness, blurred vision, tachycardia, nausea, diaphoresis, flushing, headache, dry mouth, and other adverse reactions similar to those seen in normal clinical experience (see omeprazole package insert-**ADVERSE REACTIONS**). No specific antidote for esomeprazole is known. Since esomeprazole is extensively protein bound, it is not expected to be removed by dialysis. In the event of overdosage, treatment should be symptomatic and supportive. As with the management of any overdose, the possibility of multiple drug ingestion should be considered. For current information on treatment of any drug overdose, a certified Regional Poison Control Center should be contacted. Telephone numbers are listed in the Physicians' Desk Reference (PDR) or local telephone book.

Prilosec® *(omeprazole)*

20-MG Delayed-Release Capsules

BRIEF SUMMARY Before prescribing PRILOSEC, please see full Prescribing Information. **INDICATIONS AND USAGE** *Erosive Esophagitis:* PRILOSEC Delayed-Release Capsules are indicated for the short-term treatment (4-8 weeks) in the healing of erosive esophagitis, which has been diagnosed by endoscopy. **CONTRAINDICATIONS Omeprazole** PRILOSEC Delayed-Release Capsules are contraindicated in patients with known hypersensitivity to any component of the formulation. **PRECAUTIONS** Symptomatic response to therapy with omeprazole does not preclude the presence of gastric malignancy. Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole. **Information for Patients:** PRILOSEC Delayed-Release Capsules should be taken before eating and should not be opened, chewed or crushed, and should be swallowed whole. **DRUG INTERACTIONS** *Other* Omeprazole can prolong the elimination of diazepam, warfarin and phenytoin, drugs that are metabolized by oxidation in the liver. Although in normal subjects no interaction with theophylline or propranolol was found, there have been clinical reports of interaction with other drugs metabolized via the cytochrome P-450 system (eg, cyclosporine, disulfiram, and benzodiazepines). Patients should be monitored to determine if it is necessary to adjust the dosage of these drugs when taken concomitantly with PRILOSEC. Omeprazole inhibits gastric acid secretion, therefore, it is theoretically possible that omeprazole may interfere with absorption of drugs where gastric pH is an important determinant of their bioavailability (eg, ketoconazole, ampicillin esters, digoxin, and iron salts). In clinical trials, antacids were used concomitantly with the administration of PRILOSEC. **Carcinogenesis, Mutagenesis, Impairment of Fertility:** In two 24-month carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (approximately 4 to 352 times the human dose, based on a patient weight of 50 kg and a human dose of 20 mg) produced gastric ECL cell carcinoids in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinoids seldom occur in the untreated rat. In addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg omeprazole/kg/day (approximately 35 times the human dose) for one year, then followed for an additional year without the drug. No carcinoids were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of one year (94% treated vs 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs 26%) but still showed more hyperplasia in the treated group. An unusual primary malignant tumor in the stomach was seen in one rat (2%). No similar tumor was seen in male or female rats treated for two years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. Omeprazole was not mutagenic in an *in vitro*

Ames *Salmonella typhimurium* assay, an *in vitro* mouse lymphoma cell assay and an *in vivo* rat liver DNA damage assay. A mouse micronucleus test at 625 and 6250 times the human dose gave a borderline result, as did an *in vivo* bone marrow chromosome aberration test. A second mouse micronucleus study at 2000 times the human dose, but with different (suboptimal) sampling times, was negative. In a rat fertility and general reproductive performance test, omeprazole in a dose range of 13.8 to 138.0 mg/kg/day (approximately 35 to 345 times the human dose) was not toxic or deleterious to the reproductive performance of parental animals. **Pregnancy:** *Category C* - Teratology studies conducted in pregnant rats at doses up to 138 mg/kg/day (approximately 345 times the human dose) and in pregnant rabbits at doses up to 69 mg/kg/day (approximately 172 times the human dose) did not disclose any evidence for a teratogenic potential of omeprazole). In rabbits, omeprazole in a dose range of 6.9 to 69.1 mg/kg/day (approximately 17 to 172 times the human dose) produced dose-related increases in embryo-lethality, fetal resorptions and pregnancy disruptions. In rats, dose-related embryo/ fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole 13.8 to 138.0 mg/kg/day (approximately 35 to 345 times the human dose). There are no adequate or well-controlled studies in pregnant women. Sporadic reports have been received of congenital abnormalities occurring in infants born to women who have received omeprazole during pregnancy. Omeprazole should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. **Nursing Mothers:** It is not known whether omeprazole is excreted in human milk. In rats, omeprazole administration during late gestation and lactation at doses of 13.8 to 138 mg/kg/day (35 to 345 times the human dose) resulted in decreased weight gain in pups. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from omeprazole, and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother. **Pediatric Use:** Safety and effectiveness in pediatric patients have not been established. **Geriatric Use:** No overall differences in safety and efficacy were observed between the elderly and younger individuals, and other reported clinical experience has not identified differences in responses between the elderly and younger patients, but greater sensitivity of some older individuals cannot be ruled out. **ADVERSE REACTIONS** In the U.S. clinical trial population of 465 patients (including duodenal ulcer, Zollinger-Ellison syndrome and resistant ulcer patients), the following adverse experiences were reported to occur in 1% or more of patients on therapy with PRILOSEC. Numbers in parentheses indicate percentages of the adverse experiences considered by investigators as possibly, probably or definitely related to the drug:

