NATIONALGEOGRAPHIC.COM/MAGAZINE JUNE 2006

NATIONAL GEOGRAPHIC

why the world loves soccer

A professional soccer player runs an average of **6 to 8 miles** a game.

the beautiful game

With millions of players and fans worldwide, soccer serves as a kind of global language, spoken with a multitude of dialects. At first glance, the world's love for the game seems simple: The action is constant; the players improvise tactics as the game unfolds and perform spectacular feats of skill and athleticism. But the passion for what Brazilian star Pelé called the "beautiful game" is so ingrained in many countries that over time the sport has become not just a pastime, but a reflection of national character. From diverse geographies come distinctive styles of play. Though fading as the modern game becomes more globalized, these national styles have produced some of the most riveting moments in soccer history.

NATIONAL GEOGRAPHIC

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NATIONAL GEOGRAPHIC MAGAZINE

Washington, D.C., June 2006

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Produced by National Geographic Maps for National Geographic Magazine

TROPHY OF THE FIFA WORLD CUP: PHILIPPE CARONSYGMA/CORBIS

Brazil

"Samba" football: fantasy and attacking flair

Performance artists of the soccer world, Brazil's national team plays with an artful rhythm and phenomenal skill, taking what can be a brutally physical game and turning it into something beautiful and surprising. Brazilians love to improvise—they're the best dribblers of the ball on Earth—and their tactics are often just as fluid and inventive. Led by the incomparable Pelé from 1958 to 1970, Brazil has won more World Cups than any other nation. Cheered on by its samba-dancing fans, Brazil is favored to win every time it steps on the field.

'58 '62 '70 '94 '02

5 TIMES WORLD CUP WINNER

*Brazil won the right to keep the original trophy (Jules Rimet Cup) in perpetuity after winning for the third time in 1970.

Germany

Tactical order, efficiency, and stamina

With forceful, well-organized attacks, Germany tends to play in a very direct way, controlling the game in midfield, staying patient, and picking apart defenses with either crisp one-touch passing or aerial assaults on the goal. Physically imposing and disciplined, Germany's fast and highly skilled players can intimidate opponents. Their tenacity is legendary, producing many last-minute comebacks, like this overtime rally against France in the 1982 World Cup semifinal.

'54 '74 '90

World Cup Semifinal 1982: West Germany 3, France 3

Trailing by two goals in overtime, Germany rallies to tie the game, 3-3, after wearing down the French with a long buildup **(1)**. The tying goal comes on a cross **(2)**, a header **(3)**, and a bicycle kick **(4)**, scored by striker Klaus Fischer. Germany wins the match in a penalty kick tiebreaker.

Italy

Defensive lockdown and swift counterattack

Mercilessly scrutinized by its fans and the media, Italy tends to play it safe when the pressure is on, falling back into a defensive strategy known as *catenaccio,* or lock. When their opponents make a mistake, the Italians pounce, counting on their skillful forwards to somehow steal a goal. Against West Germany in '82, Italy's cat-and-mouse strategy paid off with two goals on counterattacks, which its forwards finished with typical finesse.

'34 '38 '82

World Cup Final 1982: Italy 3, West Germany 1

With the German team pushing forward on attack **(1)**, the Italians win the ball **(2)** and quickly counterattack down the wing **(3)**. Conti's breakaway and crossing pass **(4)** finds Altobelli, who coolly beats the charging goalie and scores with a left-footed shot **(5)**.

England

Speed, aerial passes, and heading

A product of rain-soaked playing fields and a high threshold of pain, the no-nonsense English style uses long, airborne passes out of the defense to a "target" man up front, who often passes it with his head to an onrushing teammate—if he can survive the flying cleats of his slide-tackling opponents. Fast-paced and physical, the English style is changing with the influx of foreign-born players, and their finesse, into England's professional leagues.

'66

World Cup Qualifier 2001: England 5, Germany 1

After misplaying a long pass from his defense **(1)**, England's David Beckham regains possession and crosses the ball **(2)** to Emile Heskey. He heads it down **(3)** into the path of striker Michael Owen, who volleys the ball into the net with a single touch **(4)**.

Other Winners

Only seven countries have won the Cup.

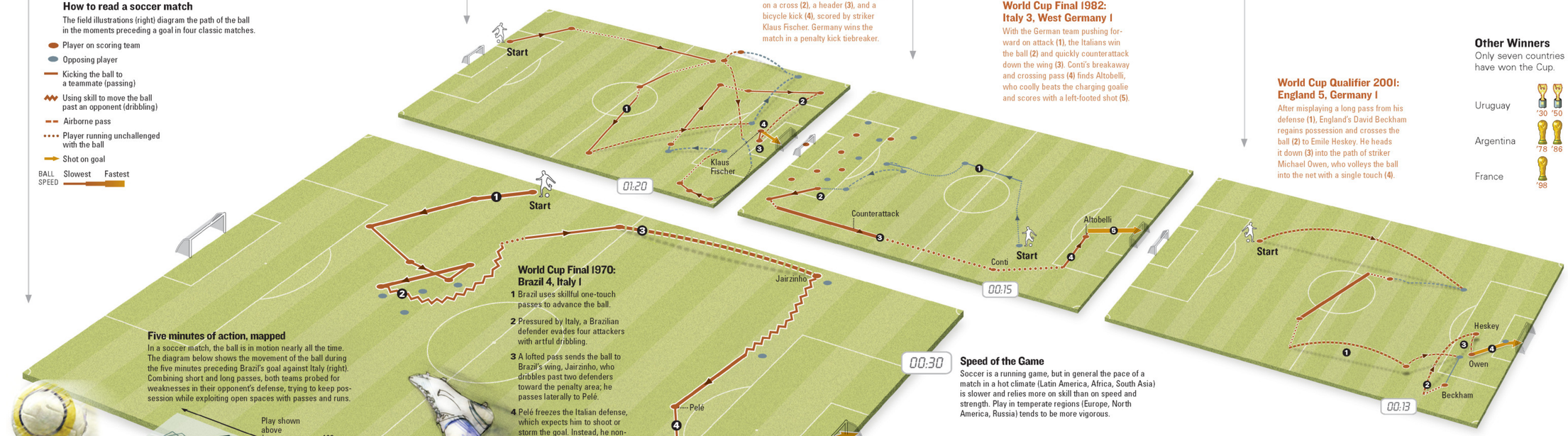
Uruguay	'30 '50
Argentina	'78 '86
France	'98

How to read a soccer match

The field illustrations (right) diagram the path of the ball in the moments preceding a goal in four classic matches.

- Player on scoring team
- Opposing player
- Kicking the ball to a teammate (passing)
- Using skill to move the ball past an opponent (dribbling)
- Airborne pass
- Player running unchallenged with the ball
- Shot on goal

BALL SPEED Slowest Fastest



World Cup Final 1970: Brazil 4, Italy 1

1 Brazil uses skillful one-touch passes to advance the ball.

2 Pressured by Italy, a Brazilian defender evades four attackers with artful dribbling.

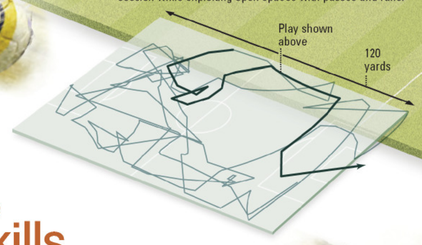
3 A lofted pass sends the ball to Brazil's wing, Jairzinho, who dribbles past two defenders toward the penalty area; he passes laterally to Pelé.

4 Pelé freezes the Italian defense, which expects him to shoot or storm the goal. Instead, he nonchalantly passes the ball into a huge, seemingly empty space on his right.

5 Sprinting 70 yards upfield, Brazil's right back, Carlos Alberto, takes the perfectly timed pass in mid-stride and sends a one-touch rocket into the back of the net.

Five minutes of action, mapped

In a soccer match, the ball is in motion nearly all the time. The diagram below shows the movement of the ball during the five minutes preceding Brazil's goal against Italy (right). Combining short and long passes, both teams probed for weaknesses in their opponent's defense, trying to keep possession while exploiting open spaces with passes and runs.

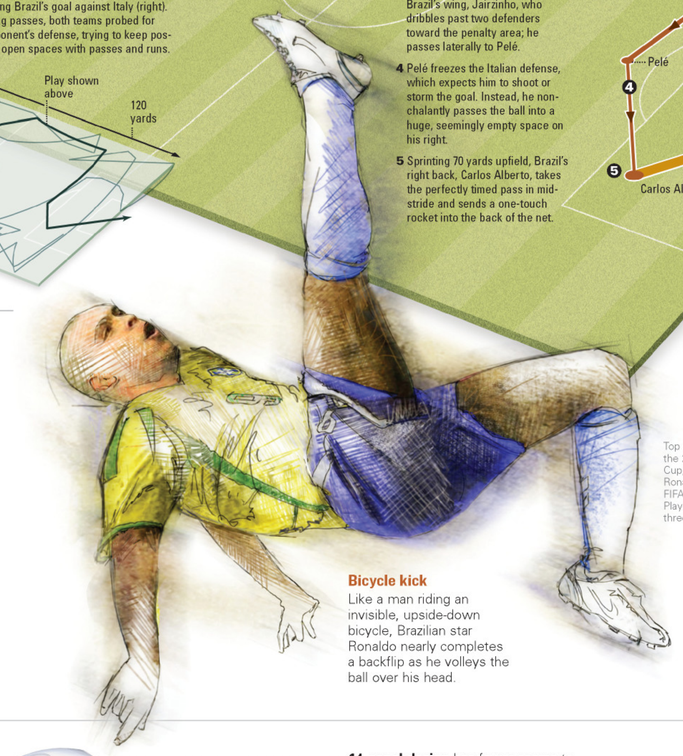


Speed of the Game

Soccer is a running game, but in general the pace of a match in a hot climate (Latin America, Africa, South Asia) is slower and relies more on skill than on speed and strength. Play in temperate regions (Europe, North America, Russia) tends to be more vigorous.

the skills

Heading, trapping, passing, shooting—the skills of soccer are the grammar of the game, the tools players use to make the ball do what they want it to. Everyone who plays soccer—from the barefoot kid on the playground to the World Cup champion—is judged on the level of his or her craftsmanship. Can he outdribble his opponent? Can she stop the moving ball? The most welcoming of sports, soccer requires very little equipment—a ball, a goal—but what it does require is skill.



Top scorer of the 2002 World Cup, Brazil's Ronaldo has won FIFA's World Player of the Year three times.

Bicycle kick

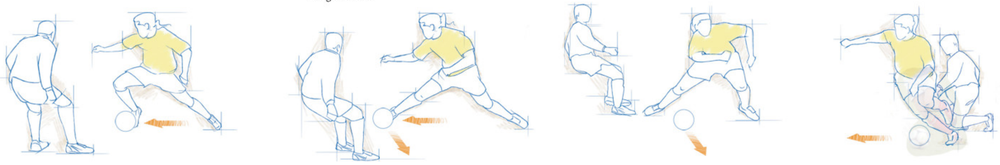
Like a man riding an invisible, upside-down bicycle, Brazilian star Ronaldo nearly completes a backflip as he volleys the ball over his head.

Dribbling

Two of soccer's biggest stars break down their signature dribbling moves, among the many tricks they use to beat an opponent. In real time, it's mostly a blur.

Ronaldinho's "elastico" Moving at top speed, Brazilian forward Ronaldinho uses this move to stretch an opponent one way, and pass him on the other.

❶ *Pushes the ball with the outside of his right foot, faking a run to the right.*
❷ *Lunging to the right, he rotates his ankle to change direction of the ball, drags it left.*
❸ *Opponent is thrown off-balance as Ronaldinho collects the ball . . .*
❹ *. . . and races past his opponent toward the goal.*



Zidane's "roulette" French midfielder Zinedine Zidane uses a high-speed, 360-degree turn to dribble past an opponent.

❶ *Shields the moving ball from an opponent by placing his foot on the ball . . .*
❷ *. . . while rotating his body in a pirouette.*
❸ *Drags the ball with his right foot, takes it with his left.*
❹ *Completes the turn, shielding the ball from opponent.*
❺ *Moves upfield with one less man to beat.*

the science

Players of great skill can perform stunts with the ball that seem to defy the laws of nature. But gifted players apply the laws of physics to help them control the game. Players at this year's World Cup will be experimenting with a new kind of ball.

+TEAMGEIST, OFFICIAL BALL OF THE 2006 FIFA WORLD CUP GERMANY

14-panel design has fewer seams to make a rounder ball. Traditional balls have 32 panels.

New panel shape eliminates surface irregularities for greater accuracy.

Thermal bonding creates seamless panels for a smoother kicking surface.

Synthetic cover reduces water absorption.

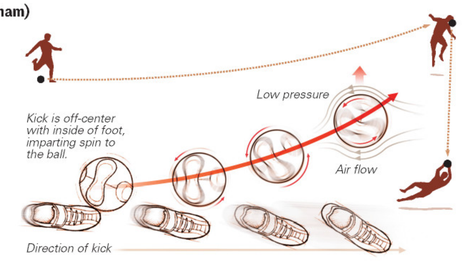
Multiple layers of polyester and/or cotton lining give strength and bounce.

Crossing the ball

In a typical attacking sequence (right), a midfielder serves a long pass for a striker to head at the opponent's goal. The opposing goalkeeper makes a save with his hands. Here's a look at the physics involved.

Bending it (like Beckham)

How do players like England's David Beckham "bend" the ball to produce a curved trajectory? By spinning it. The flight of a spinning ball creates an imbalanced airflow across its surface, which bends the ball's trajectory (right).



Heading it

A well-headed ball is struck with the center of the forehead—a hard, reflective surface that redirects the ball's momentum. If the head is moving forward when it meets the ball, it applies a force that accelerates the ball toward the target.

Catching it

If a goalie catches a ball moving at 50 miles an hour, and his hands recoil six inches during the catch, the ball will transfer 160 pounds of force—about the weight of the goalkeeper.

The World Cup's Living Legends

Pelé - Brazil
(World Cup appearances in 1958, 1962, 1966, 1970)

AFP/GETTY IMAGES

Blessed with speed, balance, agility, and the imagination to see two or three moves ahead of his opponents, Edson Arantes do Nascimento (nicknamed, Brazilian style, "Pelé") helped lead Brazil to the World Cup championship at age 17. He is the only person to have won the Cup three times as a player. Born to a poor family in the Brazilian countryside, Pelé went on to score 1,281 goals in his professional career. He is widely considered the greatest soccer player of all time.

Franz Beckenbauer - Germany
(1966, 1970, 1974)

COLORSPORT

Winner of the World Cup as both a player (1974) and a coach (1990), Beckenbauer revolutionized the role of the modern defender, often orchestrating the attack from his central "sweeper" position without ever seeming to break a sweat.

Diego Maradona - Argentina
(1982, 1986, 1990, 1994)

RICARDO ALFIERI

One of soccer's greatest, and most controversial, players, Maradona had the skills of a sorcerer: precise ball control, explosive speed and power, and an uncanny ability to penetrate defenses. His back-to-back goals against England in the 1986 World Cup illuminate both sides of Maradona's complex personality. His first goal, known to the soccer world as the Hand of God, was an act of trickery, scored illegally with his left hand. The second, scored after "El Diego" dribbled through the entire English defense, was pure genius.

Zinedine Zidane - France
(1998, 2002, 2006)

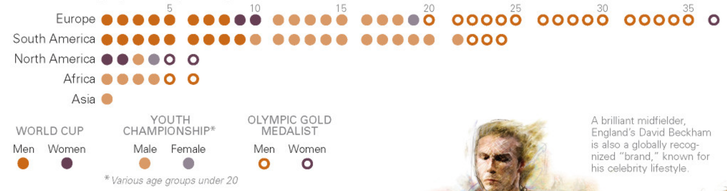
SALVATORE GIGLIO

Known for his graceful style of play, "Zizou" scored two lethal headers in the 1998 World Cup final, leading France to its first world title. Son of Algerian immigrants, Zidane is a brilliant strategist on the field—and a powerful symbol of multicultural France.

soccer unites the world

Throughout history, humans have played some version of a kicking game. What the world now calls association football, or soccer, evolved in medieval Britain and was formalized by England's Football Association in the mid-19th century. British sailors and merchants spread the game to the far corners of the world, where soccer's simple formula—imagination and a ball—found instant translation. Today the game is played in every nation on Earth, by more than 120 million regular players and countless others on beaches, playgrounds, and streets.

World and Olympic champions by continent



Like the Olympics, soccer's World Cup is held every four years. Citizens play for their countries, and the teams competing in the Finals are chosen by regional tournaments. The host country automatically qualifies.

A brilliant midfielder, England's David Beckham is also a globally recognized "brand," known for his celebrity lifestyle.

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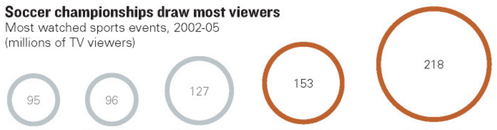
U.S. soccer star Mia Hamm, now retired, scored more goals for her country than any other player in history.

the economics

In the modern era, soccer has become big business: a multifaceted global industry generating tens of billions of dollars every year. Flush with television contracts and lucrative merchandising deals, a number of professional soccer teams now rank among the highest earning sports teams on the planet. Yet as fast as the money comes in, it goes back out—to cover players' multimillion-dollar salaries and signing fees.

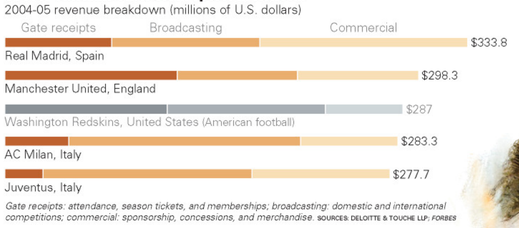
Soccer Other sport

Soccer championships draw most viewers
Most watched sports events, 2002-05
(millions of TV viewers)



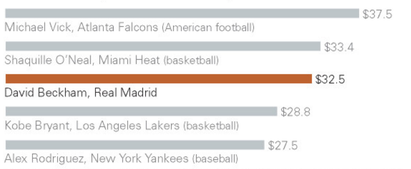
Average number of viewers based on live broadcasts. SOURCE: INITIATIVE FUTURES

Soccer outranks other team sports in riches...
2004-05 revenue breakdown (millions of U.S. dollars)

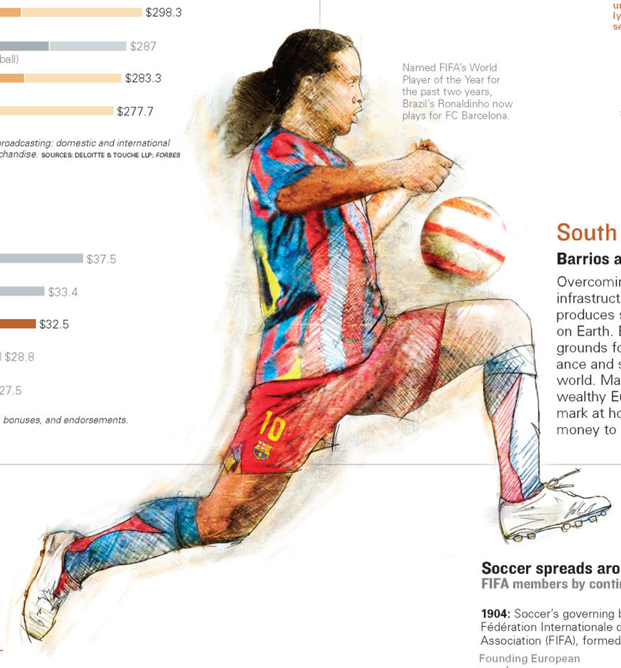


Gate receipts: attendance, season tickets, and memberships; broadcasting: domestic and international competitions; commercial: sponsorship, concessions, and merchandise. SOURCES: DELOITTE & TOUCHE LLP; *FORBES*

...but not in player salaries
2004-05 income (millions of U.S. dollars)



Income for active players in team sports only, includes salaries, bonuses, and endorsements.
SOURCE: *FORBES*



Named FIFA's World Player of the Year for the past two years, Brazil's Ronaldinho now plays for FC Barcelona.

North America

A sport for everyone

Soccer in the U.S. is both a male and female sport, since a 1970s boom in youth soccer taught girls to play—and equal opportunity laws opened new horizons for them at the college level. In 1991 the U.S. won the first Women's World Cup, and repeated in 1999. With a strong showing in World Cup 2002, the U.S. men are also on the rise, although on any given day regional rivals Mexico or Canada—or smaller nations such as Guatemala or Costa Rica—can humble their giant neighbor: Soccer is the great equalizer.

Popularity and participation

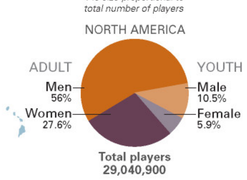
Based on multiple criteria, soccer is the number one sport for the majority of countries (in green on map). Still, in countries where it's not the number one sport (in blue) the reach of soccer continues to grow.

Number of players per 1,000 inhabitants

More than 50
26 - 50
11 - 25
5 - 10
Fewer than 5
No data available

Soccer is No. 1 sport | **Soccer not No. 1 sport**

Who's playing
Pie size proportional to total number of players



DATA: Number of players: FIFA (2000); Sports Confederation of Greenland. Population: World Development Indicators *2005 (population, 2000). Other: China Marketing & Media Study 2005. Pie charts: FIFA (2000). Data based on survey results provided by FIFA's member soccer associations*

South America

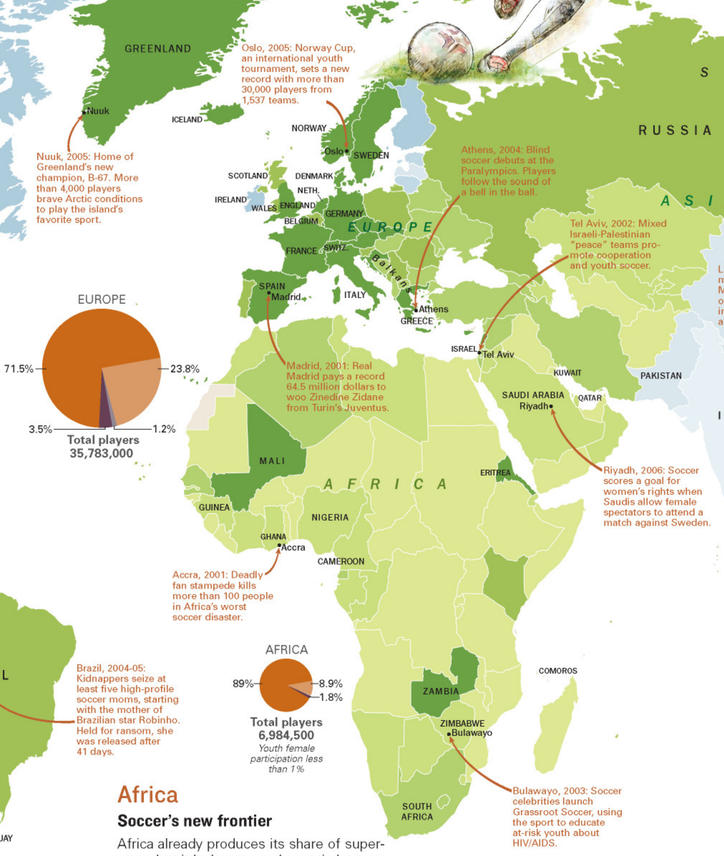
Barrios and big money

Overcoming chronic poverty and poor infrastructure, South America consistently produces some of the most exciting soccer on Earth. Brazil and Argentina are proving grounds for young players, whose flamboyance and skill are admired by the rest of the world. Many players are snapped up by wealthy European teams after making their mark at home, where clubs rarely have the money to keep them.

Europe

Lure of the rich and famous

Birthplace of the modern game, England helped popularize soccer worldwide; in 1966, on its home soil, it won its single World Cup. Today most global soccer revenue comes from Europe, home to the world's richest professional clubs. Hosted by Germany, the 2006 World Cup will bring together the best national teams in the world, who survived a rigorous, two-year competition to qualify.



Africa

Soccer's new frontier

Africa already produces its share of superstars, but it lacks strong domestic leagues and loses many of those stars to European clubs. Like South America, Africa is poor in resources but rich in talent, with thousands of gifted young players dreaming of the big time. Teams such as Nigeria and Ghana light up the world stage and could have a home-continent advantage in 2010, when South Africa hosts Africa's first World Cup.

Winkel Tripel Projection, Central Meridian 0°
SCALE 1:78,630,000 or 1 INCH = 1,241 MILES
0 mi 1500
0 km 1500

Asia

A growing passion

Over the past two decades, a heated soccer rivalry—among Japan, China, and South Korea—has stirred soccer passions across the continent. Not all countries share the fervor, however: India and Pakistan prefer other sports, especially cricket. Meanwhile, oil-rich Persian Gulf states such as Saudi Arabia, Kuwait, and Qatar are investing huge sums of money in their programs, hiring the best coaches and players money can buy.

Australia and Oceania

Soccer down under

Long dominated by cricket, rugby, and Australian Rules football, Australia has lately made room for soccer, fortifying its national team with immigrants from the Balkans and other soccer-mad regions. The 2006 World Cup will be Australia's first appearance in 32 years, after beating Uruguay in a dramatic playoff series to qualify. New Zealand, which hosted the Under-17 World Championship in 1999, also has a competitive national team.

the evolution

Precursors to association football—soccer, for short—began as far back as 2500 B.C., with the Chinese kicking game *tsu chu*. Similar games have been played the world over, from the Romans' *harpastum* to the North American Indians' *pasuckuakohowog*. English "mob football" was wildly popular, but so violent that it was outlawed five times by medieval kings. In the 1840s, English schools finally drew up rules for this rough-and-tumble football, and the modern game took shape.

1848: The first "football" rules are drawn up at England's Cambridge University.

1863: Football Association founded by 11 English clubs. First formal soccer rules adopted.

Soccer spreads around the world
FIFA members by continent

1904: Soccer's governing body, Fédération Internationale de Football Association (FIFA), formed.

1927: First radio broadcast of a game, in England.

1930: First World Cup, held in Uruguay. Thirteen countries participate; Uruguay wins.

1938: First live, televised soccer game, in England.

1950: Fourth World Cup tournament, delayed eight years because of WWII.

1958: First live, international TV coverage of World Cup, in Sweden. Brazil wins.

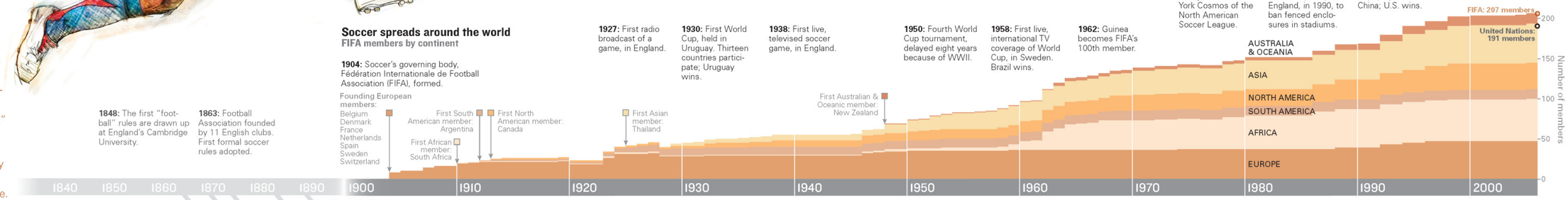
1962: Guinea becomes FIFA's 100th member.

1975: Turning point for U.S. soccer: Pelé joins the New York Cosmos of the North American Soccer League.

1980s: A rise in hooliganism and fan disasters prompts England, in 1990, to ban fenced enclosures in stadiums.

1991: First FIFA Women's World Cup, played in China; U.S. wins.

2005: Newest members to join FIFA: Comoros and East Timor.



Political milestones

In the late 1800s, "football" gave rise to a number of organized games in which hands and feet were used to advance the ball.

Canadian football
Gaelic football
American football
Rugby
Australian Rules football

1914: *International soccer play is slowed by the start of WWI. A handful of goodwill matches between combatants are held on neutral territory.*

1920: *England, Ireland, Scotland, and Wales resign from FIFA to protest continuing membership of former enemies from WWI.*

1930: *Reeling from the Depression in Europe, many countries skip the World Cup in Uruguay.*

1946: *Japan and Germany removed from FIFA for four years after WWII.*

1958: *China withdraws from FIFA after Taiwan is admitted. Rejoins in 1980.*

1976: *South Africa expelled from FIFA over apartheid; reinstated in 1992.*

1991: *Breakups of Yugoslavia and U.S.S.R. add 14 new members to FIFA.*

1992: *For Bosnia aggression, Yugoslavia barred from European Championship Finals.*

Members grouped by continent, not FIFA convention.
SOURCES: FIFA; *FIRST WORLD ATLAS OF FOOTBALL*

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Features

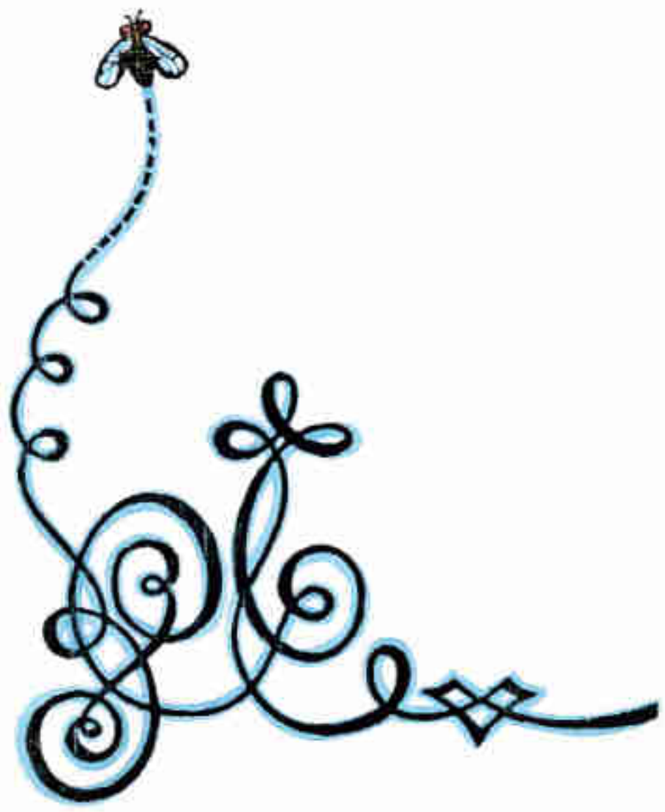
Empty eyes stare from a string of half-inch golden heads (above), one of a dozen necklaces that adorned Peru's El Brujo mummy.

PHOTO: IRA BLOCK

COVER All the world's a soccer field for a young player practicing his header in Tegucigalpa, Honduras. **PHOTO BY DAVID ALAN HARVEY**

Cover printed on recycled-content paper

Mongolia's Wild Horses



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EDITOR'S NOTE

We all have a game we can't forget. Mine is a soccer match I once saw played on the dusty field of a refugee camp in South Africa. The players were Bushman children. They raced along with lightness and grace. The frame of a missing door in a burned-out car served as one of their goals; two sticks pounded into the hard, red soil served as the other. Wadded plastic bags bound tightly with twine stood in for a ball. That day those kids played with passion, ingenuity, and joy. It was soccer,

Boys play soccer in Niamey, the capital of Niger.

the beautiful game, at its best—beautiful to see not just for the display of youthful athleticism, but also because it was one of the few times I saw those kids smile.

This month more than a billion fans will watch soccer on a much grander scale, as teams from 32 countries compete for the men's World Cup in Germany. It's a long way from that dusty field in South Africa to the manicured fields where professionals compete, but it's still the same game. "Soccer's universality is its simplicity," writes Sean Wilsey in our lead story (page 42), "the fact that the game can be played anywhere with anything."

Even on a dusty field with a wad of plastic bags for a ball.

PHOTO: DANIEL BEREHULAK, GETTY IMAGES

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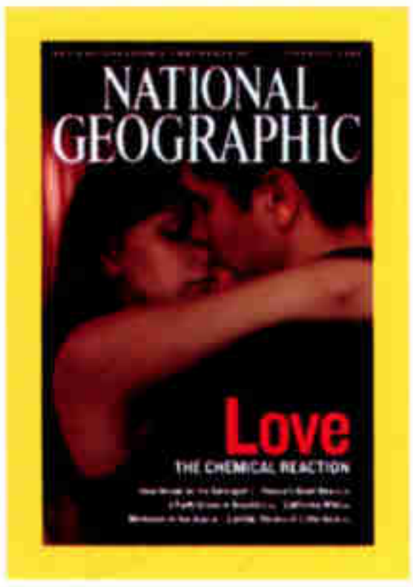
LETTERS



February 2006 *"True Love" elicited praise and consternation. While some complained the subject did not belong in the GEOGRAPHIC, others, like reader Tom Cobb, felt inspired. "May I give you my version?" he wrote. Cobb met his wife in 1948 and after almost 60 years together "cannot conceive of a day without hearing her voice or feeling the touch of her hand."*

Voice opinions about June stories at **ngm.com**.

True Love

Science has ruined everything for lovers and poets. Love is no longer a many-splendored thing, but a slosh of dopamine over a caudate nucleus. Your article enlightened me to what happened when I first saw my wife 46 years ago. It wasn't love; it was merely a squirt of dopamine.

DAVID HARVEY
Belleair, Florida

I have been a subscriber since 1949, and I have enjoyed all of your articles. However, what, in the name of Lewis and Clark, has "Love: The Chemical Reaction" to do with geography?

J. W. GILBERT
McCormick, South Carolina

The article on love was magnificent and not what I would call the usual NATIONAL GEOGRAPHIC fare. Lauren Slater's writing was emotional, sensual, humorous, and, of course, informative. As a 65-year-old man who has been married for over 40 years, I would like to say that the passion can still be very exciting. It may not be 24-7, but the feelings are still intense and the rewards even more satisfying than when we were thirtysomethings.

GREG LAPIC
Longview, Washington

A better choice for the cover would have been an elderly couple holding hands as they slowly walk home. Love is not the idle passion of dopamine-ridden youngsters. It is what holds a man and woman together through the decades of success and sorrow, loss of a child, illnesses, and moments of happiness. The love you portrayed is

only fondness, affection, or just old-fashioned lust.

BURTON SCHINDLER
Bella Vista, Arkansas

It is a difficult endeavor to update a classic, but if my response is at all consistent with that of longtime lovers of NATIONAL GEOGRAPHIC, you are succeeding! My thanks to Lauren Slater and Jodi Cobb for providing me with some of the best inspiration I've had for a February sermon in a long time! [Excerpt from the sermon, "The Stewardship of Love": If all that you and I offer God is money, then we have missed the mark and missed it badly, because what God wants from each of us much more than money is heart and soul and mind and strength and neighborliness before selfishness. Chemically speaking, this means we must be even more careful with our dopamine than we are with our dollars. We must be even more sensible with our serotonin than we are with our cents. And above all, we must be overflowing with our oxytocin.]

JEFFREY S. ROGERS
Senior Pastor, First Baptist Church
Greenville, South Carolina

Selecting one's mate with love alone is the idea that has been sold to the American public by the movie industry. In traditional societies, such as those in China and India, mates are selected to achieve three objectives. One is to produce high-quality offspring, the second is to help run the family business, and the third is to guarantee the survival of the clan through extended families. Love between the individuals is a relatively trivial thing that can be worked out later.

PINGHUI V. LIU
Boca Raton, Florida

Although your story did an admirable job of chronicling the chemistry of love, readers are left with the impression that the only form of romantic love being studied—and thus

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LETTERS

the only worthy of recognition —is heterosexual love that has marriage and reproduction as its ultimate goals.

ASHLEY SHANNON
Grand Rapids, Michigan

I subscribed to NATIONAL GEOGRAPHIC because I thought the magazine would introduce my children to the wonders of the world. I also subscribed because I thought it would contain content fit for preteen children. Having my son read about some woman talking about her tattoo of a chastity belt, how to increase oxytocin through massage and making love, and finally the kissing school are not what I consider content fit for preteen children.

RORY KOLARICH
Orlando, Florida

Meltdown in the Alps

It's about time that people start to realize what is happening and what the impact will be if we cannot use the Alps for tourism anymore. The thing I missed is what tourists themselves can do to minimize the effects of their presence in the Alps. The foundation Respect the Mountains tries to create mountain awareness and educate people about the uniqueness and the importance of preserving the Alps.

ANIEKA VAN LEEUWARDEN
Respect the Mountains
Amsterdam, Netherlands

California's Wild Crusade

Many have joined to support permanent protection of public lands along California's north coast. The Northern California Coastal Wild Heritage Wilderness Act would add 310,000 acres to our national wilderness system. California has been a leader in preserving our natural wonders. After all, the figure of my great-grandfather John Muir looking over Yosemite Valley graces our state quarter. Granddad would be pleased that his legacy of conserving California's wild heritage continues!

BILL HANNA
Napa, California

ZipUSA: Little Haiti, Florida

I was moved by your article. It presented a three-dimensional picture of Miami. It not only enlightened me, but also opened my heart to the plight the people face every day. It is a tribute to this community as its members strive to live life to the highest potential.

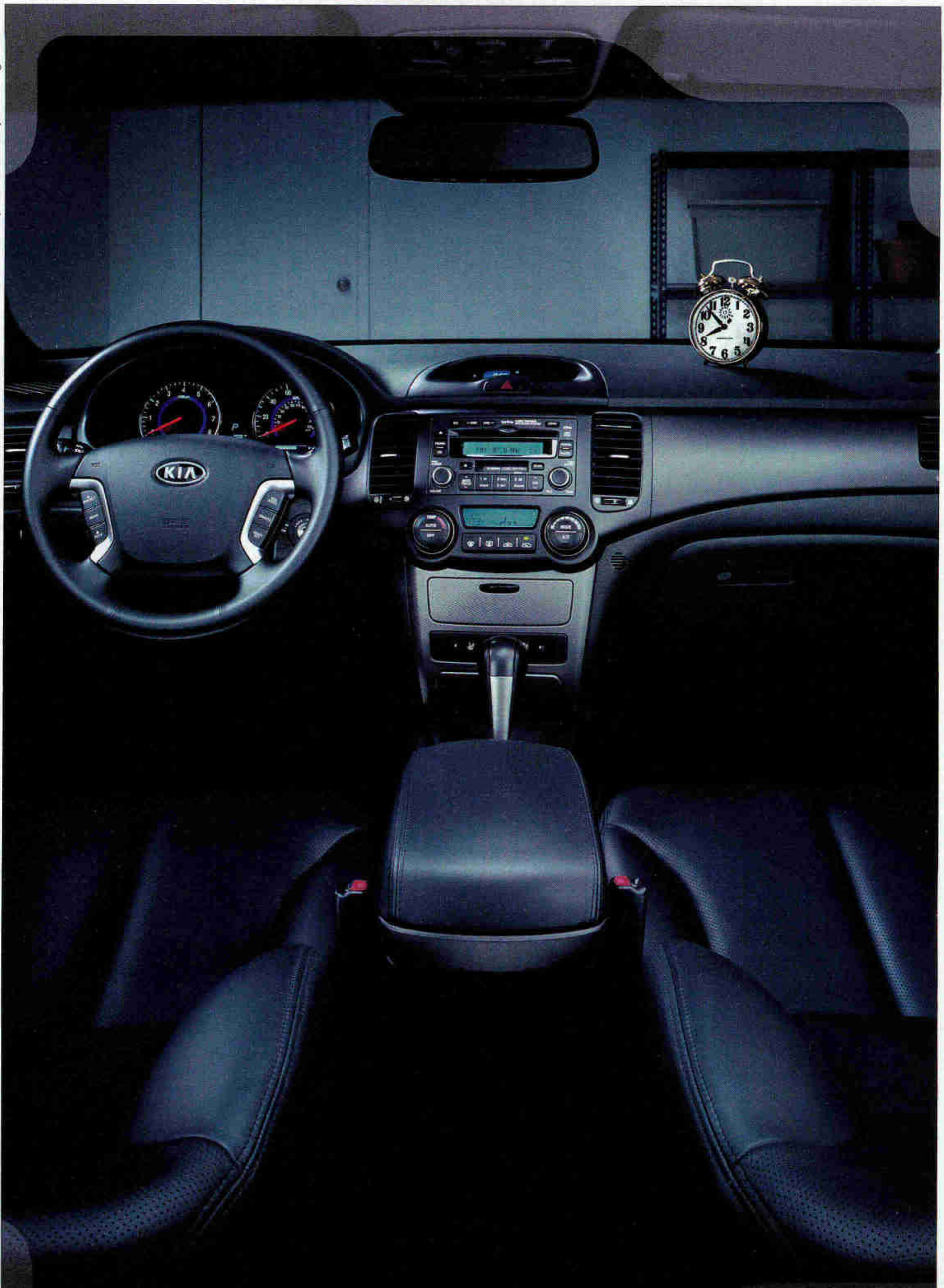
IVAN RODRIGUEZ
Miami, Florida

Behind the Scenes

How do you thank someone for saving your son's life? We never got the chance to thank Fakher Haider for helping keep Matt safe. Though we worried about Matt when he was in Iraq, our anxiety was tempered knowing Fakher was "watching his back." We have been truly shaken by the murder of this good and decent man. We are pleased that a fund has been established in his memory. Generosity of caring people will help ease his family's current troubles and provide them with a better future.

NORMA AND HUGH MOYER
Parents of photographer Matt Moyer
North Bay, New York

At press time, National Geographic members had contributed more than $26,000 to the Fakher Haider fund set up by the New York Times.



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LETTERS

A Faith Grows in Brooklyn

The worldwide Lubavitch movement functions as a community, giving each individual the opportunity to be in contact with large numbers of people. Those outside our movement often wonder how a woman can have a large family, a house open to guests, give classes in Jewish studies, be available to mentor a person in need, and all the while keep herself upbeat and attractive. Within Lubavitch we regard such a woman with respect, but not with wonder. The article had many pictures of women, and not one of them represents the spirit of the Lubavitch women I know.

ALIZA KARP
Crown Heights, New York

As delighted as I was to see your magazine investigate this complex group, I was disappointed that your article portrayed Chabad as a one-dimensional group composed entirely of Orthodox Jews. Although Lubavitcher *shluchim* are Orthodox, those who participate in their educational programs around the world range from the barely observant to the ultra-Orthodox.

J. DRUSILLA CARTER
Columbia, South Carolina

Heartbreak on the Serengeti

Forty-one years ago I was a Peace Corps volunteer stationed with the Tanzanian Department of Water Development and Irrigation in Mwanza. Our problem with poachers was the same then as it is now. They would sneak into the park and set up wire snares, which disrupted the migration path of the wildebeests. I was sent to the park's western edge to find locations for charcos (small dams). The theory was that poachers would be less likely to go into the park if they had a reliable water supply outside the park. I have wondered if any of the charcos were built and if they had any effect. It sounds like even more people have been drawn to the area, and the problem is worse than ever.

ROBERT FERRIS
Newington, Connecticut

Russia's Giant Bears

I can hardly imagine a more tragic juxtaposition of horror

and beauty than the successive photos on pages 62-3 and 65 of your February issue: the first, of three freshly skinned skulls staring blankly from their bloody butchering ground and the next of a contented, full-clawed bear chomping hungrily on a salmon. One can barely comprehend how anyone could derive pleasure from, much less pay handsomely for the privilege of, turning such a magnificent creature into such a lifeless pulp.

EDMUND TIRYAKIAN
Hong Kong, China

Geographica: Go Boldly, Voyager

I did hardware design work for the cosmic ray telescope on Voyager. It is nice to hear that something I did long ago is still going.

MYRON L. WEBER
Beecher, Illinois

As a boy, I was fascinated by the probes I thought were the first to leave the solar system, Pioneer 10 and Pioneer 11. Pioneer 10 was crossing the most outer point in 1983. Wouldn't it be the lucky one to be first out of the solar system?

NILS OTTO
Wilhelmshaven, Germany

In 1983, when Pioneer passed the orbit of Pluto, it was described by some as having left the solar system. However, the solar system stretches far beyond Pluto. Voyager will be the first spacecraft to go beyond the outermost limits. Pioneer 10, launched in 1972, is now 8.4 billion miles from the sun, while Voyager, launched in 1977 but traveling faster, is now 9.1 billion miles away. Contact with Pioneer 10 ended in February 2003 when its power became too low to transmit a signal.

Who Knew?

As my daughter, a high school sophomore, ate a snack, I started to read to her: "Solid, liquid, gas, and . . . what?" She blurted out, "plasma!" which is the right answer, but not what the author expected. The next line reads: "This should be as easy as naming John, Paul, George, and Ringo." My daughter's response: "Who?" The times they are a-changin'.

ELLEN RISSMAN-WONG
Yorba Linda, California

Where You Live Editors selected these two images on the theme of "Where I Live" from photographs submitted by readers to the Your Shot website. NATIONAL GEOGRAPHIC is now accepting submissions for the September 2006 issue on the theme of "Pets." For guidelines, a submission form, and more information, go to *ngm.com/yourshot.*

Faye Murman Philadelphia, Pennsylvania

Close to Home Faye Murman was thrift-store shopping in downtown Philadelphia when she looked up—and grabbed her camera. The Temple University photojournalism major captured this image of translucent flags (above), themselves capturing the silhouettes of tree branches along an alleyway near Fifth and Bainbridge Streets. No such urban artwork flutters over the country road leading to Marika Garland's family home in Mount Vernon, Washington. Oreo the cat (right), Garland's frequent model, is decoration enough.

Marika Garland Mount Vernon, Washington

Galapagos Hawk *(Buteo galapagoensis)*
Size: Length, 50 - 55 cm; wingspan, 100 -120 cm **Weight:** 769 -1,661 g **Habitat:** Found in all habitats within its range: from shoreline to bare lava fields, scrub country, deciduous forests and mountain peaks
Surviving number: Estimated at 800 -1000 adults

Photographed by Tui de Roy

WILDLIFE AS CANON SEES IT

All for one and one for all. In an arrangement that is rare in the bird world, many Galapagos hawks are polyandrous: several males mate with the same female, then work together to defend the nest and provide food during the nesting period, which takes place once a year. Despite these cooperative strategies, the hawk itself is becoming increasingly rare—it is now extinct on three of the Galapagos Islands where it was once a common sight. One cause is competition for food with feral cats and other introduced predators. Another reason for its steep population decline has been humans, who perceive the powerful raptor as a threat to their poultry and livestock.

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The endangered Key Largo cotton mouse is now found only on the northern third of that Florida island.