	Omeprazole (n=465)	Placebo (n=64)	Ranitidine (n=195)
Headache	6.9 (2.4)	6.3	7.7 (2.6)
Diarrhea	3.0 (1.9)	3.1 (1.6)	2.1 (0.5)
Abdominal Pain	2.4 (0.4)	3.1	2.1
Nausea	2.2 (0.9)	3.1	4.1 (0.5)
URI	1.9	1.6	2.6
Dizziness	1.5 (0.6)	0.0	2.6 (1.0)
Vomiting	1.5 (0.4)	4.7	1.5 (0.5)
Rash	1.5 (1.1)	0.0	0.0
Constipation	1.1 (0.9)	0.0	0.0
Cough	1.1	0.0	1.5
Asthenia	1.1 (0.2)	1.6 (1.6)	1.5 (1.0)
Back Pain	1.1	0.0	0.5

The following adverse reactions which occurred in 1% or more of omeprazole-treated patients have been reported in international double-blind, and open-label, clinical trials in which 2,631 patients and subjects received omeprazole and 120 patients took a placebo. A causal relationship was not assessed. The percentages are given omeprazole then placebo, respectively. *Body as a Whole, site unspecified:* Abdominal Pain 5.2% and 3.3%; Asthenia 1.3% and 0.8%. *Digestive System:* Constipation 1.5 and 0.8; Diarrhea 3.7 and 2.5; Flatulence 2.7 and 5.8; Nausea 4.0 and 6.7; Vomiting 3.2 and 10.0; Acid regurgitation 1.9 and 3.3: *Nervous System/Psychiatric:* Headache 2.9 and 2.5. Additional adverse experiences occurring in < 1% of patients or subjects in domestic and/or international trials, or occurring since the drug was marketed, are shown below within each body system. In many instances, the relationship to PRILOSEC was unclear. *Body As a Whole:* Allergic reactions, including, rarely, anaphylaxis (see also *Skin* below), fever, pain, fatigue, malaise, abdominal swelling. *Cardiovascular:* Chest pain or angina, tachycardia, bradycardia, palpitation, elevated blood pressure, peripheral edema. *Gastrointestinal:* Pancreatitis (some fatal), anorexia, irritable colon, flatulence, fecal discoloration, esophageal candidiasis, mucosal atrophy of the tongue, dry mouth. During treatment with omeprazole, gastric fundic gland polyps have been noted rarely. These polyps are benign and appear to be reversible when treatment is discontinued. Gastroduodenal carcinoids have been reported in patients with ZE syndrome on long-term treatment with PRILOSEC. This finding is believed to be a manifestation of the underlying condition, which is known to be associated with such tumors. *Hepatic:* Mild and, rarely, marked elevations of liver function tests [ALT (SGPT), AST (SGOT), γ-glutamyl transpeptidase, alkaline phosphatase, and bilirubin (jaundice)]. In rare instances, overt liver disease has occurred, including hepatocellular, cholestatic, or mixed hepatitis, liver necrosis (some fatal), hepatic failure (some fatal), and hepatic encephalopathy. *Metabolic/Nutritional:* Hyponatremia, hypoglycemia, weight gain. *Musculoskeletal:* Muscle cramps, myalgia, muscle weakness, joint pain, leg pain. *Nervous System/Psychiatric:* Psychic disturbances including depression, aggression, hallucinations, confusion, insomnia, nervousness, tremors, apathy, somnolence, anxiety, dream abnormalities; vertigo; paresthesia; hemifacial dysesthesia. *Respiratory:* Epistaxis, pharyngeal pain. *Skin:* Rash and, rarely, cases of severe generalized skin reactions including toxic epidermal necrolysis (TEN; some fatal), Stevens-Johnson syndrome, and erythema multiforme (some severe); purpura and/or petechiae (some with rechallenge); skin inflammation, urticaria, angioedema, pruritus, alopecia, dry skin, hyperhidrosis. *Special Senses:* Tinnitus, taste perversion. *Urogenital:* Interstitial nephritis (some with positive rechallenge), urinary tract infection, microscopic pyuria, urinary frequency, elevated serum creatinine, proteinuria, hematuria, glycosuria, testicular pain, gynecomastia. *Hematologic:* Rare instances of pancytopenia, agranulocytosis (some fatal), thrombocytopenia, neutropenia, anemia, leucocytosis, and hemolytic anemia have been reported. **OVERDOSAGE** Rare reports have been received of overdosage with omeprazole. Doses ranged from 320 mg to 900 mg (16-45 times the usual recommended clinical dose). Manifestations were variable, but included confusion, drowsiness, blurred vision, tachycardia, nausea, diaphoresis, flushing, headache, and dry mouth. Symptoms were transient, and no serious clinical outcome has been reported. No specific antidote for omeprazole overdosage is known. Omeprazole is extensively protein bound and is, therefore, not readily dialyzable. In the event of overdosage, treatment should be symptomatic and supportive.