Nebraska-based photographer Joel Sartore has shot 22 feature stories for NATIONAL GEOGRAPHIC.

Saving the World The Key Largo cotton mouse is in trouble. It's found in just one hardwood forest in Florida, and it needs all the publicity it can get. But it's not alone. Thousands of animals are making their last stands around the world. Though most will never get the chance, each has an amazing story to tell.

That's where I come in. These pictures should make us stop and think about what we're doing, not just to a single endangered species, but to our planet as a whole.

For those who say, "What good is it?" I offer this: A cotton mouse is truly the least among us, but shouldn't we show consideration to all creatures? Or do we alter our behavior only when it's convenient, or when money isn't a factor? We live in an age when we're drilling for oil in the last, best places—when citizens allow laws to be passed that actually lower the quality of water and air. We vote based on prices at the gas pump.

Against this background, I know that a little mouse isn't a very big priority. It's a battle to get anyone to pay much attention. But since the fate of humanity is tied to the rest of Earth's species, I have to try. Every day, I teach my children to care about the natural world, because it is humankind's gift to imagine the future and to implement change. This can be our salvation, and it gives me hope.

View more of Joel Sartore's wildlife photos at **ngm.com/0508/feature3**.

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PHOTO JOURNAL | JOEL SARTORE

Northern California's vernal pools—habitat of the vernal tadpole shrimp—are vanishing. These shrimp (above) were shot in the San Luis National Wildlife Refuge near Los Banos, California. Nebraska's Salt Creek tiger beetle (below) was added to the endangered species list in 2005. Only 153 adult tiger beetles were counted in a census last year.

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**As shown: 2006 Lincoln Zephyr with optional equipment, MSRP $30,555. Prices exclude tax, title and license fees.

Distemper ravaged the last known wild population of black-footed ferrets in the 1980s. Survivors were moved to Wyoming's Sybille Canyon captive-breeding facility, where this one (above) was photographed. A California condor (below) is proof that such programs work. Brought back from the brink, the birds are now found again in the wild.

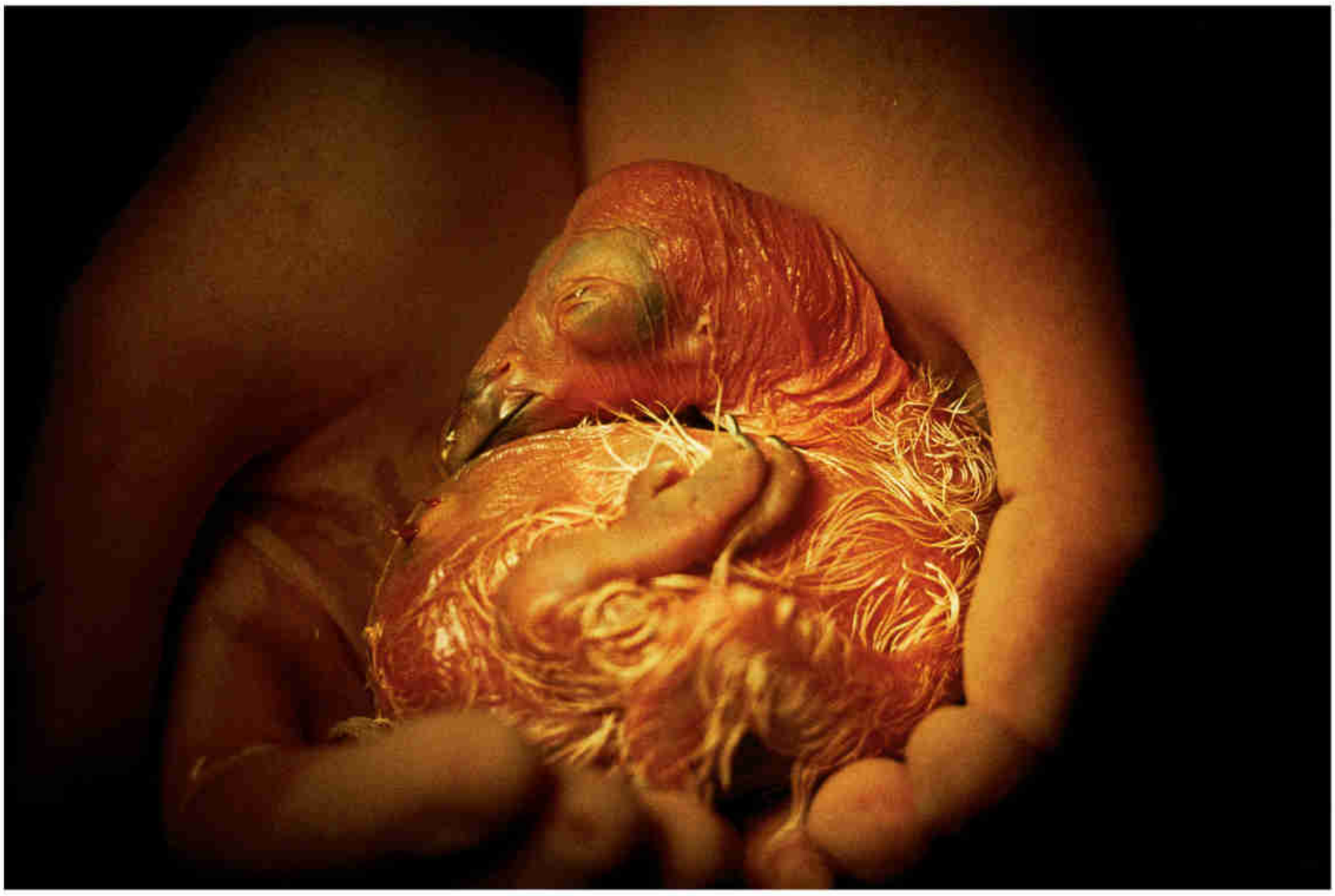

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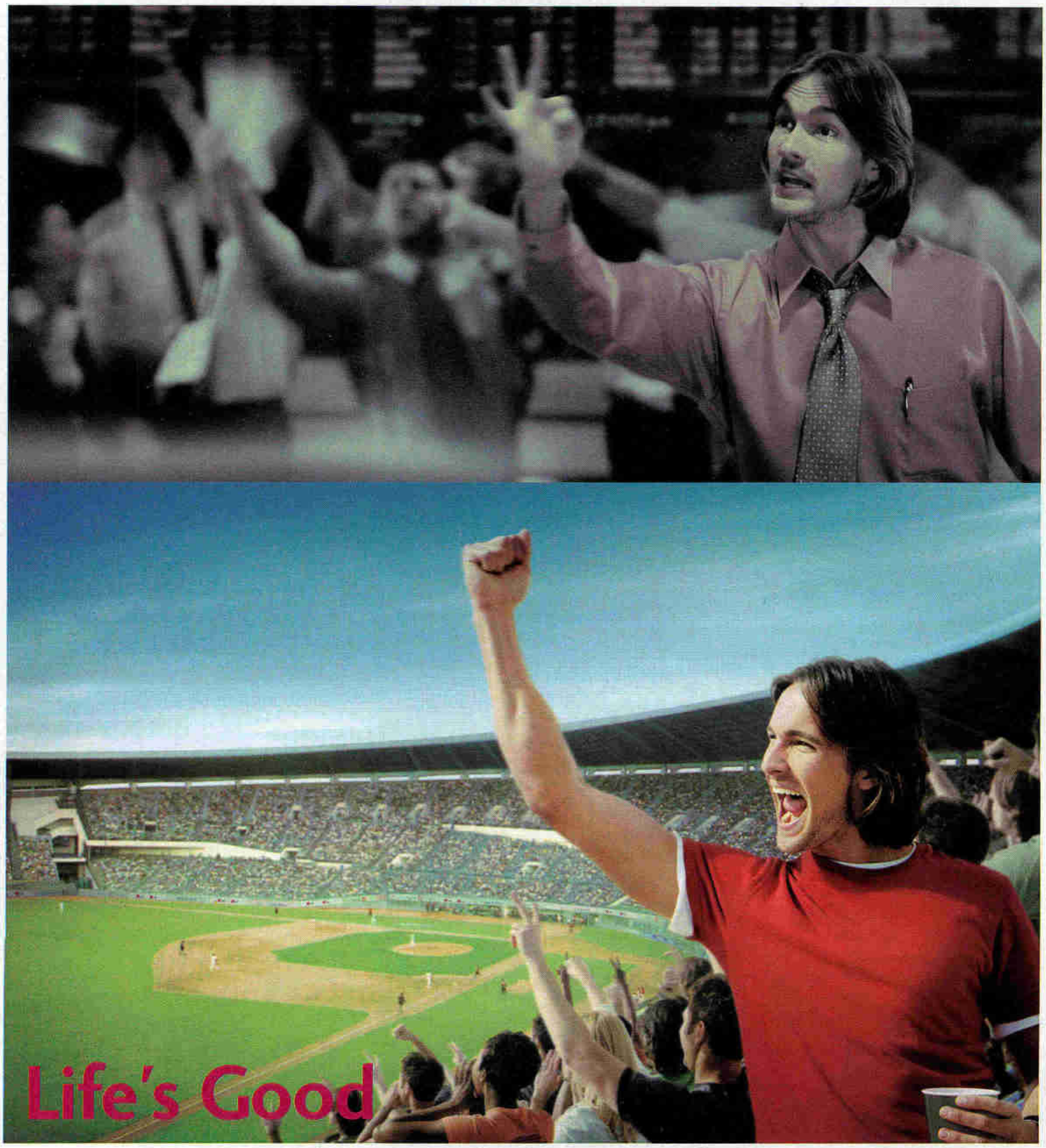
PHOTO JOURNAL | JOEL SARTORE

Plants can be threatened species, too. The rare Ash Meadows milk vetch (above) grows only on certain mineral-encrusted soils in Nevada. This close-up of a leaf of Hawaii's endangered mahoe (below) was photographed at a botanical garden in California.



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VISIONS OF EARTH

San Mateo County, California Artist Jim Denevan stands in his sand swirl. The design, which he spent hours creating with thousands of sweeps of a rake, will be erased by the incoming tide.

PHOTO: BRENT STIRTON, GETTY IMAGES

Havana, Cuba Children climb, swing, and hang upside down at a city park. Photographer Alex Webb often wanders by the park when he's in Havana. "There's an intense energy to the children's play," he says.

PHOTO: ALEX WEBB, MAGNUM PHOTOS

Pusztaszer, Hungary Two herons fight over a fish snatched from a hole in the ice-covered lake below. Neither bird won. During the quarrel the fish fell to the ice, and another hungry heron snagged the catch.

Decorate your desktop with this and other images in Fun Stuff at **ngm.com/0606.**

PHOTO: BENCE MÁTÉ

A vendor sells her wares on a Taiwan thoroughfare.

Betel Nut Menace Young women stationed along Taiwan's roads sell a dangerous treat that's on the rise, the seeds of the areca palm. Customers spread the seeds with slaked lime, wrap them in leaves from the betel pepper plant—which gives the concoction its nickname, betel nut—pop them in their mouths, and chew. The treats are addictive. Like a wad of tobacco, the quid gives chewers a buzz, quiets hunger, and fights fatigue. It's also messy: It stimulates the salivary glands and stains the resulting flood of spit bright red.

Traditionally offered as a sign of hospitality, betel nuts come in various regional preparations. Hill tribes in Thailand and Cambodia, for instance, add cloves and cinnamon. In parts of India, cardamom, jellied fruits, or grated coconut and sugar may be folded in. Often tobacco adds extra kick.

New studies show that heavy use of betel nuts leads to mouth cancer and contributes to heart disease, diabetes, asthma, and cirrhosis. For many years, the tobacco caught the blame. Now it's clear the areca seeds too are carcinogenic, putting at risk the several hundred million chewers across southern Asia, the South Pacific, and immigrant communities around the world. Officials in some countries are trying to curb betel nut use, but modern marketing is working against them. Flavored quids now come prepackaged in bright wrappers to attract new customers—including children. *—A. R. Williams*

Chewing the seed of the areca palm provides a burst of energy—and carcinogens.

PHOTOS: WALLY SANTANA, AP IMAGES (TOP); EDDIE SHIH, AP IMAGES

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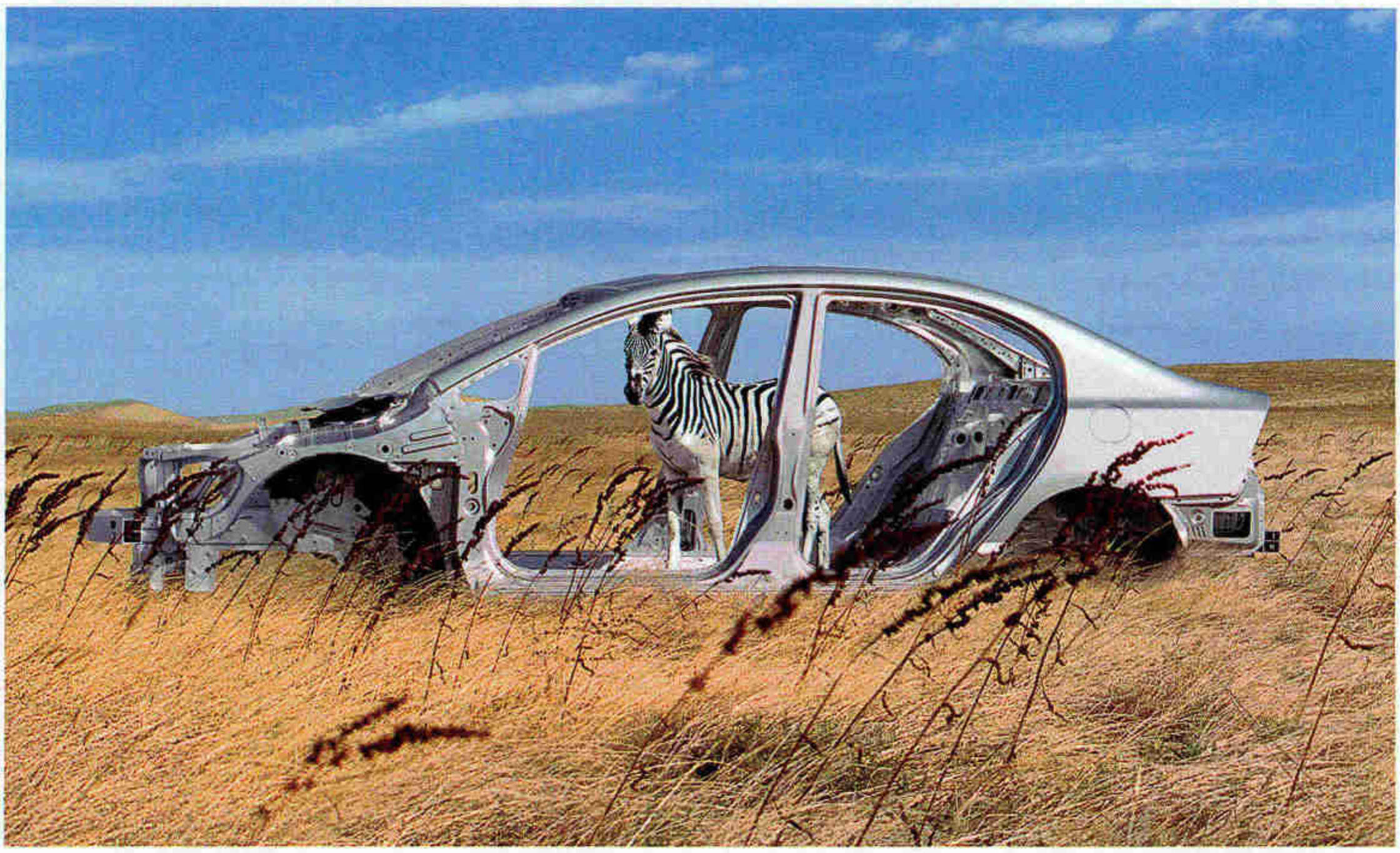

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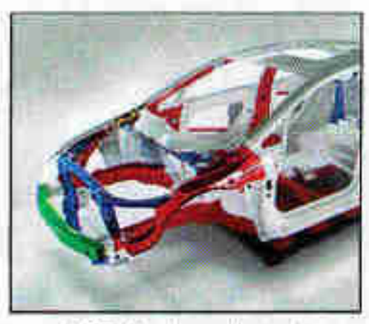

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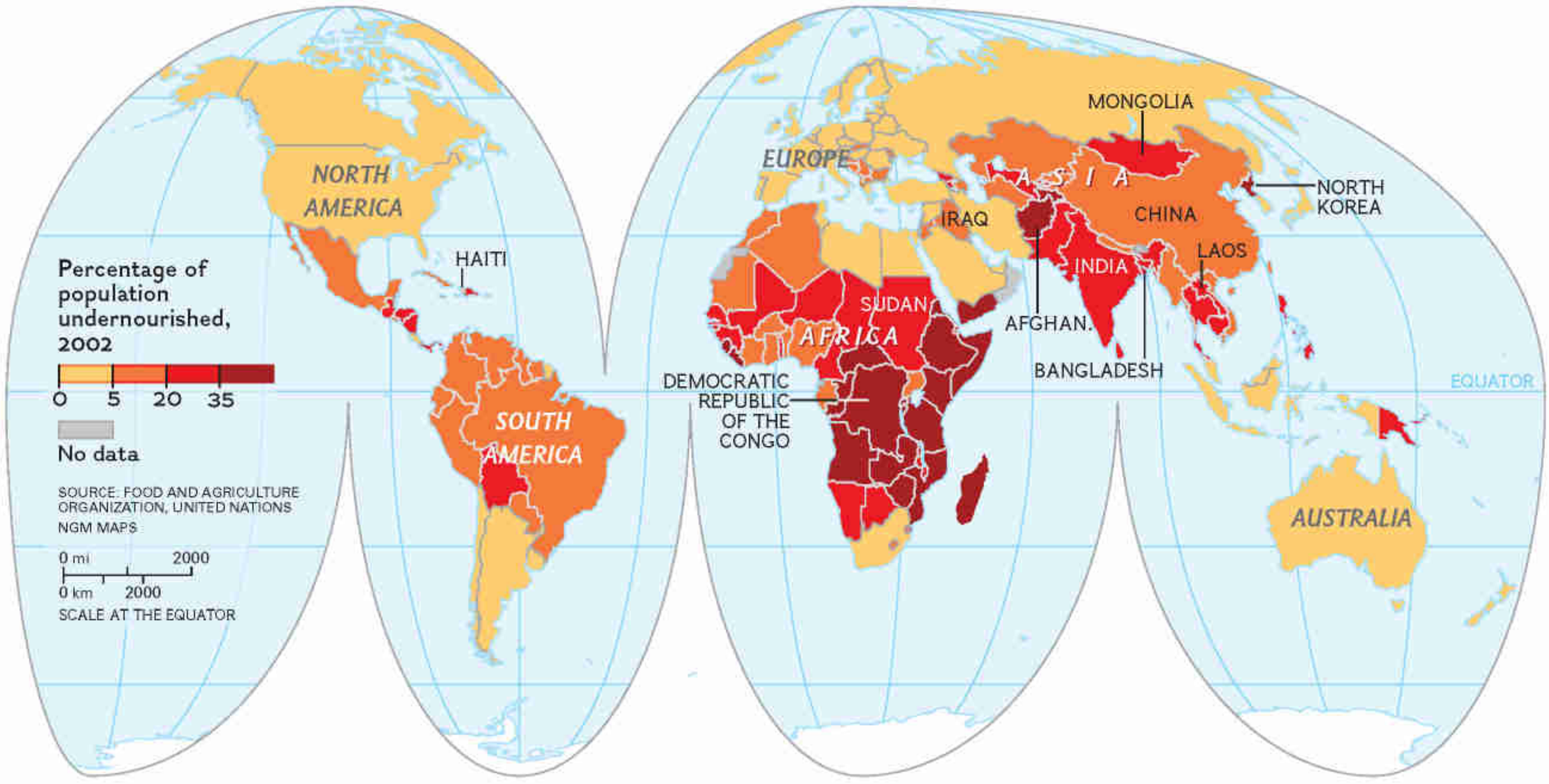


COUNTRIES WITH THE MOST UNDERNOURISHED PEOPLE

- Democratic Republic of the Congo 35.5 million
- Bangladesh 42 million
- China 142 million
- India 221 million

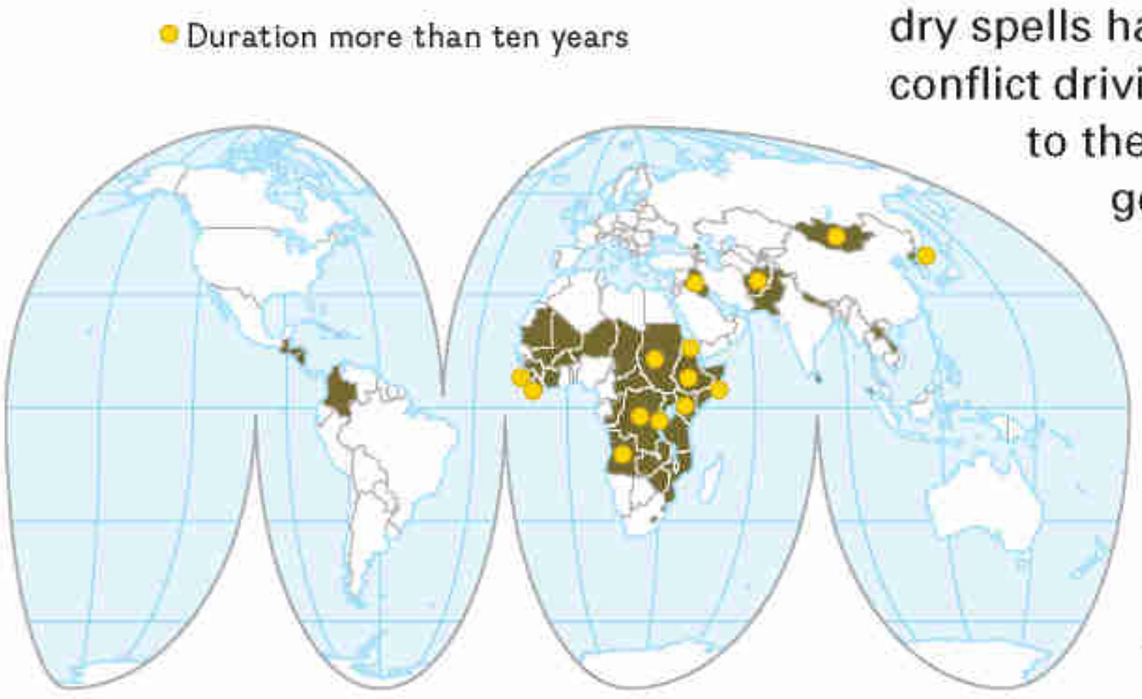
The Hungry Planet

More than 850 million people around the world—one in nearly seven—don't have enough to eat. Although current global food production is sufficient to feed everyone, the number eating less than the minimum the human body needs—an average 2,100 calories a day for adults—now grows by more than ten million a year, mostly in the poorest nations. Countries with unstable food supplies teeter on the brink of famine; natural or man-made disasters push them over the edge.

Drought causes more than half of all food shortages and damaged last year's harvests in Haiti, Mongolia, and Laos. Repeated dry spells have also hammered sub-Saharan Africa. Human conflict driving farmers from fields into refugee camps also adds to the problem. Since 1992 the percentage of food emergencies caused by warfare and civil unrest, such as in Afghanistan, Iraq, and Sudan, has more than doubled. Bad governance is another reason for hunger. North Korea's reluctance to request foreign assistance after floods in the 1990s caused widespread famine. "There are disasters in the making every year," says Jennifer Parmelee of the UN World Food Programme. "We're not winning this war. We need to find the long-term solution." *—Scott Elder*

FOOD EMERGENCIES DESIGNATED BY THE UN IN 2005

Urgent situations where events cause human suffering include natural disasters, such as tsunamis and earthquakes, or emergencies resulting from war.



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A *takhi* cuts loose in Mongolia.

Mongolian Horses Run Free Extinct in the wild since 1969, the *takhi,* an Asian equid, is galloping again across the Gobi desert and Mongolian steppe, its natural habitats. Sometimes called Przewalski's horse for the Russian explorer who brought news of it to the West in 1879, the takhi is the only remaining wild horse. Other "wild" species are actually feral and were once domesticated.

The takhi clung to existence in European and American zoos during the last century, declining to a few dozen after World War II. A breeding program on both sides of the Atlantic increased their population to roughly 1,500 by the mid-1980s. Since 1992 a coalition of zoos and takhi conservation groups has put about 200 horses back in Mongolia. "It's amazing to see how quickly they adapt. The first winter is tough, but then the horses look better, fatter," says Petra Kaczensky, a biologist with the International Takhi Group. "It's like a party when we release them (above). Everyone wants to be the one who lifts the doors." *—Michael Klesius*

Other animal species under pressure in Mongolia:

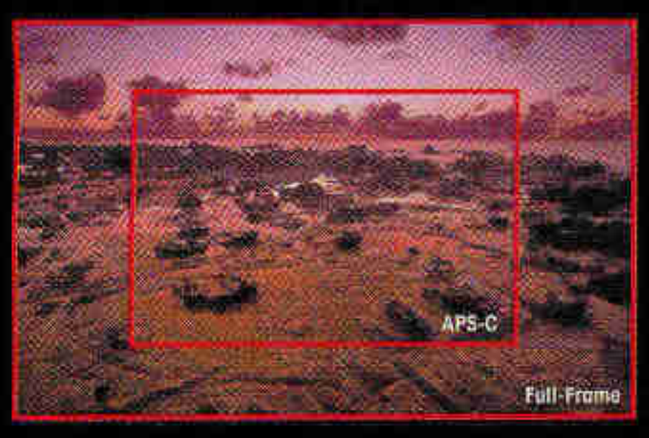
- **Wild Bactrian camel** About 1,500 survive in China and Mongolia. Known for their double humps, they're officially protected but are poached for meat.
- ***Zeren*** Perhaps two million of the Mongolian gazelles remain. The migratory herds need huge grazing areas but must compete with increased livestock.
- ***Dziggetai*** The Mongolian wild ass numbers about 20,000 but suffers a 10 percent annual decline due to poaching and human encroachment on its habitat.

PHOTOS: CHRIS WALZER, INTERNATIONAL TAKHI GROUP (TOP); PETRA KACZENSKY, INTERNATIONAL TAKHI GROUP

What was Canon thinking when they developed a digital SLR with the personality of a film camera?

"Exactly what I was thinking."

George Lepp If you're like me, you love the freedom and creative advantages that digital affords. But you don't want to give up the nuances of film. That's why I find the EOS 5D such an incredible camera. It's got a full-frame CMOS sensor–exactly the same size as a 35mm frame, so I not only get huge files with incredible detail, but the full-frame sensor lets me compose my shots without a lens conversion factor. And because it's so small and light, it's the perfect companion for those long treks into the wild. It's really no surprise that Canon is the only maker of a 35mm full-frame D-SLR. After all, they're the guys who listen.



To learn more about the full-frame CMOS sensor, visit the Canon Digital Learning Center at www.photoworkshop.com/canon

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FOSSILS

Did Dinosaurs Have Day Care? Nobody knows what buried them so quickly. Their den might have collapsed or flooded, or drifts of volcanic ash could have suffocated them. But 125 million years ago, an adult and 34 young psittacosaurs died suddenly—still huddled as they'd been in life. The recent discovery of their fossilized remains in China's Liaoning Province has opened new questions about dinosaur behavior. Was the adult psittacosaur the parent—or was it the babysitter?

"The small ones are clearly juveniles," says Montana State University's David Varricchio, one of the paleontologists who examined the find at China's Dalian Natural History Museum. Thirty-four offspring in a single brood is an unusually high number, he says, so a group of young this big may be evidence of communal parenting. Gathering multiple broods would have been a more efficient way to protect the young from predators while the adults fed. Some crocodilians and birds—the dinosaurs' closest modern relatives—engage in group care after the eggs are hatched. Psittacosaurs may have practiced this, too.

"The near-perfect preservation shows that they were buried very rapidly," Varricchio says, adding that the proximity of the adult to the babies might be the clincher. "This is likely our best evidence of 'child care' in any dinosaur." *—Angela Botzer*

Psittacosaur Facts

- **How Big** Adults reached a length ranging from 3 to 6.5 feet.
- **When They Lived** 135 to 100 million years ago
- **What They Ate** The herbivorous beaked dinosaurs preferred cycads, ginkgoes, and conifers.
- **What Ate Them** Another juvenile psittacosaur fossil was recently discovered in Liaoning, China—in the stomach of a 130-million-year-old mammal the size of a house cat, *Repenomamus robustus*.

ART: RAUL MARTÍN

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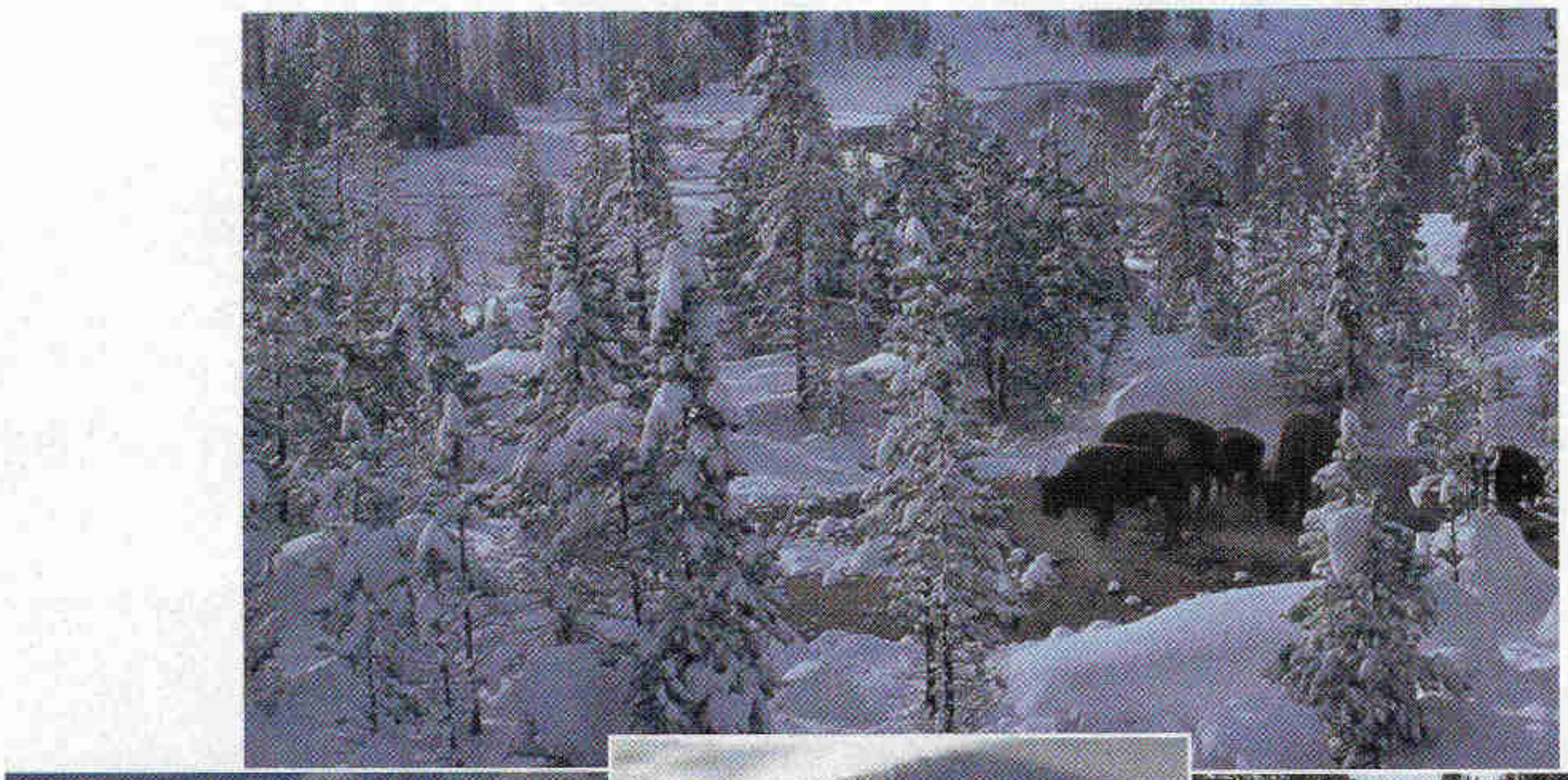

Wintertime in Yellowstone

Perhaps no other location lures America's families like Yellowstone National Park. As one of the country's most beloved destinations, the park intrigues visitors of all ages, and according to wildlife biologist Jeremy Schmidt, who has spent more than 30 years in the area, there's no better time to visit than winter. "It's almost deserted; you don't see many other people, so you feel quite special and privileged. There's a feeling of exclusivity," he says. The geyser fog, combined with the deep snow, the high mountains, and ice that forms on the trees, makes Yellowstone one of the most unique places in the world.

Wildlife abounds during the park's winter months. "The wildlife of Yellowstone move down to the valley, giving visitors an excellent chance of spotting bison, elk, deer, and coyote," says Schmidt. Lucky visitors may see a wolf while taking a drive through Lamar Valley, located in the northern section of the park. "There's nowhere like Yellowstone," adds Schmidt. "When you visit with your family, you all have the sense that together you visited one of the country's greatest inventions."

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Scientists extrapolated from the size of this 20,000-year-old footprint that the man who left it may have been about six feet tall.

An Echo From the Past An ancient stone tool can say only so much about the person who used it. A footprint, however, can tell a story. More than 450 footprints between 19,000 and 20,000 years old have been discovered in southeastern Australia. The largest cache of Pleistocene footprints ever found, the site provides a unique snapshot of life during the last ice age.

Here's the tale they tell: Along shallow waters in the Willandra Lakes system—then an oasis rich in fish and game—some men ran very fast, one at 12 miles an hour. Another lagged behind at a trot. The runners were tall, well fed, and athletic. The mud oozed between their toes as they ran. Possibly they were hunting waterbirds. Children followed along, and women, too. Someone dragged a heavy object. A kangaroo hopped through the area, and a young emu chick made an appearance, suggesting that the season was spring.

All this evidence was imprinted in calcareous clay that hardened rapidly like concrete. Silty clay and sand soon buried the tracks, now exposed by wind erosion. So far, archaeologists have identified 22 individual paths. And radar tests reveal that the clay pan extends for several hundred more yards, hidden under sand dunes. Perhaps thousands of footprints lie waiting to tell their stories. *—Siobhan Roth*

A local landowner walks among tracks left 20,000 years ago in what is now Mungo National Park in southeastern Australia.

PHOTOS: MICHAEL AMENDOLIA, DIGITAL RAILROAD

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WHERE IN THE WORLD?

An emerald load of sludge, mud, and dreams washes across the delta and into the Caspian Sea.

A River Runs Through Russia Millions of people call her *matushka,* or mother. Though slowed by dams and burdened with pollution—just 3 percent of surface water in her vast basin is safe to drink—she remains a devoted parent until the end, nourishing rich fisheries, carrying countless merchant ships, and cooling holiday crowds. After threading 2,300 miles through Russia, the river's emerald load of sludge, mud, and dreams washes across a sprawling delta and swirls into the deeper waters of the Caspian Sea, as shown in this satellite image. She is the Volga River, Europe's longest, and it's in the sea that she finally finds rest. *—Neil Shea*

PHOTO: JEFFREY E. SCHMALTZ, MODIS RAPID RESPONSE TEAM, NASA

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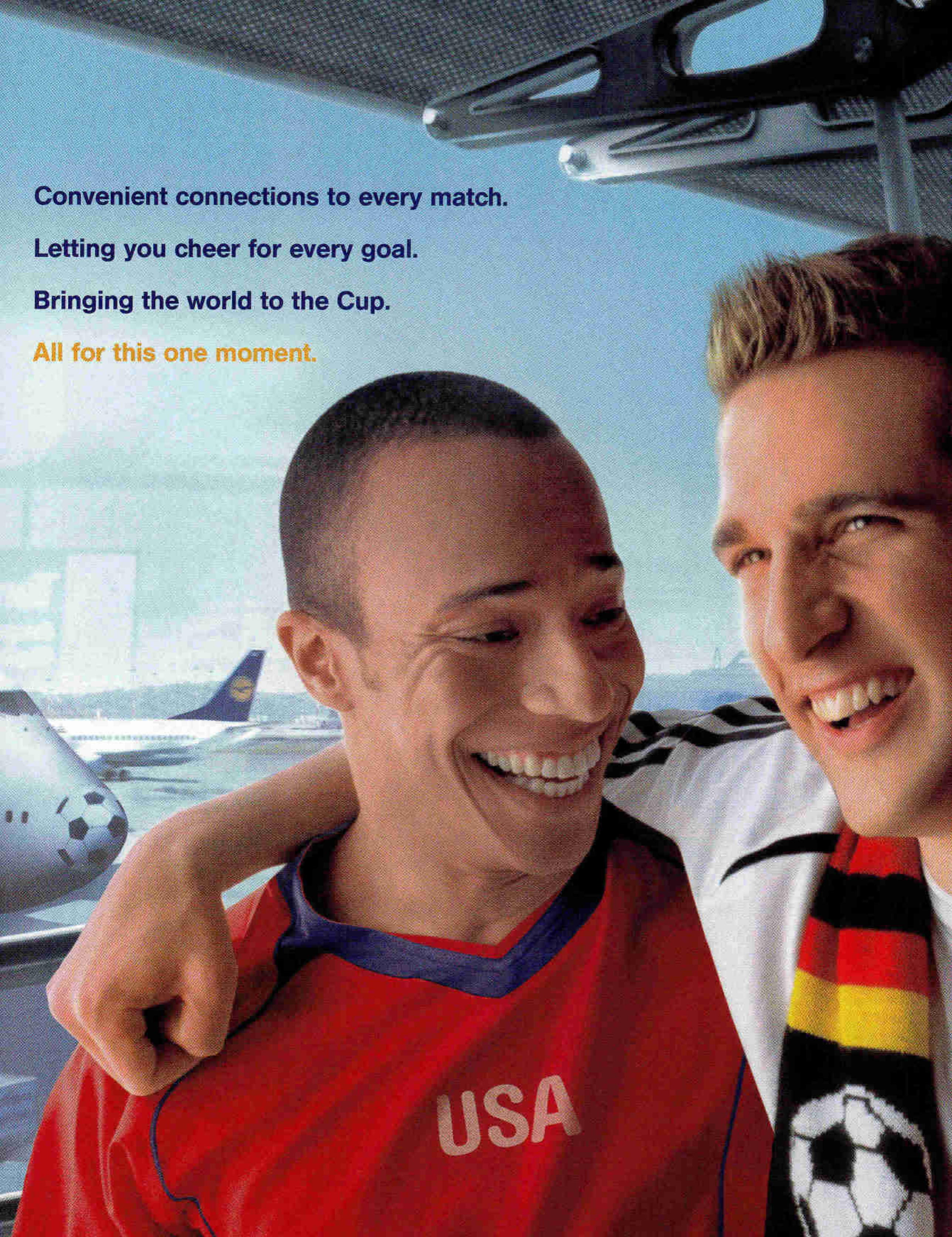

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CULTURE

A flag shines through office windows in New York City.

Allegiance to the Pledge? Last September a federal judge ruled unconstitutional the recitation of the U.S. Pledge of Allegiance in public schools, sparking debates nationwide. But the pledge had innocent origins. In 1892 the *Youth's Companion* magazine suggested students say a 22-word sentence—"I pledge allegiance to my Flag and the Republic for which it stands: one Nation indivisible, with Liberty and Justice for all"—at school on Columbus Day. Twelve million purportedly complied, and a tradition was born. The National Flag Conference added clarifying words in the 1920s, and in 1942 Congress made the pledge official. On June 14, 1954—Flag Day—President Dwight Eisenhower authorized its last and controversial addition: "under God." —*Whitney Dangerfield*

Culture Beat

Niall of the Nine Hostages, a fifth-century warlord famous for his raiding practices, appears to have sired quite a legacy. Recent genetic tests suggest that one in twelve Irish men may be his descendants. King Niall Noigiallach, who died around A.D. 450, was the ancestor claimed by several powerful Irish royal dynasties known as the Uí Néill. He is also traditionally recognized as the slave raider who captured the boy who would later become St. Patrick. Geneticists at Trinity College, Dublin, believe that as many as three million males of the world's Irish diaspora could also be related to the king.

China's Dragon Boat Festival, held on the fifth day of the fifth lunar month—usually June—commemorates the 278 B.C. death of poet and government minister Qu Yuan. The poet drowned himself in the Miluo River when he heard that a rival state had seized his own. Local fishermen launched their boats to go in search of him, while people on shore tossed rice dumplings into the water to prevent fish from eating the body—which according to legend was never recovered. Today dragon boat racing is the festival's main event, with 20 paddlers plying each 40-foot craft. Race spectators eat dumplings of glutinous rice.

PHOTO: JEFFREY AARONSON, NETWORK ASPEN

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Mighty Flighty

A fly can do one thing extremely well: fly. Recently a team of British scientists declared that the common housefly is the most talented aerodynamicist on the planet, superior to any bird, bat, or bee. A housefly can make six turns a second; hover; fly straight up, down, or backward; do somersaults; land on the ceiling; and perform various other show-off maneuvers. And it has a brain smaller than a sesame seed.

Michael Dickinson, who studies fly flight in his lab at Caltech, says the housefly isn't actually the best flier. "Hoverflies are the be-all and end-all," he says. They can hover in one spot, hurtle through the air to another location, and then race back to their original hovering point—precisely.

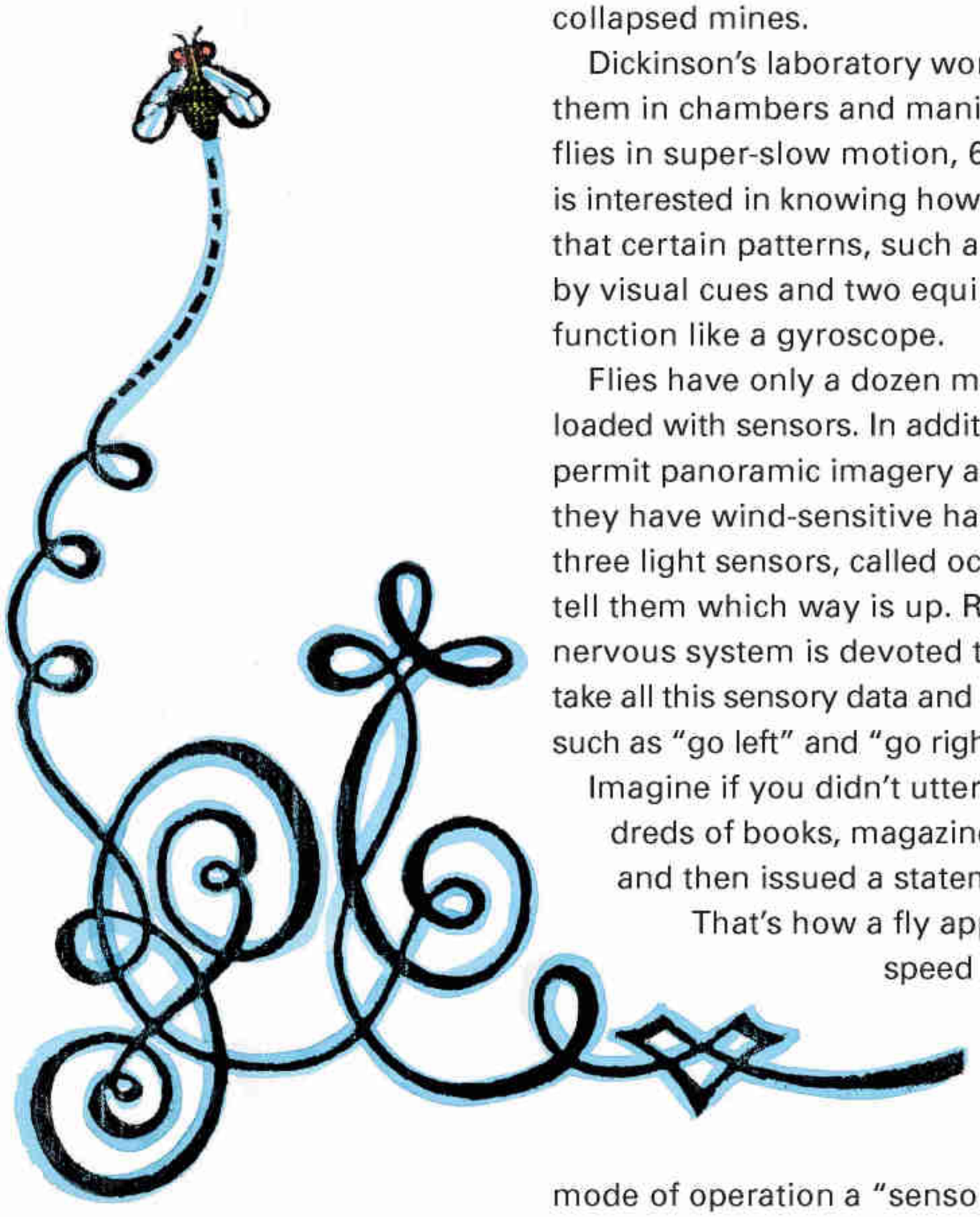
Scientists, engineers, and military researchers want to know how creatures with such small brains can do that. Maybe they could reverse-engineer a fly to make a robotic device that could reconnoiter dangerous places, such as earthquake zones or collapsed mines.

Dickinson's laboratory works with fruit flies. Researchers put them in chambers and manipulate the visual field, filming the flies in super-slow motion, 6,000 frames a second. Dickinson is interested in knowing how flies avoid collisions. He has found that certain patterns, such as 90-degree turns, are triggered by visual cues and two equilibrium organs on their backs that function like a gyroscope.

Flies have only a dozen muscles for maneuvering, but they're loaded with sensors. In addition to their compound eyes, which permit panoramic imagery and are excellent at detecting motion, they have wind-sensitive hairs and antennae. They also have three light sensors, called ocelli, on the tops of their heads, which tell them which way is up. Roughly two-thirds of a fly's entire nervous system is devoted to processing visual images. They take all this sensory data and boil it down to a few basic commands, such as "go left" and "go right."

Imagine if you didn't utter an opinion until you had read hundreds of books, magazines, newspaper articles, and blogs, and then issued a statement based on a few basic notions. That's how a fly approaches flying. Only the fly is a speed reader. The information processing takes a fraction of a second. Researcher Rafal Zbikowski of Cranfield University in Shrivenham, England, calls this mode of operation a "sensor-rich feedback control paradigm."