PRILOSEC is a registered trademark of the AstraZeneca group of companies.

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AstraZeneca

NOTE: This summary provides important information about NEXIUM and PRILOSEC. If you would like more information, ask your doctor or pharmacist to let you read the professional labeling and then discuss it with them.

Final Edit

KING COBRA

Kiss of Death

"I know I have mastered the snake when I can touch it with my lips," Othman Ayib (above) told photographer Mattias Klum. Klum joined the snake charmer and naturalist at the Tok Snake Sanctuary in Langkawi, northwestern Malaysia, to see a recently captured king cobra that had been spotted on a golf course and would have been killed had Ayib not gone to its rescue. "When he let it out of the bag, it struck at everything that moved," says Klum. "But Othman had a way of calming it, slowly following its movements so he could reach out and caress its head. Finally he leaned in for the kiss." Klum photographed the scene lying on his stomach a few feet away. "That was close enough," he says. "Neither of them offered me a kiss, and I didn't ask for one."

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ON ASSI

ON THE ROAD, IN THE FIELD,

MZIMA SPRINGS, KENYA

Getting Beneath the Surface

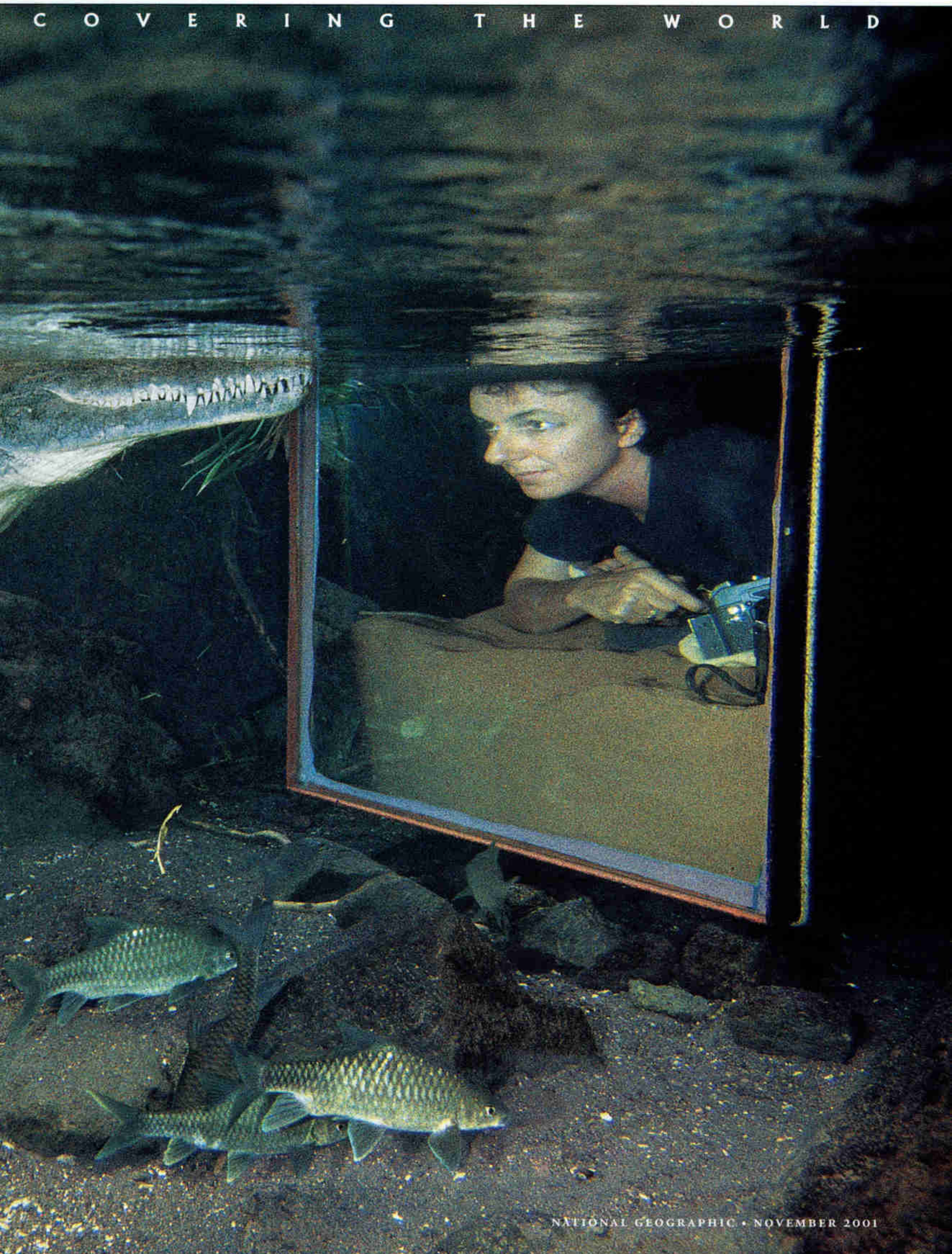
Photographers' "coffin" keeps them dry—and alive—as they record behavior

The problem for **Victoria Stone** and **Mark Deeble** at Mzima Springs: how to get close enough to photograph a crocodile underwater without becoming its breakfast. The solution: a steel "coffin" with a glass front so a photographer, in this case Victoria, could lie very still and see out without disturbing the croc. "It's uncomfortably cramped," Mark recalls, "and you're in there for an average of ten hours a day." The pair spent two years in Kenya with their two young sons capturing the cycles of life in Mzima Springs.