Given that flies have evolved for hundreds of millions of years (and that they were the first animals to take to the air), we shouldn't be surprised that they're such good fliers. "They just don't have brains like ours. Studying flies," says Dickinson, "is like traveling to another planet."



Joel Achenbach is a staff writer for the *Washington Post*.

ART: SAM HUNDLEY

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VOICES

Peter Hessler is a keen observer of street life in China, as here in central Beijing's historic Qianmen district, due to be renovated for the 2008 Olympic Games.

Peter Hessler in China

INTERVIEW BY TODD CARREL

In the past decade Peter Hessler emerged as one of the preeminent Western writers living in China. Originally from Missouri, he started out in China as a Peace Corps volunteer at Fuling Teachers College. The experience led to lasting friendships and the publication of his first book, River Town: Two Years on the Yangtze *(HarperCollins, 2001). Hessler's deep immersion in the culture is evident in his new book,* Oracle Bones: A Journey Between China's Past and Present, *published last month, also by HarperCollins. In 1992, Todd Carrel, then the ABC News bureau chief in China, was severely beaten by police while covering a protest in Tiananmen Square, an attack that left him permanently disabled. He now teaches Digital TV and the World, a journalism course at the University of California, Berkeley. On a recent trip to Beijing, he and Hessler talked about what it means for millions of young people to uproot themselves from their rural villages in the hope of fulfilling their dreams in China's booming cities.*

CARREL: In the early '90s, I remember doing stories about migrants going to coastal cities like Shenzhen and Guangzhou in the south. People were being sent back to their home villages because there weren't enough jobs to go round. There was chaos and confusion. Since then, more people have been leaving the countryside. What's impelling them to move to these places?

HESSLER: I think it's both the lack of opportunity in the countryside and abundance of opportunity along these coastal areas. Willy is one of my former students, and I went home with him one year for the spring festival in his village. Everybody of his generation is gone. You see these people coming back—they're all dressed nicely, very differently from their parents. They're obviously picking up new ideas. He would often write me about how sad he would feel whenever he went back, because he realized that the village was never going to be what it was when he was growing up.

CARREL: And what does this mean for the old people? What's going on in their minds? What are they talking about?

HESSLER: I think some of them feel they've been left behind, and some of them depend quite heavily on these younger people to send money back. Often there can be a lot of pressure within a village—sometimes prestige is gained through how many kids

PHOTO: MARK LEONG, REDUX

There's a huge amount of opportunity here. And I think more and more people—the educated people—tend to realize this.

you have who are out working and how much money they're sending. This is the kind of thing that people in the village talk about. But on the whole, they're not looking ahead. I think often they feel quite isolated and quite left out.

CARREL: So in a sense they're richer—their sons or daughters are sending back money—and yet they're worse off in terms of social fabric?

HESSLER: Yes. And they're removed from where everything is happening in China, and the gaps are really tremendous. When I went with Willy to his village, I went out with his father one day, and we walked down by the river, and there was a guy fishing in the river with an otter—a trained otter with a chain around its neck. This is the kind of thing you would still see in that village. I followed Willy to his home in the boomtown, where everything is quite modern. Like going to a different country.

CARREL: And how did Willy reckon with this change? With making a decision not to go back to the rural village?

HESSLER: He struggles with the idea of whether he'll return to that area. He won't return to the village—he knows that's impossible. It depresses him because things just haven't changed. His brothers have stayed there, and their children are going to local schools, and he worries that the quality of their education is much lower than in the city.

CARREL: I'm wondering about the triumphs, the agony, or the problems these people face. They pluck themselves out of the countryside, go so far to a new city, then try to establish themselves. And figure out a future. What are they really going through?

HESSLER: My former student Emily was a young woman—I believe 21—when she went to Shenzhen. Everything she went through—first of all, just trying to find a job. You go to talent markets, as they're called, where people are looking for folks to hire. Then she did find a job. She was in a factory that was basically set up illegally, in that they had the workers working on the bottom two floors and were storing the materials in the same building. And the dormitories were on the top two floors in a six-floor building, which was not safe because a lot of what they were working with were flammable materials and chemicals—and technically it was illegal. She had a huge number of issues to deal with. She was trying to find a way to earn a living, to save some money, and then she had the other things that any young person wants to deal with: Finding a boyfriend, thinking about the future. Sometimes there's not all that much energy to put into things we would consider to be very basic. That's changing as far as the emphasis on safety goes—I think worker consciousness has changed a lot.

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I was talking with a guy who was setting up a factory in a small town. He said a lot of people now really care about the environment and the safety of the job.

CARREL: So workers are coming up with demands? Or they're leaving substandard factories to find better positions at better places?

HESSLER: You hear this a lot. A lot of bosses in the early factory towns like Shenzhen now say, "At first, all we had to do was put a notice on the factory gate for workers, and they would pour in, and we could take our pick." That's no longer the case because now there are so many factories and jobs. Many workers now go to the second-tier factory towns because the economy is moving inland into new cities, new towns—the factory districts. And along the way, they've learned to become more discerning. I was just talking with a guy who was setting up a factory in a small town in Zhejiang Province, and he identified that as the biggest change he's seen. He said a lot of people now really care about the environment, and the safety of the job, and they've heard if something's bad for them or if something's dangerous, and they'll try to avoid it.

CARREL: What about China's resources? Just several decades ago, it was very much a culture of scarcity. The country was quite poor in many respects. And now all of a sudden it seems that for a lot of people—the urban people—it's the age of wastefulness and profligacy and using resources quickly. It also bears on the environment. Rivers are filling up with effluent from factories or seem to be running dry. People are scavenging in these places to their own detriment. Things seem to get dirtier and dirtier. The air is brown. Is the environment slipping away because of the pressure of so many people and development?

HESSLER: I'd say that they're at the stage where people are starting to recognize that this is a problem. I was in one of these new cities, where people have been moved to make way for a dam, and I met one family and was watching them move into their new home. These people were solidly middle class or upper middle class, and they'd decorated their home. In the entrance room, they had all these red lights in the ceiling because they said that it gave you a warm feeling, and they had electric blue lights on the main ceiling because it was like the sky. They had a chandelier that had 32 lights in it. So we had dinner, and the men were complaining about the dam and the relocation and nobody getting the settlement they were promised, and meanwhile there were 65 lightbulbs in this room. And every single one of them was on.

So there's a long way to go. People have not been consuming for very long. I sympathize with how this feels to a Chinese person, especially when foreigners tell them, "Hey, you gotta be careful. You need to slow down." These people didn't have much for generations. I can understand that desire to improve your life, to live a more comfortable life. But as to where it goes, it's just simple math—the resources aren't there. And so eventually

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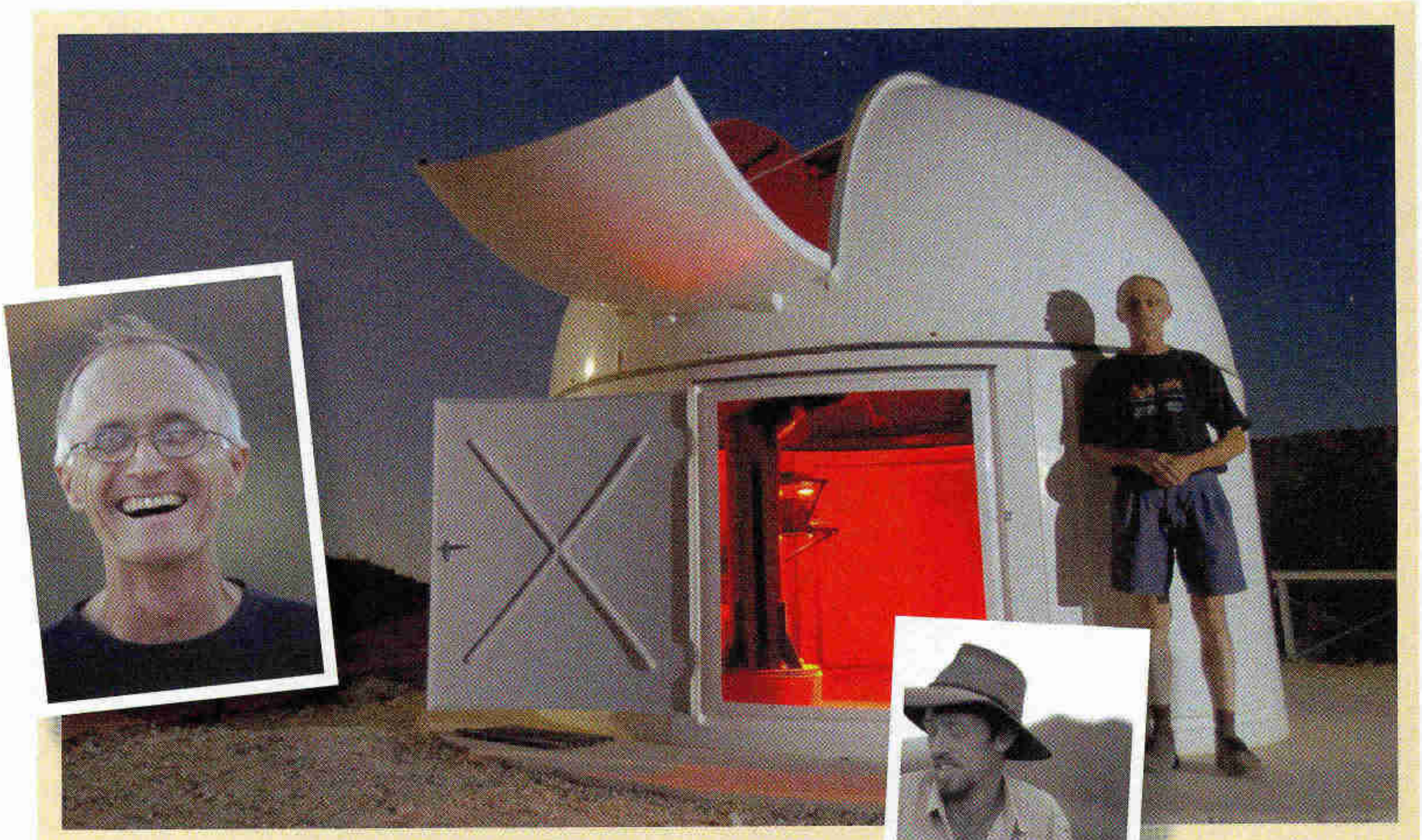
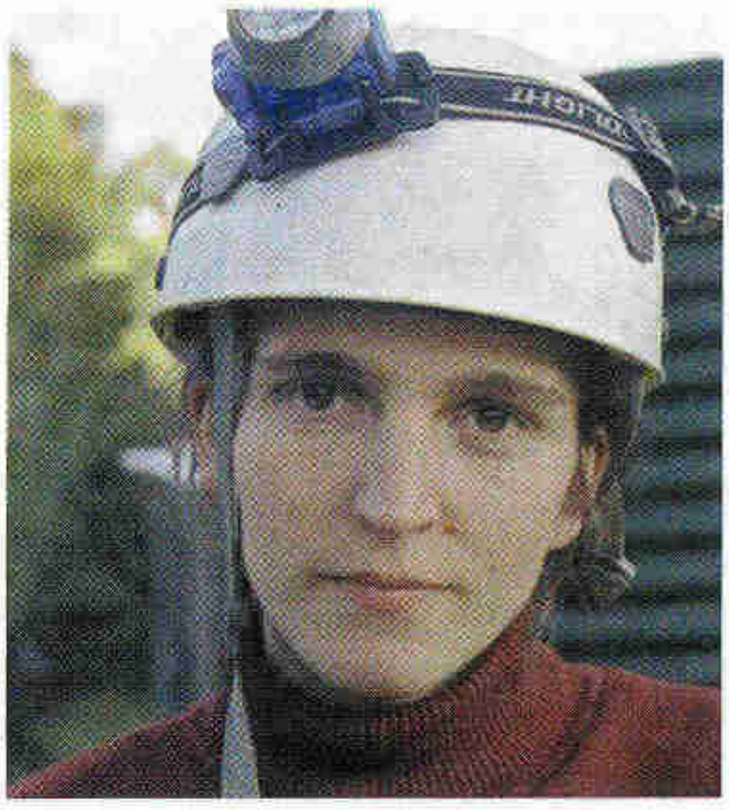


Doug Sprigg & Ryan McMillan
"Astronomers"

Arkaroola, South Australia

"I'm actually a diesel mechanic and commercial pilot by trade," says Doug, whose observatory at Arkaroola is among the best. "Statistically, we have the clearest night sky in the Southern Hemisphere." Not many people realise this. Another thing most people don't know about Doug is that he's also a geological expert – despite never having been to university in his life. "Dad studied under the Antarctic explorer Sir Douglas Mawson. As a kid, I spent a lot of time mucking about with rocks – and it went on from there."

Another character you should meet at Arkaroola is Ryan (right). "I originally came to work one Easter and loved the place so much, I decided to stay. That was five years ago." Now the two of them have NASA scientists queuing up here to conduct studies. "They come here to study bacteria that can live in radioactive granites," says Doug, "something we have in the north of Arkaroola. NASA thinks these sorts of extremes existed on Mars." You don't need a PhD to have a chat with Doug and Ryan though, you can find them in Arkaroola's restaurant. Pull up a chair and they'll tell you anything you want to know about the sky above. Better than that, they'll show you, at the observatory a short drive away.



Jason Gardner & Alice Liddell

"Mycologists"

Southport, Tasmania

Say hello to Alice Liddell, an expert on mycology – the study of mushrooms. Along with partner Jason Gardner, Alice is conducting arguably the most important survey of fungi in the Southern Hemisphere. But you won't find them in any academic journals; instead you'll have to go to Hastings Caves State Reserve, where they work as guides. The self-taught couple recently uncovered the most significant finding of Tasmania's only underground plant (thismia). "There were rumors the plant was growing here," says Jason, "but no-one had seen it. I was taking a shot of some mushrooms and I thought I'd come across a new orchid. That would have been big news – but no-one bothers about fungi. People don't realise that they're probably the most important organisms on the planet. Without them, trees can't extract nutrients, so they'd die. If they go, it's bad news for us." If you drop by, Alice and Jason will happily show you round the amazing Tasmanian forest.

David Elliot

"Paleontologist"

Winton, Queensland

"Granddad was a sheep cocky, dad was a sheep cocky and I'm a sheep cocky," says David Elliot. "I belong here. This country is a unique piece of ground – and I know just about every rock on it. When I first came here, I found a piece of dinosaur bone a few inches long; it was ten years later before I found another one. We had this little 50HP tractor, but we dug and we dug – and eventually we found the remains of this HUGE dinosaur. We haven't even scratched the surface of what's here," he says of what is one of Australia's most significant finds of dinosaur fossils. "I'm passionate about watching these things come to life, so people can come see them. I'll always be a sheep cocky, but the dinosaurs are the most exciting part of my life."

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These people didn't have much for generations. I can understand that desire to improve your life. But as to where it goes, it's just simple math —the resources aren't there.

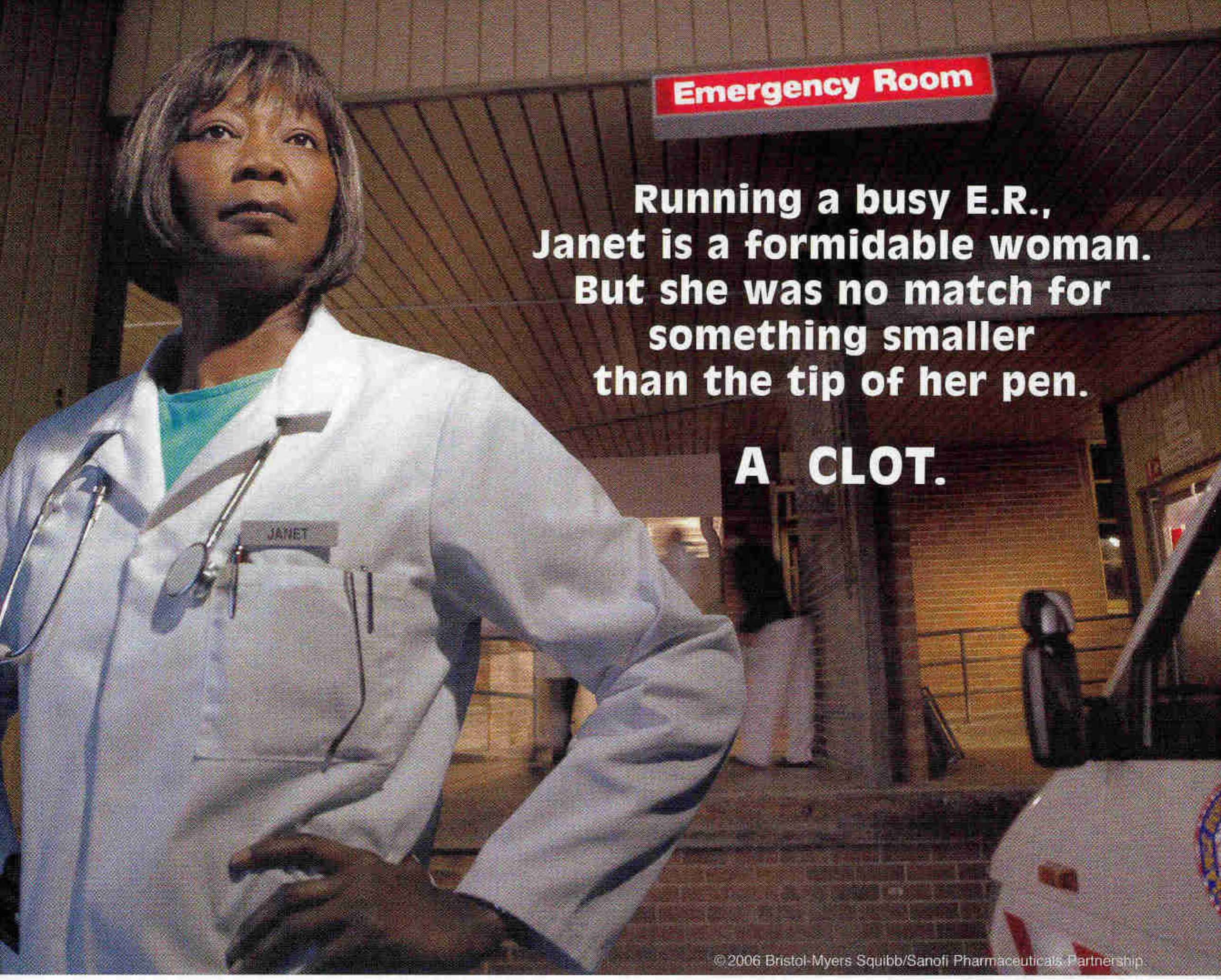
people are going to have to realize they will have to change some of the ways they live. America doesn't provide a very good model for this—people driving big cars and living quite wastefully. And you wonder about these two big countries that have this pattern of consuming. What does that mean for the rest of the world?

CARREL: Perhaps we may be looking, in a sense, at an age of attainment where much more is possible. In my time in China in the '80s and the '90s, a lot of people imagined the best thing they could do was go overseas. Often they were thinking of leaving the country and not coming back because they felt too terribly oppressed. Yet what appears to have been happening in recent years is that the reason for going overseas is to gather more knowledge, to improve yourself, and then to come back and get more status, a better job.

HESSLER: There's a province in the south called Fujian, which has typically contributed a lot of immigrants to the U.S. and Europe. I met one guy who was a cabby, and he told me, "I was about to go—it was going to cost $50,000. I was borrowing the money from relatives, and then at the last minute I decided, No, because I didn't want to leave my wife and child. I wasn't sure about working basically as an indentured servant." And so he bought a car here, and now he's doing great, and I'm sure he's better off than if he had been in the States. In the States people might be able to make a higher dollar figure, but they certainly won't have a better life if they're going there illegally. So there's a huge amount of opportunity here. And I think more and more people—the educated people—tend to realize this. A large number of people are coming back. They also aren't being punished for it. People would go overseas, and then they'd come back, and they'd have to work in a traditional work unit arrangement, and some of the supervisors who had never had an opportunity to go overseas would resent that and treat them badly. That's not the situation anymore. A lot of these people are in private industry, and a private company can't afford to operate like that. If they have talent, they want to let the talent show and use it in the best way possible.

CARREL: So this is maybe an end to the wasting of so much talent. Is that what you're suggesting?

HESSLER: It is something that you realize. One of the things that I value was speaking with people in their 80s and 90s. It's too easy to forget where they came from and what they went through. Really a very inspiring group, because the Chinese do respect age. There is a dignity here that I don't always sense in the States, where old people tend to be discarded more. These generations in China went through so much, and there is a type of wisdom. They often aren't comfortable with what happened to them, and they often haven't addressed it directly,



Clots are the number one cause of heart attack and stroke, but you can help reduce your risk.

This is important information if you've been hospitalized with heart-related chest pain or a certain type of heart attack.

That's because these conditions, known as Acute Coronary Syndrome–or ACS –are usually caused when blood platelets stick together and form clots that block blood flow to your heart. And if you've already had a clot, you're at an increased risk for a future heart attack or stroke.

PLAVIX, in combination with aspirin, helps provide greater protection against a future heart attack or stroke than aspirin alone.

PLAVIX, taken with aspirin, plays its own role in helping reduce your risk of heart attack and stroke. That's because, unlike your cholesterol and blood pressure medications, prescription PLAVIX works to help keep blood platelets from sticking together and forming clots.

IMPORTANT INFORMATION: If you have a stomach ulcer or other condition that causes bleeding, you shouldn't use PLAVIX. When taking PLAVIX alone or with some medicines including aspirin, the risk of bleeding may increase. To minimize this risk, talk to your doctor before taking aspirin or other medicines with PLAVIX. Additional rare but serious side effects could occur.

Talk to your doctor today to learn more about PLAVIX.

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See important product information on the following page.

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INDICATIONS AND USAGE

PLAVIX (clopidogrel bisulfate) is indicated for the reduction of atherothrombotic events as follows:

- **Recent MI, Recent Stroke or Established Peripheral Arterial Disease**
  For patients with a history of recent myocardial infarction (MI), recent stroke, or established peripheral arterial disease, PLAVIX has been shown to reduce the rate of a combined endpoint of new ischemic stroke (fatal or not), new MI (fatal or not), and other vascular death.
- **Acute Coronary Syndrome**
  For patients with acute coronary syndrome (unstable angina/non-Q-wave MI) including patients who are to be managed medically and those who are to be managed with percutaneous coronary intervention (with or without stent) or CABG, PLAVIX has been shown to decrease the rate of a combined endpoint of cardiovascular death, MI, or stroke as well as the rate of a combined endpoint of cardiovascular death, MI, stroke, or refractory ischemia.

CONTRAINDICATIONS

The use of PLAVIX is contraindicated in the following conditions:

- Hypersensitivity to the drug substance or any component of the product.
- Active pathological bleeding such as peptic ulcer or intracranial hemorrhage.

WARNINGS

Thrombotic thrombocytopenic purpura (TTP):

TTP has been reported rarely following use of PLAVIX, sometimes after a short exposure (<2 weeks). TTP is a serious condition that can be fatal and requires urgent treatment including plasmapheresis (plasma exchange). It is characterized by thrombocytopenia, microangiopathic hemolytic anemia (schistocytes [fragmented RBCs] seen on peripheral smear), neurological findings, renal dysfunction, and fever. (See **ADVERSE REACTIONS**.)

PRECAUTIONS

General

PLAVIX prolongs the bleeding time and therefore should be used with caution in patients who may be at risk of increased bleeding from trauma, surgery, or other pathological conditions (particularly gastrointestinal and intraocular). If a patient is to undergo elective surgery and an antiplatelet effect is not desired, PLAVIX should be discontinued 5 days prior to surgery.

Due to the risk of bleeding and undesirable hematological effects, blood cell count determination and/or other appropriate testing should be promptly considered, whenever such suspected clinical symptoms arise during the course of treatment (see **ADVERSE REACTIONS**).

In patients with recent TIA or stroke who are at high risk for recurrent ischemic events, the combination of aspirin and PLAVIX has not been shown to be more effective than PLAVIX alone, but the combination has been shown to increase major bleeding.

GI Bleeding: In CAPRIE, PLAVIX was associated with a rate of gastrointestinal bleeding of 2.0%, vs. 2.7% on aspirin. In CURE, the incidence of major gastrointestinal bleeding was 1.3% vs 0.7% (PLAVIX + aspirin vs. placebo + aspirin, respectively). PLAVIX should be used with caution in patients who have lesions with a propensity to bleed (such as ulcers). Drugs that might induce such lesions should be used with caution in patients taking PLAVIX.

Use in Hepatically Impaired Patients: Experience is limited in patients with severe hepatic disease, who may have bleeding diatheses. PLAVIX should be used with caution in this population.

Use in Renally-impaired Patients: Experience is limited in patients with severe renal impairment. PLAVIX should be used with caution in this population.

Information for Patients

Patients should be told it may take them longer than usual to stop bleeding, that they may bruise and/or bleed more easily when they take PLAVIX or PLAVIX combined with aspirin, and that they should report any unusual bleeding to their physician. Patients should inform physicians and dentists that they are taking PLAVIX and/or any other product known to affect bleeding before any surgery is scheduled and before any new drug is taken.

Drug Interactions

Study of specific drug interactions yielded the following results:

Aspirin: Aspirin did not modify the clopidogrel-mediated inhibition of ADP-induced platelet aggregation. Concomitant administration of 500 mg of aspirin twice a day for 1 day did not significantly increase the prolongation of bleeding time induced by PLAVIX. PLAVIX potentiated the effect of aspirin on collagen-induced platelet aggregation. PLAVIX and aspirin have been administered together for up to one year.

Heparin: In a study in healthy volunteers, PLAVIX did not necessitate modification of the heparin dose or alter the effect of heparin on coagulation. Coadministration of heparin had no effect on inhibition of platelet aggregation induced by PLAVIX.

Nonsteroidal Anti-Inflammatory Drugs (NSAIDs): In healthy volunteers receiving naproxen, concomitant administration of PLAVIX was associated with increased occult gastrointestinal blood loss. NSAIDs and PLAVIX should be coadministered with caution.

Warfarin: Because of the increased risk of bleeding, the concomitant administration of warfarin with PLAVIX should be undertaken with caution. (See **PRECAUTIONS– General.**)

Other Concomitant Therapy: No clinically significant pharmacodynamic interactions were observed when PLAVIX was coadministered with **atenolol, nifedipine,** or both atenolol and nifedipine. The pharmacodynamic activity of PLAVIX was also not significantly influenced by the coadministration of **phenobarbital, cimetidine** or **estrogen.**

The pharmacokinetics of **digoxin** or **theophylline** were not modified by the coadministration of PLAVIX (clopidogrel bisulfate).

At high concentrations *in vitro*, clopidogrel inhibits P_{450} (2C9). Accordingly, PLAVIX may interfere with the metabolism of **phenytoin, tamoxifen, tolbutamide, warfarin, torsemide, fluvastatin,** and many **non-steroidal anti-inflammatory agents,** but there are no data with which to predict the magnitude of these interactions. Caution should be used when any of these drugs is coadministered with PLAVIX.

In addition to the above specific interaction studies, patients entered into clinical trials with PLAVIX received a variety of concomitant medications including **diuretics, beta-blocking agents, angiotensin converting enzyme inhibitors, calcium antagonists, cholesterol lowering agents, coronary vasodilators, antidiabetic agents** (including **insulin**), **antiepileptic agents, hormone replacement therapy, heparins** (unfractionated and LMWH) and **GPIIb/IIIa antagonists** without evidence of clinically significant adverse interactions. The use of oral anticoagulants, non-study anti-platelet drug and chronic NSAIDs was not allowed in CURE and there are no data on their concomitant use with clopidogrel.

Drug/Laboratory Test Interactions

None known.

Carcinogenesis, Mutagenesis, Impairment of Fertility

There was no evidence of tumorigenicity when clopidogrel was administered for 78 weeks to mice and 104 weeks to rats at dosages up to 77 mg/kg per day, which afforded plasma exposures >25 times that in humans at the recommended daily dose of 75 mg.

Clopidogrel was not genotoxic in four *in vitro* tests (Ames test, DNA-repair test in rat hepatocytes, gene mutation assay in Chinese hamster fibroblasts, and metaphase chromosome analysis of human lymphocytes) and in one *in vivo* test (micronucleus test by oral route in mice).

Clopidogrel was found to have no effect on fertility of male and female rats at oral doses up to 400 mg/kg per day (52 times the recommended human dose on a mg/m² basis).

Pregnancy

Pregnancy Category B. Reproduction studies performed in rats and rabbits at doses up to 500 and 300 mg/kg/day (respectively, 65 and 78 times the recommended daily human dose on a mg/m² basis), revealed no evidence of impaired fertility or fetotoxicity due to clopidogrel. There are, however, no adequate and well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of a human response, PLAVIX should be used during pregnancy only if clearly needed.

Nursing Mothers

Studies in rats have shown that clopidogrel and/or its metabolites are excreted in the milk. It is not known whether this drug is excreted in human milk. Because many drugs are excreted in human milk and because of the potential for serious adverse reactions in nursing infants, a decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the nursing woman.

Pediatric Use

Safety and effectiveness in the pediatric population have not been established.

Geriatric Use

Of the total number of subjects in controlled clinical studies, approximately 50% of patients treated with PLAVIX were 65 years of age and over. Approximately 16% of patients treated with PLAVIX were 75 years of age and over.

The observed difference in risk of thrombotic events with clopidogrel plus aspirin versus placebo plus aspirin by age category is provided in Figure 3 (see **CLINICAL STUDIES**). The observed difference in risk of bleeding events with clopidogrel plus aspirin versus placebo plus aspirin by age category is provided in Table 3 (see **ADVERSE REACTIONS**).

ADVERSE REACTIONS

PLAVIX has been evaluated for safety in more than 17,500 patients, including over 9,000 patients treated for 1 year or more. The overall tolerability of PLAVIX in CAPRIE was similar to that of aspirin regardless of age, gender and race, with an approximately equal incidence (13%) of patients withdrawing from treatment because of adverse reactions. The clinically important adverse events observed in CAPRIE and CURE are discussed below.

Hemorrhagic: In CAPRIE patients receiving PLAVIX, gastrointestinal hemorrhage occurred at a rate of 2.0%, and required hospitalization in 0.7%. In patients receiving aspirin, the corresponding rates were 2.7% and 1.1%, respectively. The incidence of intracranial hemorrhage was 0.4% for PLAVIX compared to 0.5% for aspirin.

In CURE, PLAVIX use with aspirin was associated with an increase in bleeding compared to placebo with aspirin (see Table 3). There was an excess in major bleeding in patients receiving PLAVIX plus aspirin compared with placebo plus aspirin, primarily gastrointestinal and at puncture sites. The incidence of intracranial hemorrhage (0.1%), and fatal bleeding (0.2%), were the same in both groups.

The overall incidence of bleeding is described in Table 3 for patients receiving both PLAVIX and aspirin in CURE,

Table 3: CURE Incidence of bleeding complications (% patients)

Event	PLAVIX (+ aspirin)* (n=6259)	Placebo (+ aspirin)* (n=6303)	P-value
Major bleeding †	3.7 ‡	2.7 §	0.001
Life-threatening bleeding	2.2	1.8	0.13
Fatal	0.2	0.2	
5 g/dL hemoglobin drop	0.9	0.9	
Requiring surgical intervention	0.7	0.7	
Hemorrhagic strokes	0.1	0.1	
Requiring inotropes	0.5	0.5	
Requiring transfusion (≥4 units)	1.2	1.0	
Other major bleeding	1.6	1.0	0.005
Significantly disabling	0.4	0.3	
Intraocular bleeding with significant loss of vision	0.05	0.03	
Requiring 2-3 units of blood	1.3	0.9	
Minor bleeding ¶	5.1	2.4	<0.001

* Other standard therapies were used as appropriate.

† Life threatening and other major bleeding.

‡ Major bleeding event rate for PLAVIX + aspirin was dose-dependent on aspirin: <100 mg=2.6%; 100-200 mg= 3.5%; >200 mg=4.9%
Major bleeding event rates for PLAVIX + aspirin by age were: <65 years = 2.5%, ≥65 to <75 years = 4.1%, ≥75 years 5.9%

§ Major bleeding event rate for placebo + aspirin was dose-dependent on aspirin: <100 mg=2.0%; 100-200 mg= 2.3%; >200 mg=4.0%
Major bleeding event rates for placebo + aspirin by age were: <65 years = 2.1%, ≥65 to <75 years = 3.1%, ≥75 years 3.6%

¶ Led to interruption of study medication.

Ninety-two percent (92%) of the patients in the CURE study received heparin/LMWH, and the rate of bleeding in these patients was similar to the overall results.

There was no excess in major bleeds within seven days after coronary bypass graft surgery in patients who stopped therapy more than five days prior to surgery (event rate 4.4% PLAVIX + aspirin; 5.3% placebo + aspirin). In patients who remained on therapy within five days of bypass graft surgery, the event rate was 9.6% for PLAVIX + aspirin, and 6.3% for placebo + aspirin.

Neutropenia/agranulocytosis: Ticlopidine, a drug chemically similar to PLAVIX, is associated with a 0.8% rate of severe neutropenia (less than 450 neutrophils/μL). In CAPRIE severe neutropenia was observed in six patients, four on PLAVIX and two on aspirin. Two of the 9599 patients who received PLAVIX and none of the 9586 patients who received aspirin had neutrophil counts of zero. One of the four PLAVIX patients in CAPRIE was receiving cytotoxic chemotherapy, and another recovered and returned to the trial after only temporarily interrupting treatment with PLAVIX (clopidogrel bisulfate). In CURE, the numbers of patients with thrombocytopenia (19 PLAVIX + aspirin vs. 24 placebo + aspirin) or neutropenia (3 vs. 3) were similar.

Although the risk of myelotoxicity with PLAVIX (clopidogrel bisulfate) thus appears to be quite low, this possibility should be considered when a patient receiving PLAVIX demonstrates fever or other sign of infection.

Gastrointestinal: Overall, the incidence of gastrointestinal events (e.g. abdominal pain, dyspepsia, gastritis and constipation) in patients receiving PLAVIX (clopidogrel bisulfate) was 27.1%, compared to 29.8% in those receiving aspirin in the CAPRIE trial. In the CURE trial the incidence of these gastrointestinal events for patients receiving PLAVIX + aspirin was 11.7% compared to 12.5% for those receiving placebo + aspirin.

In the CAPRIE trial, the incidence of peptic, gastric or duodenal ulcers was 0.7% for PLAVIX (clopidogrel bisulfate) and 1.2% for aspirin. In the CURE trial the incidence of peptic, gastric or duodenal ulcers was 0.4% for PLAVIX + aspirin and 0.3% for placebo + aspirin.

Cases of diarrhea were reported in the CAPRIE trial in 4.5% of patients in the PLAVIX group compared to 3.4% in the aspirin group. However, these were rarely severe (PLAVIX=0.2% and aspirin=0.1%). In the CURE trial, the incidence of diarrhea for patients receiving PLAVIX + aspirin was 2.1% compared to 2.2% for those receiving placebo + aspirin.
In the CAPRIE trial, the incidence of patients withdrawing from treatment because of gastrointestinal adverse reactions was 3.2% for PLAVIX and 4.0% for aspirin. In the CURE trial, the incidence of patients withdrawing from treatment because of gastrointestinal adverse reactions was 0.9% for PLAVIX + aspirin compared with 0.8% for placebo + aspirin.
Rash and Other Skin Disorders: In the CAPRIE trial, the incidence of skin and appendage disorders in patients receiving PLAVIX was 15.8% (0.7% serious); the corresponding rate in aspirin patients was 13.1% (0.5% serious). In the CURE trial the incidence of rash or other skin disorders in patients receiving PLAVIX + aspirin was 4.0% compared to 3.5% for those receiving placebo + aspirin.
In the CAPRIE trial, the overall incidence of patients withdrawing from treatment because of skin and appendage disorders adverse reactions was 1.5% for PLAVIX and 0.8% for aspirin. In the CURE trial, the incidence of patients withdrawing because of skin and appendage disorders adverse reactions was 0.7% for PLAVIX + aspirin compared with 0.3% for placebo + aspirin.
Adverse events occurring in ≥2.5% of patients on PLAVIX in the CAPRIE controlled clinical trial are shown below regardless of relationship to PLAVIX. The median duration of therapy was 20 months, with a maximum of 3 years.

Table 4: Adverse Events Occurring in ≥2.5% of PLAVIX Patients in CAPRIE

	% Incidence	(% Discontinuation)
Body System **Event**	**PLAVIX [n=9599]**	**Aspirin [n=9586]**
Body as a Whole – general disorders		
Chest Pain	8.3 (0.2)	8.3 (0.3)
Accidental/Inflicted Injury	7.9 (0.1)	7.3 (0.1)
Influenza-like symptoms	7.5 (<0.1)	7.0 (<0.1)
Pain	6.4 (0.1)	6.3 (0.1)
Fatigue	3.3 (0.1)	3.4 (0.1)
Cardiovascular disorders, general		
Edema	4.1 (<0.1)	4.5 (<0.1)
Hypertension	4.3 (<0.1)	5.1 (<0.1)
Central & peripheral nervous system disorders		
Headache	7.6 (0.3)	7.2 (0.2)
Dizziness	6.2 (0.2)	6.7 (0.3)
Gastrointestinal system disorders		
Abdominal pain	5.6 (0.7)	7.1 (1.0)
Dyspepsia	5.2 (0.6)	6.1 (0.7)
Diarrhea	4.5 (0.4)	3.4 (0.3)
Nausea	3.4 (0.5)	3.8 (0.4)
Metabolic & nutritional disorders		
Hypercholesterolemia	4.0 (0)	4.4 (<0.1)
Musculo-skeletal system disorders		
Arthralgia	6.3 (0.1)	6.2 (0.1)
Back Pain	5.8 (0.1)	5.3 (<0.1)
Platelet, bleeding, & clotting disorders		
Purpura/Bruise	5.3 (0.3)	3.7 (0.1)
Epistaxis	2.9 (0.2)	2.5 (0.1)
Psychiatric disorders		
Depression	3.6 (0.1)	3.9 (0.2)
Respiratory system disorders		
Upper resp tract infection	8.7 (<0.1)	8.3 (<0.1)
Dyspnea	4.5 (0.1)	4.7 (0.1)
Rhinitis	4.2 (0.1)	4.2 (<0.1)
Bronchitis	3.7 (0.1)	3.7 (0)
Coughing	3.1 (<0.1)	2.7(<0.1)
Skin & appendage disorders		
Rash	4.2 (0.5)	3.5 (0.2)
Pruritus	3.3 (0.3)	1.6 (0.1)
Urinary system disorders		
Urinary tract infection	3.1 (0)	3.5 (0.1)

Incidence of discontinuation, regardless of relationship to therapy, is shown in parentheses.
Adverse events occurring in ≥2.0% of patients on PLAVIX in the CURE controlled clinical trial are shown below regardless of relationship to PLAVIX.

Table 5: Adverse Events Occurring in ≥2.0% of PLAVIX Patients in CURE

	% Incidence	(% Discontinuation)
Body System **Event**	**PLAVIX (+ aspirin)* [n=6259]**	**Placebo (+ aspirin)* [n=6303]**
Body as a Whole– general disorders		
Chest Pain	2.7 (<0.1)	2.8 (0.0)
Central & peripheral nervous system disorders		
Headache	3.1 (0.1)	3.2 (0.1)
Dizziness	2.4 (0.1)	2.0 (<0.1)
Gastrointestinal system disorders		
Abdominal pain	2.3 (0.3)	2.8 (0.3)
Dyspepsia	2.0 (0.1)	1.9 (<0.1)
Diarrhea	2.1 (0.1)	2.2 (0.1)

*Other standard therapies were used as appropriate.

Other adverse experiences of potential importance occurring in 1% to 2.5% of patients receiving PLAVIX (clopidogrel bisulfate) in the CAPRIE or CURE controlled clinical trials are listed below regardless of relationship to PLAVIX. In general, the incidence of these events was similar to that in patients receiving aspirin (in CAPRIE) or placebo + aspirin (in CURE).
Autonomic Nervous System Disorders: Syncope, Palpitation. *Body as a Whole-general disorders:* Asthenia, Fever, Hernia. *Cardiovascular disorders:* Cardiac failure. *Central and peripheral nervous system disorders:* Cramps legs, Hypoaesthesia, Neuralgia, Paraesthesia, Vertigo. *Gastrointestinal system disorders:* Constipation, Vomiting. *Heart rate and rhythm disorders:* Fibrillation atrial. *Liver and biliary system disorders:* Hepatic enzymes increased. *Metabolic and nutritional disorders:* Gout, hyperuricemia, non-protein nitrogen (NPN) increased. *Musculo-skeletal system disorders:* Arthritis, Arthrosis. *Platelet, bleeding & clotting disorders:* GI hemorrhage, hematoma, platelets decreased. *Psychiatric disorders:* Anxiety, Insomnia. *Red blood cell disorders:* Anemia. *Respiratory system disorders:* Pneumonia, Sinusitis. *Skin and appendage disorders:* Eczema, Skin ulceration. *Urinary system disorders:* Cystitis. *Vision disorders:* Cataract, Conjunctivitis.
Other potentially serious adverse events which may be of clinical interest but were rarely reported (<1%) in patients who received PLAVIX in the CAPRIE or CURE controlled clinical trials are listed below regardless of relationship to PLAVIX. In general, the incidence of these events was similar to that in patients receiving aspirin (in CAPRIE) or placebo + aspirin (in CURE).
Body as a whole: Allergic reaction, necrosis ischemic. *Cardiovascular disorders:* Edema generalized. *Gastrointestinal system disorders:* Gastric ulcer perforated, gastritis hemorrhagic, upper GI ulcer hemorrhagic. *Liver and Biliary system disorders:* Bilirubinemia, hepatitis infectious, liver fatty. *Platelet, bleeding and clotting disorders:* hemarthrosis, hematuria, hemoptysis, hemorrhage intracranial, hemorrhage retroperitoneal, hemorrhage of operative wound, ocular hemorrhage, pulmonary hemorrhage, purpura allergic, thrombocytopenia. *Red blood cell disorders:* Anemia aplastic, anemia hypochromic. *Reproductive disorders, female:* Menorrhagia. *Respiratory system disorders:* Hemothorax. *Skin and appendage disorders:* Bullous eruption, rash erythematous, rash maculopapular, urticaria. *Urinary system disorders:* Abnormal renal function, acute renal failure. *White cell and reticuloendothelial system disorders:* Agranulocytosis, granulocytopenia, leukemia, leukopenia, neutrophils decreased.

Postmarketing Experience
The following events have been reported spontaneously from worldwide postmarketing experience:

- *Body as a whole:*
  -hypersensitivity reactions, anaphylactoid reactions, serum sickness
- *Central and Peripheral Nervous System disorders:*
  -confusion, hallucinations, taste disorders
- *Hepato-biliary disorders:*
  -abnormal liver function test, hepatitis (non-infectious), acute liver failure
- *Platelet, Bleeding and Clotting disorders:*
  -cases of bleeding with fatal outcome (especially intracranial, gastrointestinal and retroperitoneal hemorrhage)
  -thrombotic thrombocytopenic purpura (TTP) – some cases with fatal outcome- (see **WARNINGS**).
  -agranulocytosis, aplastic anemia/pancytopenia
  -conjunctival, ocular and retinal bleeding
- *Respiratory, thoracic and mediastinal disorders:*
  -bronchospasm, interstitial pneumonitis
- *Skin and subcutaneous tissue disorders:*
  -angioedema, erythema multiforme, Stevens-Johnson syndrome, toxic epidermal necrolysis, lichen planus
- *Renal and urinary disorders:*
  - glomerulopathy, increased creatinine levels
- *Vascular disorders:*
  - vasculitis, hypotension
- *Gastrointestinal disorders:*
  - colitis (including ulcerative or lymphocytic colitis), pancreatitis, stomatitis
- *Musculoskeletal, connective tissue and bone disorders:*
  - myalgia

OVERDOSAGE
Overdose following clopidogrel administration may lead to prolonged bleeding time and subsequent bleeding complications. A single oral dose of clopidogrel at 1500 or 2000 mg/kg was lethal to mice and to rats and at 3000 mg/kg to baboons. Symptoms of acute toxicity were vomiting (in baboons), prostration, difficult breathing, and gastrointestinal hemorrhage in all species.
Recommendations About Specific Treatment:
Based on biological plausibility, platelet transfusion may be appropriate to reverse the pharmacological effects of PLAVIX if quick reversal is required.

DOSAGE AND ADMINISTRATION

Recent MI, Recent Stroke, or Established Peripheral Arterial Disease
The recommended daily dose of PLAVIX is 75 mg once daily.

Acute Coronary Syndrome
For patients with acute coronary syndrome (unstable angina/non-Q-wave MI), PLAVIX should be initiated with a single 300 mg loading dose and then continued at 75 mg once daily. Aspirin (75 mg-325 mg once daily) should be initiated and continued in combination with PLAVIX. In CURE, most patients with Acute Coronary Syndrome also received heparin acutely (see **CLINICAL STUDIES).**
PLAVIX can be administered with or without food.
No dosage adjustment is necessary for elderly patients or patients with renal disease. (See **Clinical Pharmacology: Special Populations.)**

Distributed by:
Bristol-Myers Squibb/Sanofi Pharmaceuticals Partnership
New York, NY 10016

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Brief Summary of Prescribing Information Revised February 2006

PLA-FEB06-B-Af

e l e v a t e what's next

What if everyone settled for average? What if nobody raised the bar? What if everyone decided to let someone else figure it out? At ConocoPhillips, we're not only finding new sources of natural gas, we're developing new technologies to solve the demanding increase in global energy needs. By investing in Russia's oil and natural gas reserves, the world's second largest, we're helping ensure global energy production for decades to come. Turning "what ifs" into "what's next" is just another way we elevate.

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I laugh sometimes when people talk about the threat of China. I think Americans should be grateful that this is the kind of place they're dealing with. People seem quite rational—very, very pragmatic.

but they've survived. And you can feel that. You can feel the toughness and a certain measure of dignity. But at the same time you realize so many of these people were gifted, and had the skills, had all the right values—were willing to make sacrifices for the common good. And almost in every case their talents were wasted. And that's very sad, but very illuminating, and it has helped me value the sense that young people have today, which is that if they work hard, if they study hard, and if they prepare well, there is an avenue for them to succeed. There isn't the same fear of some political campaign coming out of nowhere and wiping out their hopes. It's really a world of improvement over what their grandparents knew.