MARK DEEBLE AND VICTORIA STONE

GNMENT

COVERING THE WORLD

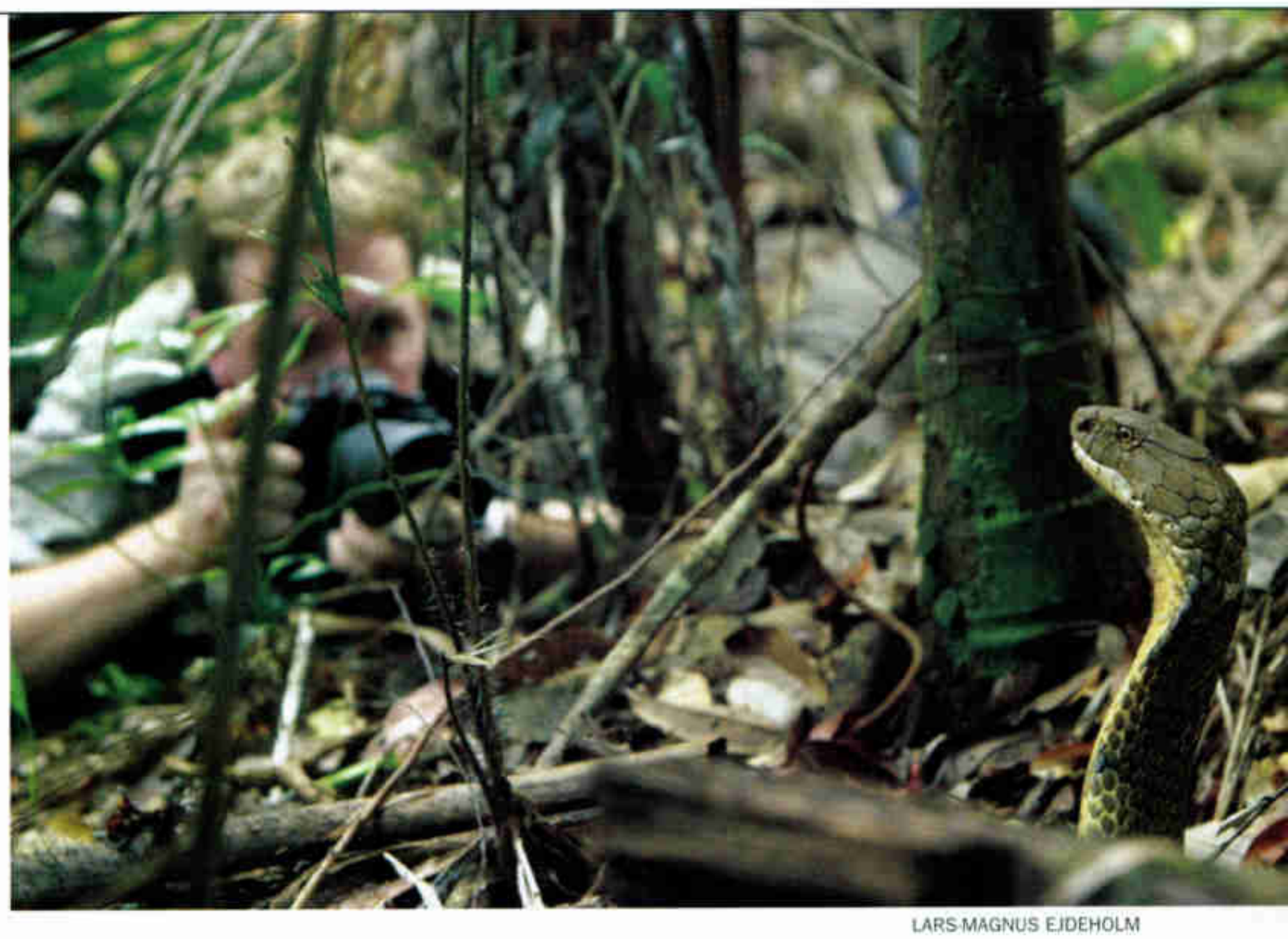


BORNEO

Mutual Wariness

Mattias Klum traveled all over Asia in search of king cobras to photograph. So when he saw this one (right) on a creek bank in Borneo's Danum Valley, he dashed through the creek and got into position. "I said to myself, Let's not mess this up—we need the pictures." He spent 10 to 15 minutes with the snake before it slithered into the creek and sped downstream. "It wasn't agitated, but it didn't want to be near me," Mattias says.

Many of us would not want to be near a cobra, but Mattias was there enthusiastically, using patience and his prior experience photographing snakes to read its behavior. "You try to do the best you can as well as, obviously, survive," he says. "Getting bitten by a king cobra in the middle of a rain forest is not the best thing that could happen."



LARS MAGNUS EJDEHOLM

WORLDWIDE

"I absolutely love the Russian people," says photographer **Gerd Ludwig.** Gerd guesses he's spent nearly two years of the past decade in the former Soviet Union, working on six assignments for the magazine. The Society has just published *Broken Empire,* a collection of Gerd's work there. Novelist and journalist Tatyana Tolstaya (below, in her Moscow apartment with Gerd), a distant relative of novelist Leo Tolstoy, wrote the introduction.

There sat author **Kenny Taylor** at midnight in a hot tub at Blachford Lake Lodge in Canada's Northwest Territories, with temperatures sinking toward 20° below zero F and an aurora overhead. "The steam rising from the tub froze on our hair and eyebrows," reports Kenny (above). "Eyebrows would grow ice crystals, hair would turn white, you'd see people age a hundred years in 45 minutes. The challenge is to get out of the tub and into the lodge quickly. It's seriously cold there."

Author **Peter de Jonge** took a break from writing a novel to visit Steelville, Missouri, for this month's ZipUSA. "Going there from New York felt like traveling to another country," he says. Its residents impressed Peter: "The area is depressed, but the people aren't."

Staff photographer **William Albert Allard** loves to cook. When a Steelville veterinarian asked him to dinner, Bill agreed if he could prepare the meal: "I picked up a pork tenderloin at the grocery and roasted it in a lovely honey-mustard sauce with rosemary. We both thought it was delicious." Bill too liked the residents of Steelville; he corresponds with several of them.

NORBERT ROSING (CENTER); MAXIM KUZNETSOV

MORE ON OUR WEBSITE

Find more stories about life on assignment from our authors and photographers, including their best, worst, and quirkiest experiences, at **nationalgeographic.com/ngm/0111.**

ATTENTION ALL PERSONS OR ENTITIES WHO PURCHASED CERTAIN "INDIRECT VITAMIN PRODUCTS" (as defined below) BETWEEN JANUARY 1, 1990 AND DECEMBER 31, 1999

PLEASE READ THIS SUMMARY NOTICE CAREFULLY AND IN ITS ENTIRETY

WHY SHOULD I READ THIS SUMMARY NOTICE?

Your rights may be affected by class action lawsuits and/or lawsuits filed by the State Attorneys General pending in the District of Columbia, Arizona, Florida, Hawaii, Idaho, Illinois, Kansas, Maine, Michigan, Minnesota, Nevada, New Mexico, New York, North Carolina, North Dakota, Puerto Rico, Rhode Island, South Dakota, Tennessee, Vermont, Washington, West Virginia, and Wisconsin (the "Settling States"). Courts in the Settling States have preliminarily approved a settlement agreement (the "Settlement Agreement") providing for partial settlements of these lawsuits, appointed counsel for the Settlement Classes ("Class Counsel"), and scheduled hearings to consider the fairness, adequacy, and reasonableness of the proposed settlements.

WHAT ARE THE LAWSUITS ABOUT?

Plaintiffs, on behalf of themselves and all other similarly situated persons and entities, together with the attorneys general of each of the Settling States (the "State Attorneys General"), allege that defendants BASF Corporation, Daiichi Pharmaceutical Co., Ltd., Eisai Co. Ltd., Aventis Animal Nutrition S.A. (formerly known as Rhone-Poulenc Animal Nutrition S.A.), Hoffmann-La Roche Inc., Roche Vitamins Inc., and Takeda Chemical Industries Ltd. (the "Settling Defendants") and certain related entities have, among other things, unlawfully conspired to fix, raise, maintain, or stabilize the prices of, and allocate volumes, markets or customers for, certain vitamin products, and that such conduct violated the antitrust and/or consumer protection laws of the Settling States and injured the Settlement Classes. The Settling Defendants deny any liability.

WHAT ARE INDIRECT VITAMIN PRODUCTS?

Indirect Vitamin Products include (a) vitamin A, astaxanthin, vitamin B1 (thiamin), vitamin B2 (riboflavin), vitamin B4 (choline chloride), vitamin B5 (calpan), vitamin B6, vitamin B9 (folic acid), vitamin B12 (cyanocobalamine pharma), beta-carotene, carotenoids, vitamin C, canthaxanthin, vitamin E, and vitamin H (biotin); (b) products containing, or constituted of (in whole or in part), any of the foregoing, including blends and premixes; and (c) products derived from animals that consumed any of the foregoing. Indirect Vitamin Products do not include bulk vitamins or premixes purchased directly from certain manufacturers.

WHO IS IN THE SETTLEMENT CLASSES?

The Settlement Classes include a **Consumer Settlement Class** defined as all natural persons (excluding the Released Parties) who purchased Indirect Vitamin Products for use or consumption by themselves and/or others and not for resale in any form, and who: (i) were residents of one or more of the Settling States as of October 10, 2000; and (ii) purchased Indirect Vitamin Products from within one or more of the Settling States at any time during the Relevant Period.