CARREL: If you look at the world today, it appears there's strong fundamentalism in different parts of our globe—the United States and Middle Eastern countries, and beyond. What is China's fundamentalism?

HESSLER: Well, it's not at all the same. I laugh sometimes when people talk about the threat of China, as if this is America's great threat or great challenge. Really, I think Americans should be grateful that this is the kind of place they're dealing with. This generation of Chinese—you can pretty much predict how people respond because they tend to act in their own best interest. It's one thing that's made living here easier in some ways. It hasn't been that hard as an outsider to function here. People seem quite rational—very, very pragmatic.

CARREL: This new pragmatism you're talking about, you've described it as affecting the generation that was born more or less in the '70s. They've come of age in a new atmosphere. But the older generation who went through a traumatic period, especially the Cultural Revolution—it seems that a lot of those people learned to betray one another, to fight each other, criticize each other harshly, abuse each other. And there are memories of that. But people just don't care to confront it or talk about it. So I'm wondering: Does it have to be exhumed for China to move on, or is it becoming irrelevant to this practical new generation?

HESSLER: That's a critical question. As an outsider, my instinct is always that eventually they're going to have to come to grips with this. But that could just be the way that I would like to deal with it, and the way that my culture might be more likely to deal with it. I had a conversation with somebody who had grown up in another communist society, in Hungary. And when we came to this point, she disagreed, and she said, "You know, maybe they're just never going to address it." □

China Specialist Listen to more of Peter Hessler's insights about Chinese culture—from the reverence for education to the pervasiveness of counterfeiting—at **ngm.com/0606.**

the beautiful game

why soccer rules the world

This month in Germany 32 teams will compete for the World Cup of soccer, a game that unites—and divides—countries around the globe.

Rain can't hide the muscle and grace of a player during a match in Rome.

Political Passion

Fans called the "Bad Blue Boys" light up the night in Zagreb, Croatia, as their team takes on archrivals from Split. Such fervor can change history. When a Belgrade team came to Zagreb in 1990, long-standing animosities erupted into a riot, an early spark in the vicious Balkan war for Croatian independence.

NIKOLA SOLIC, REUTERS

Introduction by Sean Wilsey

There are many beautiful things about being an American fan of men's World Cup soccer—foremost among them is ignorance. The community in which you were raised did not gather around the television set every four years for a solid, breathless month. Your country has never won. You can pick whatever team you like best and root for it without shame or fear of reprisal. You have not been indoctrinated into unwanted-yet-inescapable tribal allegiances by your soccer-crazed countrymen. You are an amateur, in the purest sense of the word. So with the World Cup taking place this month in Germany—and the World Cup is the only truly international sporting event on the planet (no, the Olympics, with their overwhelming clutter of boutique athletics, do not matter in the same way)—you can expect to spend the month in paradise.

That's what I do. The world of the World Cup is the one I want to live in. I cannot resist its United Nations–like pageantry and high-mindedness, the apolitical display of national characteristics, the revelation of deep human flaws and unexpected greatnesses, the fact that entire nations walk off the job or wake up at 3 a.m. to watch men kick a ball. There are countries that have truly multiracial squads—France, England, and the United States—while other teams are entirely blond or Asian or Latin American. A Slovakian tire salesman, an Italian cop, or a German concert pianist—having passed the official fitness tests—will moonlight as referee. There are irritating fans: "U.S.A.! U.S.A.! U.S.A.!" (Blessedly few.) There are children who hold hands with each player as he walks onto the field. National anthems play. Men paint themselves their national colors and cry openly at defeat. An announcer shouts *"GOOOOOOOOOOLLLLLLL! GOL, GOL, GOL!"* on the Spanish-language channel you're watching. (It's often the only way you can see the game live.) There are two back-to-back 45-minute segments without

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Adapted from The Thinking Fan's Guide to the World Cup, *edited by Matt Weiland and Sean Wilsey. HarperCollins, 2006. Printed with permission.*

commercials. To quote the book every traveling athlete finds in his hotel room: "Rejoice, and be exceeding glad: for great is your reward in heaven." Or, as my copy of "Soccer and Its Rules" says: "Are you ready? Ready to cheer the players to victory, marvel at their fitness, speed, and skills, urging them to win every tackle for the ball, ready to explode at a powerful shot? Ready for the excitement of flying wingers, overlapping backs, curling corners, slick one-two passing and goals scored with panache? Ready for another moment in a fantasy world?"

I am ready.

Soccer's worldwide popularity isn't surprising when you look at what has always motivated humanity: money and God. There's lots of money in soccer, of course. Club soccer (like capitalism) is basically the childlike desire to make dreams come true, no matter what the cost, realized by men with enough money to combine such commodities as the best Brazilian attacker, Dutch midfielder, British defender, and German goalie and turn them loose on whatever the other billionaires can put together—an unfair situation that describes much of the world these days. But the divine's there, too.

What is soccer if not everything that religion should be? Universal yet particular, the source of an infinitely renewable supply of hope, occasionally miraculous, and governed by simple, uncontradictory rules ("laws," officially) that everyone can follow. Soccer's laws are laws of equality and nonviolence and restraint, and free to be reinterpreted at the discretion of a reasonable arbiter. What the ref says goes, no matter how flagrantly in violation of dogma his decisions may be. My official rule book, after presenting a detailed enumeration of soccer's 17 laws, concludes that the ref can throw out any of them in order to apply what it rather mystically calls "the spirit of fair play."

The religious undercurrent in soccer runs especially deep in World Cup years. Teams from across the globe converge on the host nation in something of an unarmed, athletic crusade. As in the Crusades, the host nation tends to repel them. There's a weird power in home-team advantage. Hosts find a level of success disproportionate to their talents on paper, triumphing over stronger teams, as if exerting a gravitational pull on the game, causing it to be played the way they want to play it, as if, to carry this metaphor to its inevitable conclusion, God were on their side.

It's well-known that soccer, like religion, can provoke violence—hooliganism and tramplings at overcrowded, Mecca-mid-hajj-like stadiums are what many Americans assume about the game. But soccer has also proved unique in its ability to bridge differences and overturn national prejudices. The fact that the World Cup could even take place in South Korea and in Japan, as it did in 2002, was a victory for tolerance and understanding. In less than half a century South Korea had gone from not allowing the Japanese national team to cross its borders for a World Cup qualifier, to co-hosting the tournament with the former occupier. Give the world another 50 years and we might see the Cup co-hosted by Israel and Palestine.

And why not? Soccer's universality is its simplicity—the fact that the game can be played anywhere with anything. Urban children kick the can on concrete and rural kids kick a rag wrapped around a rag wrapped around a rag,

Sean Wilsey is the author of the memoir Oh the Glory of It All *and the editor-at-large at* McSweeney's Quarterly, *a literary journal.*

barefoot, on dirt. Soccer is something to believe in now, perhaps empty at its core, but not a stand-in for anything else.

The beautiful game—let's call it business and religion combined—will be at its most unfair, frustrating, and magnificent this month in unified Germany's first World Cup. And what makes the World Cup most beautiful is the world, all of us together. The joy of being one of the billion or more people watching 32 countries abide by 17 rules fills me with the conviction, perhaps ignorant, but like many ignorant convictions, fiercely held, that soccer can unite us all.

IVORY COAST

The Way to Win: Juju on the Field

By Paul Laity

Paul Laity is an editor at the London Review of Books *who plays left back in pickup soccer games.*

The party began at ten to six. Ivory Coast had just qualified for the World Cup—for the first time ever. In an instant, the city of Abidjan was full of people and noise. Fans in tangerine and white and green poured onto the streets, drivers hooted their horns; loud *zouglou* music was playing, and pots and pans were joyously banged. The partygoers danced a new dance, the "Drogbacité," named in honor of the team's star striker, Didier Drogba: They mimed his feints, turns, and the unleashing of unstoppable shots. Others tried out the *fouka-fouka,* Drogba's trademark celebratory hip-swivel—a little piece of Ivoirian culture known to soccer fans everywhere. The *maquis*—open-air cafés, bars, and mini-nightclubs—stayed open all night serving "Drogbas," bottles of local beer, so called because of their size and potency. A number of the drinkers had "Les Éléphants" painted on their chests, the nickname of the national team: Elephants represent power and are said to be lucky, too—protected by a spell. The team had suffered its share of disappointments; finally, the name seemed appropriate. Excited fans announced that soccer could do more than any politician to put an end to the civil war.

Over the past six years, the Ivory Coast's southern-based regime has fomented hatred of immigrants and Muslims, yet many of the country's best soccer players are from Muslim and immigrant families, so the national team has become an irresistible symbol of unity. At the end of the Abidjan victory parade, the head of the Ivory Coast Football Federation addressed a plea to President Laurent Gbagbo: "The players have asked me to tell you that what they most want now is for our divided country to become one again. They want this victory to act as a catalyst for peace in Ivory Coast, to put an end to the conflict and to reunite its people. This success must bring us together." The party on the streets lasted another whole day.

President Gbagbo did his best to be identified with the conquering team. He talked of a rejuvenated nation and gave each of the players the equivalent of a knighthood and a swanky villa. But Henri Michel, the French coach of the Ivoirian soccer team, was notably absent from the celebration at President Gbagbo's residence. He was, presumably, an awkward reminder of the

colonial legacy. The governmental sponsors of anti-French thinking in today's Ivory Coast face a difficulty when it comes to soccer, however. Of the first-choice players on the national team, many play on French teams during the regular season, and a number have lived in France most of their lives: Drogba left the Ivory Coast at the age of five to stay with an uncle and tells of a childhood watching European soccer on TV.

Gbagbo will choose to ignore the importance of France to Ivoirian soccer as long as Ivory Coast keeps winning, and he has loudly publicized the extent to which his government has financed the national team. But he is likely to distance himself from another form of assistance. In 1992, the only time apart from this year that Ivory Coast played in the final of the African Nations Cup, the sports minister enlisted a battalion of *fétisheurs*—juju men—to give the Ivoirian team a supernatural advantage against Ghana. The story goes that when the minister reneged on promises to pay the fétisheurs, they put a hex on the team, which suffered a ten-year run of disappointing results. In April 2002, defense minister Moise Lida Kouassi approached the witch doctors to make amends, offering them bottles of gin and large sums of money. The hex was lifted, and presto: World Cup qualification.

Witch doctors scatter charms on the field or smear the goalposts with magic ointments to keep the ball out. In 1984 no fewer than 150 fétisheurs stayed with the Ivoirian national team at their hotel before a crunch game in the African Nations Cup: Each player took a bath in water treated with various potions, before being invited to make a wish in the ear of a pigeon. Another soccer club was taken to court in 1998 when, following a decisive league match in Bouake, its players admitted to drinking a concoction prepared by a juju man (the case was dismissed).

Soccer's governing body in Africa is aware of the PR damage done by juju stories and has now banned "team advisers" from being part of a squad's official entourage. But superstition, of one kind or another, has always played a large part in sport, and fetishism is sure to continue in Ivoirian soccer. Before last September's crucial World Cup qualifier against Cameroon, the gutters of Abidjan ran red with chicken blood. For better or worse this is V. S. Naipaul's Africa: a place of magic that is also on display at the many roadblocks in the north and west of the country, where soldiers are convinced that the amulets they wear around their necks will ward off bullets. War, too, encourages superstition.

Everybody—on both sides of the war—is willing the team to do well in Germany. But the mix of soccer and politics can get ugly. When the Ivoirians lost for the second time to Cameroon in the qualifiers, and it was believed their chance had gone, Drogba—who had played brilliantly in the match and scored two goals—received threats and menacing messages from fans, and was worried enough to consider not playing for the national team. In 2000 Gen. Robert Guei, who had just engineered the country's first military coup, held the national team in detention for two days as punishment for being knocked out of the African Nations Cup in the first round. He stripped the players of their passports and cell phones, publicly denounced them, and suggested they should learn some barracks discipline. "You should have spared us the shame," he said. *(Continued on page 54)*

Colonial Legacy

Dust flies as boys play a pickup match in southern Yemen, once a protectorate of the British Empire. In colonial days, British soldiers and missionaries spread the game to the empire's remotest corners. Today rivalries between colonized countries and their former overlords give World Cup matches added drama.

FERDINANDO SCIANNA, MAGNUM PHOTOS


SIEMENS
OTE
OTE

Fiery Match

Players head the ball in a duel between Athens and Piraeus as fans wield flares in the stands. Following a disputed penalty, fans threw rocks, attacked a referee, and ripped out seats. "Such violence is tribal," says Peter Marsh, an expert on soccer culture. "Appearing tough and hard gives you status."

ARIS MESSINIS, AP

(Continued from page 49) With qualification for the World Cup secured, there is, for the time being, no shame. By itself, soccer will never bring about national reconciliation. But the summer of 2006 promises to remind Ivoirians, however fleetingly, of a national life beyond politics.

ENGLAND

Faded Glory: Taming the Hooligans

By Nick Hornby

Nick Hornby is the author of Fever Pitch, *a memoir of his lifelong support of England's Arsenal soccer club. His latest novel is* A Long Way Down.

It was all so straightforward back in the '60s, when I started to watch soccer. England had just won the 1966 World Cup and, therefore, unarguably, were the best team in the world: fact, period, end of story. Then everything went wrong, pretty much forever. For a start, I became a grown-up and much more troubled about what it meant to belong to a country; meanwhile England's soccer team was hopeless. (I may not have been so conflicted about the subject of patriotism if they'd been any good.) The team didn't even qualify for the World Cup of 1974 and 1978; the world-class players we'd been blessed with in the '60s had gone, and by the '80s, the whole subject of patriotism and soccer had become much more complicated.

In the mind's eye now, England games during that decade were only just visible through a cloud of tear gas, used by European police to disperse our rioting hooligans. England fans were fast becoming a pretty sinister bunch. If you went to see England play at Wembley, you could observe people around you making the Nazi salute during the national anthem, and abuse of black players—even those playing for the home team—was commonplace. Sometimes it seemed as though the thousand worst scumbag fans from every single league club were gathered at Wembley so they could make monkey noises and sing anti-IRA songs. If you saw someone coming toward you in a T-shirt sporting the Union Jack, you'd have been best advised to cross the street. The T-shirt was a graphic alternative to a slogan that might say something like, "I'm a racist, but I hate you no matter what color you are."

And so some soccer fans started to feel a little conflicted about the national team. In 1990, when England played Cameroon in the quarterfinals of the World Cup, it wasn't hard to find people in England—middle-class, liberal people, admittedly, but people nonetheless—who wanted Cameroon to win. I watched that game with some of them, and when England went 2-1 down (they eventually won 3-2 in extra time), these people cheered. I understood why, but I couldn't cheer with them, much to my surprise. Those drunk, racist thugs draped in the national colors.... They were, it turned out, my people, not the nice liberal friends I was watching the game with, and England was my soccer team. I mean, you can't choose stuff like that, right? The 1990 World Cup turned out to be a turning point. The team wasn't embarrassing. The fans weren't embarrassing either. After a horrendous couple of decades, the national team once again basked in the warmth of the nation's affections.

The rebirth lasted about five minutes. There was a disastrous managerial appointment, which resulted in yet another failure to qualify. And by 1998

soccer was a different game. Many of the players in our top division came from outside the British Isles. The globalization of the transfer market was beginning to rob international football of much of its point. In the old days, you'd look at the best players in the club teams and think, What would they be like if they played together? And the answer was they looked like the national team. Now, Chelsea, Manchester United, Real Madrid, Juventus, AC Milan, and Barcelona have replaced the national teams as fantasy soccer teams.

In 1989 England played out a goalless draw against Sweden, helping to ensure qualification for the 1990 World Cup. The enduring image of that game is of the England captain, Terry Butcher, swathed in a bandage, his white England shirt and shorts covered in blood that had pumped steadily out of a head wound throughout the game. "Off the pitch I was always an ordinary, mild-mannered bloke," said Butcher in an interview. "But put me in a football shirt and it was tin hats and fixed bayonets. Death or glory."

That was the old England: the war imagery, the crucial nil-nil draw against modest opposition, the unavoidable replacement of style and talent with blood and graft. Those who loathe David Beckham, the current England captain, would claim that he will wear a tin hat and bandages only when tin hats and bandages become de rigueur in some ludicrously fashionable European nightclub. That's not fair, because despite his looks and his cash, he has worked hard to compensate for things he lacks as a player, notably pace. But there's no doubt he is brilliantly illustrative of a new kind of English sportsman: professional, media-aware, occasionally petulant, and very, very rich.

The England fans who went to the 2005 friendly match against Argentina (resulting in a meaningless but enthralling last-minute win) were still singing their "No surrender to the IRA" song, and there's more than a suspicion that they'd rather be watching Terry Butcher and his fixed bayonets than David Beckham, a man who, after all, has been photographed wearing a sarong. But then, that's England all over at the moment. We'd still rather be bombing the Germans; but after 60 years, there's a slowly dawning suspicion that those days aren't coming back any time soon, and in the meantime we must rely on sarong-wearing, multimillionaire pretty boys to kick the Argies for us. We're not happy about it, but what can we do?

BRAZIL

Ballet With the Ball: A Love Story

By John Lanchester

Why do we fall in love with soccer? What happens? At some deep level the reason soccer snags us is that good soccer is beautiful, and it's difficult, and the two are related. A team kicking the ball to each other, passing into empty space that is suddenly filled by a player who wasn't there two seconds ago and who is running at full pelt and who without looking or breaking stride knocks the ball back to a third player who he surely can't have seen, who, also at full pelt and without breaking stride, then passes the ball, at say 60 miles an hour, to land on *(Continued on page 60)*

John Lanchester is a novelist who began his career reporting on soccer matches. His memoir, Family Romance, *will be published next year.*

Founding Fathers

Players at England's prestigious Harrow School pose in the late 1860s, shortly after the world's first football association formed in London. Though "Harrow football," like rugby, permits catching the ball, soccer (as the game is called in the U.S.) evolved into the hands-off kicker's sport it is today. In all, more than 200 countries now field national soccer teams.

BTH/POPPERFOTO/CLASSICSTOCK

National Devotion

A fan shows his colors as Italy plays Denmark to a scoreless tie in the 2004 European championships. Patriotic fervor will soar among the three million fans expected to attend this year's World Cup—and the billion-plus TV viewers tuning in.

SALVATORE GIGLIO

(Continued from page 55) the head of a fourth player who has run 75 yards to get there and who, again all in stride, jumps and heads the ball with, once you realize how hard this is, unbelievable power and accuracy toward a corner of the goal just exactly where the goalkeeper, executing some complex physics entirely without conscious thought and through muscle-memory, has expected it to be, so that all this grace and speed and muscle and athleticism and attention to detail and power and precision will never appear on a score sheet and will be forgotten by everybody a day later—this is the strange fragility, the evanescence of soccer. It's hard to describe and it is even harder to do, but it does have a deep beauty, a beauty hard to talk about and that everyone watching a game discovers for themselves, a secret thing, and this is the reason why soccer, which has so much ugliness around it and attached to it, still sinks so deeply into us: Because it is, it can be, so beautiful.

No country tries as hard or as consistently to play beautiful soccer as Brazil. It's an ideological thing. That is why Brazilian players are so loved. Not in South America, of course, where they have the status of a regional sporting superpower, but by pretty much everyone else in the world. In fact, the Brazil soccer team is unique in sports in being an example of a beloved overdog. In general, sports fans, and especially soccer fans, hate the overdogs (Real Madrid in Spain, Juventus in Italy, Manchester United/Chelsea in England). But Brazil, the only team to have won five World Cups, the only team to have won it playing away from its own continent, is loved. So a great many soccer fans have, at the national level, two teams: their own, and Brazil. It is the only favorite that's a favorite.

COSTA RICA

Soccer Inc: Marketing Fanaticism

By Matthew Yeomans

Matthew Yeomans, a journalist in Cardiff, Wales, has covered the past three World Cups.

What's the point of turning soccer into big business if your fans continue to treat the sport as just a game? Watching Costa Rican ("Tico") soccer had always been a low-key pursuit compared with the craziness associated with Argentine, Mexican, and Brazilian soccer. For one thing most of the stadiums were rudimentary—not exactly the intimidating cauldrons of Milan's San Siro, Real Madrid's Bernabéu, or Boca Juniors' Bombonera—and the fans, though occasionally demonstrating the blind, all-enveloping mania associated with hard-core *hinchas,* didn't see the need to get worked up on a regular basis. Maybe it was the relaxed Tico spirit, or maybe it was half a century of soccer underachievement, but on a continent where two of Costa Rica's neighbors, Honduras and El Salvador, had actually gone to war over a soccer game, Costa Rica fans lacked a little something in attitude.

So in 1995 the Saprissa soccer club decided to galvanize its fan base. In what must surely be the first instance of a club recruiting hooligan consultants, Saprissa brought in the ardent fans of Chile's Universidad de Católica to develop a local *fanático* culture. The result was La Ultra, a superfan

clique that looked to mirror the rabid commitment of the best-organized *barras bravas,* or hooligans, and chants were scripted, La Ultra congregated en masse, dressed all in purple, and smoke bombs began to appear on the once less intimidating back terraces. The Alajuelense club soon followed suit, launching its own hard-core fan base known as La Doce (the 12th man).

The results of this investment in fanaticism were quick and spectacular. A gang culture tied to La Ultra and La Doce quickly took root, fueled by a growing sense among poor Ticos that the burgeoning national economy was leaving them behind. With it came a startling increase in fan violence at soccer matches and at least one death. The traditional animosity of the regular Clásico between Saprissa and Alajuelense took on new venom.

Fan violence became such a problem that both Saprissa and Alajuelense took steps to bring La Ultra and La Doce under control. Today, the outright crime has subsided, but the underlying mood of fan anger remains.

SPAIN

Morality Play: Soccer as Theater

By Robert Coover

Robert Coover, a novelist and essayist, first became obsessed with soccer while living in Spain. He has since chased the game through several decades and continents. His most recent book is A Child Again.

Spain, summer of '82. The smog cap over Barcelona is like the lid of a pressure cooker, ablaze with sunlight, and up here on the top tier of the little Sarriá soccer stadium, where Brazil, Italy, and Argentina are meeting in a World Cup knockout round-robin, they seem to have sold ten tickets for every square foot of space. We have to go an hour and a half early just to squeeze in at all. No way to sit, no chance to go for drinks, by the time the matches start it's hard to breathe. My teenage son spends one entire game hanging over an exit from a stair railing. Each day we say: If it's not bloody sensational, we'll go to a bar and watch it on TV, this is crazy. And each day we stay.

We've been here before. The other time, in 1977, two years after the death of the dictator Franco, it was raining and dark and turning cold. We stayed that time, too, huddled under an umbrella high up on the roof under the floodlights in the blustery winds and pouring rain in the only seats we could get, and happy to have them. That night we were watching a late autumn Spanish league match between the two archrivals of this city, FC (Fútbol Club) Barcelona and Real Club Deportivo Español (the Spanish Royal Sports Club), a match that was more like a reenactment of the Spanish Civil War than a mere athletic event.

There are, it sometimes seems, only two universal games: war and soccer. War is perhaps closer to the realm of fantasy, soccer to that of the real, but both share this ubiquity and centrality, as though arising from some collective libidinous source, primary and intuitive. Perhaps they are simply variations of the same game, modern industrial-era ritualizations of some common activity from the Dreamtime of the species, back when both used the same players and the same field—which is to say, all the men of the tribe and all of nature. Still today, they often fade into one another. Soccer

managers "declare war," generals apply soccer tactics and terminology, war-like violence invades the soccer field, spreads into the stands and out into the communities, soldiers wear their team colors into battle, fan clubs are known as "armies."