You need not take any action to remain in the Consumer Settlement Class and you will be represented by Class Counsel and the State Attorneys General. The Consumer Settlement Fund will be distributed cy pres to charitable organizations and other eligible entities.

The Settlement Classes also include a **Commercial Settlement Class** *for each Settling State except* Hawaii. The Commercial Settlement Class includes all persons or entities (excluding government entities and the Settling Defendants) who, during the Relevant Period, made any purchase of Indirect Vitamin Products for resale, for incorporation into another product for resale, or for use in the manufacture, processing, or development of another product (including the feeding of an animal) for resale, where such purchase was (a) made by a buyer in one or more of the Settling States; (b) made from a seller in one or more of the Settling States; or (c) delivered by or on behalf of the seller to the buyer in one or more of the Settling States if the buyer's principal place of business was in one of the Settling States; *provided* that the purchase did not include bulk vitamins or premixes purchased directly from certain manufacturers; and *further provided* that such purchase was not a "California Purchase" as that term is defined in the Settlement Agreement. Such California Purchases are the subject of similar class action litigation in California. You may obtain information relating to the California litigation by calling 415-956-1253.

You need not take any action to remain in the Commercial Settlement Class and your rights under the Settlement Agreement will be represented by Class Counsel. If you wish to file a claim against the Commercial Settlement Fund, you must submit a claim form so that it is received by the Settlement Administrator on or before January 7, 2002.

If you wish to exclude yourself from the Consumer and/or Commercial Settlement Classes, you must submit a request for exclusion so that it is received by the Settlement Administrator on or before December 7, 2001, even if you have filed your own lawsuit.

WHAT ARE THE PROPOSED SETTLEMENT TERMS?

In exchange for the release of the claims of the Settlement Classes, the Settling Defendants have agreed to pay up to $225,250,000.00 (the "Settlement Amount") for the benefit of consumers and businesses in the Settling States.

If you choose to remain in either or both of the Settlement Classes you may, but are not required to, appear in person at the settlement fairness hearings and/or submit comments regarding the fairness, adequacy, and reasonableness of the proposed settlements.

If the settlements are finally approved by the courts, the judgments entered will bind all persons and/or entities in the Settlement Classes who do not timely and properly exclude themselves, and their claims against the Settling Defendants and related entities shall be forever released and dismissed. You are urged to obtain more information as described below in order to preserve your rights.

HOW CAN I OBTAIN ADDITIONAL INFORMATION?

You may obtain additional information concerning the proposed settlements (including hearing dates, claim forms, and requests for exclusion) by (a) writing to the Settlement Administrator: Indirect Vitamin Antitrust Litigation, P.O. Box 8809, Melville, NY 11747-8809; (b) by calling 1-800-424-6662; or (c) visiting the internet web site located at www.vitaminlitigation.com.

You may direct any other questions you may have concerning the Settlement Agreement or this Summary Notice to either Plaintiffs' Lead Counsel: David Boies III, Straus & Boies, LLP, 10513 Braddock Road, Fairfax, Virginia 22032 or Liaison Counsel for the State Attorneys General: Kathleen Harris, Deputy Chief, Antitrust Bureau, Office of the Attorney General of the State of New York, 120 Broadway, New York, New York 10271.

Flashback

HENRY ROWEN LEMLY

RUSSIA RISING

Padding His Assets

A bulging coat added bulk to this already sizable Russian coachman, whose photograph was cataloged by the Society in 1925. Gilbert H. Grosvenor's November 1914 article, "Young Russia: The Land of Unlimited Possibilities," had explained 11 years earlier the uniform's rationale.

"The drosky drivers wear padded coats that look like great wrappers round their bodies," reads a caption in that story. "The fatter they are the more prosperous and well-fed they are supposed to be, and consequently the more high-priced."

This photograph has never before been published in the magazine.

MORE ON OUR WEBSITE

You can find this image as well as access the Flashback photo archive at **national geographic.com/ngm/flashback/0111.**

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Rosemary Harris
Navigation Specialist
U.S. Navy

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Miguel and Maria Gonzales

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