The explanations advanced for soccer's intense mysterious power, the trance-like quality of great matches, its worldwide domination over all other sports, have been many. There is the game's inherent theatricality—not the razzmatazz of an American halftime, but the inner dramas of sin and redemption, the testing of virtue, the pursuit of pattern and cohesion, the collision of paradoxical forces. Soccer has often been compared to Greek tragedy, or seen as a kind of open-ended morality play. Perhaps the difficulty in scoring (and thus the usual narrowness of margins of victory, even between teams of markedly unequal ability) intensifies this sense of theater, causing the denouement—or the collective catharsis—to be withheld almost always until the final whistle. Nor, until that whistle, is there relief from the tyranny of time's ceaseless flow: Once you've fallen into a game, there is no getting out. The player must stay with that flow, maintain the rhythm, press for advantage, preserving all his skills, his mind locked into the shifting patterns; and the spectator, though less arduously, shares this experience.

One is left at the end, not with data, but with impressionistic images of bodies in motion. Nothing of importance can be statistically recorded about a match except corners, shots, goals, and saves (the American effort to record assists is admirable but—since it's often a complete mystery, even with TV replays, who's scored the goal—a bit desperate), and these will tell you almost nothing about the game itself. The player who actually wins the game may be the one who moves into space at the opposite side of the field, drawing a defender, forcing a new configuration upon the defense and making virtually inevitable a goal that was before impossible, but no one—not even he—may be aware of this. It's all narrative, and thus subjective: Each game is a story, a sequence of ambivalent metaphors, a personal revelation couched in the idiom of the faith. No game I know of is so dependent upon such flowing intangibles as "pattern" and "rhythm" and "vision" and "understanding." Which may all be illusions. And at the same time it is a very simple game: like dreams, almost childlike.

ANGOLA

Greater Goal: Healing a War-Torn Land

By Henning Mankell

The first time I visited Angola I was not aware that I was in that country. It was 1987 and I was living in the northwestern corner of Zambia, near the Angolan border. Narrow sand roads twisted through the endless bush. It was easy to get stuck while driving, and I often lost my bearings on my way to some distant village. When I'd stop to ask for directions, if the person I spoke to answered in Portuguese then it was imperative to get back to the right side of the invisible border quickly. Angola, so deeply

wounded by its long colonial period, was throttled after liberation from Portugal by a violent civil war. The rebel leader Jonas Savimbi's warriors, infamous for indiscriminate violence, were everywhere. A generation of Angolans did not know what it was to live in a country where peace reigned.

But there was also something magical about that land beyond the invisible border: Soccer was everywhere. On gravel pitches and sandy beaches, on sidewalks and city squares, the ball was played back and forth between hordes of young men. The balls were made of the most remarkable materials, an old T-shirt or fishing net or woman's handbag filled up with paper and grass. But they rolled and bounced, and you could do headers with them and make goals with them. War could never kill soccer in Angola. The soccer fields were demilitarized zones, and the face-off between teams conducting an intense yet essentially friendly battle served as a defense against the horrors that raged all around. It is harder for people who play soccer together to go out and kill each other.

Angola has seen many of its soccer players leave the country to seek their livelihood, mostly in Portugal. But they have not given up their citizenship. And when they are called home to put on black shorts and red socks and jerseys, their national team colors, they do not hesitate. They are known fondly as Palancas Negras, the "black antelopes."

On the eighth of October 2005, Angola arrives at Amahoro Stadium in Kigali. At that moment the astonishing situation is that if Angola can beat Rwanda by even a single goal, it will qualify for the World Cup ahead of Nigeria—no matter what happens in Nigeria's game against Zimbabwe. It is a nightmarish wait for all the Angolans who sit with their ears glued to radios. Luanda stands still, Huambo, Lubango, Namibe, Lobito, Benguela, Malanje, every city, every village is gathered at radios. Perhaps even the antelopes themselves stand out on the savanna with pricked ears.

When the first half ends, the score is tied at zero. Meanwhile, Nigeria is on its way to victory over Zimbabwe. But in Kigali the game continues without a goal. It all seems to be ending badly for Angola. One wonders what the players and coaches said to each other at the half. Nervousness spreads among the players. Rwanda, playing only for its honor, comes close to scoring on several occasions. Everyone agrees that Angola is playing miserably. It is a team at the edge of a breakdown, missing passes and misunderstanding each other. There are ten minutes left. The Angolans are almost unconscious in their desperation. Then the last-minute replacement Zé Kalanga makes a cross pass that is as surprising as it is brilliant. Fabrice "Akwa" Maieco is in the right place. With a header he perfectly launches the game's only goal, past Rwanda's goalie, one bounce on the ground, and then the ball flies up into the net.

A person would have to live for a long time in Africa to understand what this victory means. Of course no one imagines today that Angola will get very far in the tournament. But it is in the very nature of soccer to be unpredictable. If it were not the case that underdogs can sometimes defeat the predicted winners, soccer would be uninteresting.

But a great victory has already been won. It brought no gleaming cup. This triumph exists first of all in the hearts and *(Continued on page 68)*

Henning Mankell is the author of some 40 novels, including crime novels featuring inspector Kurt Wallander. He divides his time between Sweden and Mozambique, where he directs Teatro Avenida.

Inspired Play

American superstar Mia Hamm shows the form that helped propel her team to victory over China in the 1999 women's World Cup. Hamm joined the U.S. team in 1987—the youngest ever at age 15—and inspired a generation. In the past two decades, the U.S. Youth Soccer League has added more than a million players.

ANNIE LEIBOVITZ, CONTACT PRESS IMAGES

Follow the Ball

Street-corner kids kick it around in Mikindani, Tanzania, perhaps dreaming of stardom. And why not? Africa now fields hundreds of pro soccer teams, and recruiters from around the world woo African players—furthering the reach of this global sport.

SVEN TORFINN, PANOS PICTURES

(Continued from page 63) minds of the Angolan people. To go to the finals of the World Cup in soccer means an enormous amount to the self-confidence of a country that has been ravaged by war and deprivation. A country, battered for so long, will be built up again.

ARGENTINA

Ode to Maradona: Falklands' Revenge

By Thomas Jones

Thomas Jones is an editor and writer at the London Review of Books.

The highest compliment anyone could pay anyone else when I was growing up in England in the 1980s was "skill" (as in "man, your new skateboard is so skill"), and nobody was more skill than Diego Armando Maradona. His name was invoked as the highest form of praise, on the soccer field and elsewhere ("man, your new skateboard is so Maradona"). It took me a while to realize that the word referred to a human being, let alone a soccer player. Then I saw him score against Italy in the 1986 World Cup, leaping several feet into the air outside the left edge of the six-yard box to tap the ball deftly over the outstretched right leg of the Italian captain, past the outstretched arms of the keeper, and into the bottom right-hand corner of the goal. It was evident, even to me, that Maradona was not merely skillful, but skill embodied.

The next time Maradona scored was June 22, the day Argentina played against England. The two nations had last clashed four years earlier, not on a soccer field but in the Falklands War, which Argentine writer Jorge Luis Borges later compared to "a fight between two bald men over a comb." By the time Britain had retaken the islands from Argentina, more than 900 men (most of them Argentines) had lost their lives. The victory saw Margaret Thatcher's popularity soar in Britain; the defeat contributed to the downfall of the right-wing military junta that had ruled Argentina since 1976.

All that was ancient history four years later—or so both teams insisted before the game. Maradona scored both of Argentina's goals in a 2-1 victory over England. The second of them, 11 dazzling seconds of superhuman skill, was voted Goal of the Century in 2002. When Maradona executed an exquisite arabesque, stretching his right leg elegantly behind him, I wouldn't have been surprised if he'd taken off into the air and started flying. He appeared to be moving through a different time frame from the England players, who came to tackle him only once he was already past them.

To my surprise, nobody I knew wanted to talk about that second, extraordinary goal. All anyone wanted to talk about was the one he'd scored four minutes earlier, with his fist. Maradona's one-time fans were seething with fury, as if he'd betrayed them personally. Overnight his name had become an insult, a by-word for cheating. I was baffled. What became known as the Hand of God incident just didn't seem so bad to me; it still doesn't. For one thing, I find it impressive that Maradona, five feet five inches tall, should have beaten the goalie, who was nearly a foot taller, to the ball. And weren't the referee and linesman most at fault, for not spotting the foul and for

allowing the goal? I've always suspected that high-minded censure of the Hand of God is a way of dressing up disappointment and frustration that England lost; that the behavior for which England fans will never be able to forgive Maradona is not his cheating, but his running around five England players like so many wooden posts to score the greatest goal that's ever been scored and knock England out of the World Cup.

CROATIA

Group Therapy: A Nation is Born

By Courtney Angela Brkic

Not so long ago, when Croatia was part of Yugoslavia, soccer was an expression of ethnicity, of political orientation, of self. Many feel that a 1990 match between Zagreb's Dinamo and Belgrade's Red Star marked the beginning of Croatia's war for independence. At the beginning of the match, fans from both sides clashed in the stands and on the field. The Serb-dominated police beat Croatian fans while allowing Serb fans to run amok, and the events caused the already bubbling frustrations with Yugoslavia to boil over. Even the players were not immune. Upon witnessing a policeman beating a fallen Dinamo fan, midfielder Zvonimir Boban karate-kicked him, becoming a hero of the growing independence movement.

The war that followed was long and brutal. More than ten thousand people were killed, and one thousand are still missing today. Not surprisingly, tourists stopped visiting the Croatian coast, and the region became associated with suffering. For a country so rich in potential, so enthusiastic about what it could achieve now that it was on its own, being classified simply as a war zone or a former Yugoslav republic was a blow.

Croatia's independence was recognized in 1992, but the 1998 World Cup brought another form of recognition. Elation had already begun to sweep the country when Croatia beat powerhouse Germany in the quarterfinals. "Is it really possible?" people seemed to be asking one another, unable to contain their optimism. In Zagreb, large-screen televisions were set up on the city squares so people could watch the Croatia-Netherlands third-place match in raucous groups. It was a Saturday, and I watched in my apartment with friends, drifting out to the balcony to listen to the excited conversations and shouts coming from the cafés below. The sound of cheers filled the air when Croatia scored. It was like the city was one gigantic living room, everyone's eyes on a single television set. Traffic all but stopped, and the street below was empty. When the game finished with Croatia the winner, people flooded the streets. They filled the main square, and that night, all night, we heard happy, drunken voices singing.

Coming nearly three years after the war ended, it was an emotional moment in a young country's history. On television, reporters interviewed grown men who could not stop weeping. The country had not seen such unified celebration since its declaration of independence. Now no one could deny Croatia its place on the map. □

Courtney Angela Brkic is the author of Stillness: And Other Stories *and* The Stone Fields: An Epitaph for the Living.

Soccer Savvy

Read the complete text of essays by Sean Wilsey, Nick Hornby, and Robert Coover, from *The Thinking Fan's Guide to the World Cup,* online at **ngm.com/0606.**

Mystery of the Tattooed Mummy

She lived and died 1,600 years ago among the Moche of ancient Peru, a people ruled by fierce men. Yet this remarkably preserved woman was buried with symbols of power, including a golden crown bearing a savage supernatural face. Who was this elite figure?

By A. R. Williams NATIONAL GEOGRAPHIC SENIOR WRITER
Photographs by Ira Block

The Moche didn't embalm their dead. Most corpses decayed normally, leaving bare bones as the only proof of lives extinguished. In a very few instances, though, nature and human reverence worked together to preserve the deceased as a mummy. This was the fate of the tattooed woman whose elaborately wrapped remains were discovered last year at a ceremonial site called El Brujo—the Wizard—on the north coast of Peru. Rising to power a thousand years before the Inca, her people created a sophisticated culture now known for its fine ceramics and masterful metalwork.

A recent autopsy revealed that the tattooed woman had borne at least one child and died in her late 20s, but no trace of what killed her was evident. Her untimely demise must have shocked her people, who laid her to rest in full regalia at the peak of a temple where bloody sacrifices were performed (National Geographic, July 2004). Her body was daubed with cinnabar—a red mineral associated with the life force of blood—wrapped in layers of cotton cloth, and entombed in thick courses of adobe. Then the dry climate of the Moche's desert realm desiccated her body.

No other Moche woman like her has ever been found. "Based on our preliminary study, we think she was a ruler," says archaeologist Régulo Franco, whose work is supported by Peru's National Institute of Culture and the Augusto N. Wiese Foundation. If so, she may revolutionize ideas about the Moche, whose leaders were believed—until now—to be men.

Tattoos of snakes and spiders (left), creatures linked to agricultural rites, mark the mummy's arm. "Maybe she predicted bumper crops or harvest failures," says archaeologist Régulo Franco. A ceramic vessel from her tomb shows a healer and a mother holding a baby girl—clues, perhaps, to who she was in life.

Domain of the Dead

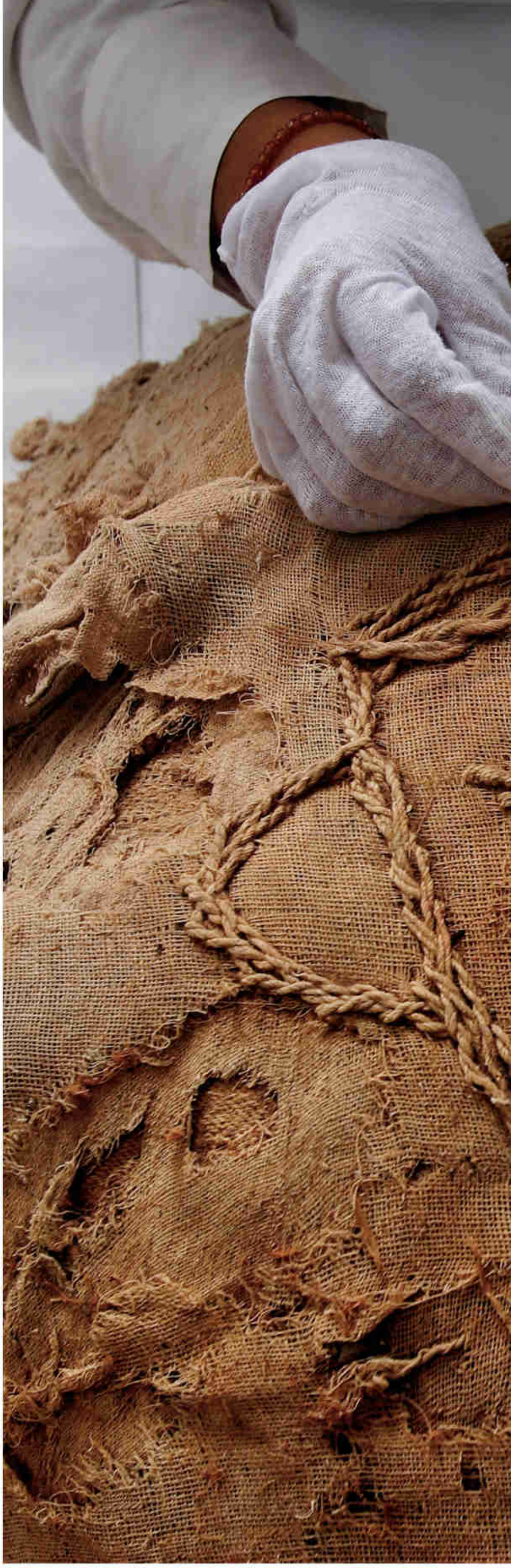
High above the Pacific Ocean, an ornate enclosure holds four graves (below): the largest, belonging to the tattooed woman, from about A.D. 450; and others, still enigmatic, containing men. "This patio was the señora's mausoleum, built for her in a sacred space," says Régulo Franco. Those who came to honor her burned offerings and poured libations into a vessel set above her tomb. Beneath six courses of adobe, a cane scaffolding, a reed mat, and six tree trunks, archaeologists discovered the large bundle containing her body (right). At her side lay the skeleton of a sacrificed girl with a cord still around her neck. After carefully removing the bundle, workers carry it to a lab for unwrapping (far right).

The Moche Culture

Peru's Pacific coast has been home to a succession of cultures. The Moche flourished in Andean river valleys for more than seven centuries. El Brujo was one of many seats of power, as was Sipán, where excavations in the 1980s uncovered two male rulers.

Surprising Details

Never before seen in a Moche burial, an embroidered face adorns the mummy's funerary bundle. To start the unwrapping, textile expert Arabel Fernández removes the stitches. "I think the face humanized the bundle and reminded mourners that this was no ordinary person," she says. A wooden statuette with a war club was interred nearby, likely as a symbolic guardian.



Confused Identity

Stripping off the first several layers of cloth, which winds continuously around the bundle, a team of specialists finds sheets of a copper-gold alloy flanked by two huge ceremonial war clubs (far left). No such weapons have ever been found with a woman, so they initially assume the deceased is male. But beneath the cotton batting of layer 17, Arabel Fernández and an assistant (left) uncover tools for weaving, a craft probably practiced by women. Deeper still lie golden bands sewn to fabric (above) now beginning to reveal the shape of this puzzling figure.

Intact Treasure

At the center of the bundle lies the mummy, whole, with a golden bowl over the face and beads spilling from necklaces long since disintegrated. Protruding from the fabric, two nose rings reveal one side of their symmetrical design: a head pecked by a condor (far left) and a man carrying a war club (left). Such adornments, previously found with high-ranking males, add to the mystery of the burial—especially after an exam proved the mummy is female. Did she use all these goods while she was alive? Or were some meant as postmortem hallmarks of her family's heritage?

Body of Evidence

Though she kept a Moche woman's traditional braids (opposite), this extraordinary female may have taken up the masculine trappings of power once she rose to the top of the hierarchy at El Brujo. Did she dress for state occasions as a figure from a mythical sacrifice ceremony, appearing in a necklace of heads and one of the four crowns from her funerary bundle? Did she brandish a war club while wearing these delicate earrings (below, center)? Studies now under way will consider many such questions about this intriguing burial. □

Ancient Keepsakes View a gallery of artifacts from the tomb of this mysterious Moche woman, and find a list of related resources at **ngm.com/0606.**

ART BY KAZUHIKO SANO

Ungainly Grace

The American White Pelican

By Mel White

Photographs by Klaus Nigge

An American white sails above the Slave River in Canada's Northwest Territories. A wingspan of nine feet

gives this bird, awkward on the ground, astounding grace and endurance in the air.

Wintering in shallow waters on Florida's west coast, American whites cluster on a sandbar, alert with heads

raised as a boat passes. The birds live in large flocks, working together to catch fish.

An adult feeds a three-week-old chick regurgitated fish, crayfish, and salamander larvae at Montana's Medicine Lake (opposite). Some 4,000 breeding pairs come here each April. West Nile virus came too in 2003, killing about a thousand chicks. Fewer have died in the years since—not enough to threaten the overall population of more than 100,000. During mating season, both males and females grow a knob on the bill (visible on bird in foreground, above).

Should we pity the poor young pelican?

The Ugly Duckling, after all, grew up to be a beautiful swan, while the baby pelican—surely among the homeliest creatures on Earth—can look forward only to becoming . . . an adult pelican. Whether this constitutes much of an improvement is debatable.

Consider some of the words used by writers from Audubon onward to describe the American white pelican: clumsy, awkward, ungainly, grotesque, and absurdly ridiculous. Even the authoritative and no-nonsense new series *The Birds of North America* temporarily abandons scientific detachment to call the pelican somewhat comic, as if it were a feathered basset hound.

All right, then: The pelican is no swan, all sensuous curves and stateliness. It's chunky. It's jowly. It has clown feet and a bill like a shovel, and it expresses sexual ardor by turning red in the face and growing a giant wart on its nose.

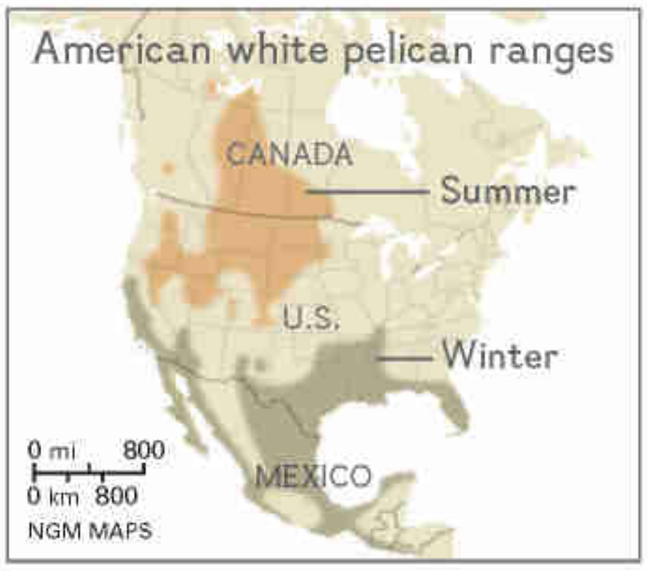
So what are we to make of the fact that those same writers reverse themselves, often in the very same paragraph, to call the white pelican majestic, magnificent, graceful, and truly beautiful?

Here's the reason: Our clumsy bird stood up, waddled forward, spread its wings, and took off. And voilà—caterpillar to butterfly in ten seconds.

Like loons and hot-air balloons, pelicans are not seen to their best advantage on terra firma. On the water, as Audubon wrote, "how changed do they seem!" Air sacs under the skin give them tremendous buoyancy; waves tip them back and forth like so many toy boats.

But it's in the air that pelicans are truly transformed. They rise with surprising speed for so large a bird, their flared primaries searching for wind currents and thermals to help them climb. They soar in great circles, dozens of birds wheeling together in an aerial ballet. An aircraft designer would say that the pelican's nine-foot wingspan, combined with a weight of around 15 pounds, gives it low wing loading. The nontechnical among us, presented with the sight of a sunlit gyre of pelicans, resort to words like majestic, magnificent . . . well, see above.

As is usually the case in nature, the pelican's beauty of form stems from roots of plain function. Waters where adults find the 150 pounds of fish it takes to raise one chick can be more than a



A pouch with a three-gallon capacity can hold a large fish (below). The pelican keeps its beak down to let water drain out, then tips its head back to swallow the fish whole. A gull harasses a pelican, perhaps defending its nesting territory (opposite). Pelicans can travel a hundred miles from their own nests and back again in a day to find enough food to feed their young.

hundred miles from breeding colonies—a commute made easier by the ability to soar and glide rather than flap continuously.

Nearly all American white pelicans migrate between nesting areas in the Great Plains and Great Basin and wintering grounds on the Gulf Coast, in California, and in Mexico. (A small number of nonmigratory birds nest in Texas and Mexico.) In the continent's midsection, pelicans flock together and follow the big rivers—the Mississippi, the Missouri, the Arkansas, the Red—on their journeys. For an Oklahoma rancher or an office worker in downtown Kansas City, the sudden materialization of 200 or more huge white birds circling overhead can be almost shocking.

Many white pelicans spend winters in the company of brown pelicans, their saltwater cousins. In coastal areas, a watcher from shore can compare the two species' feeding styles. The brown folds its wings in flight and plunges into the water at speeds up to 40 miles an hour. White pelicans feed while afloat, large flocks often fishing cooperatively in the ornithological version of Olympics-style synchronized swimming. Birds herd schools of small fish into coves or form a circle that gradually tightens like a seine net. Then the pelicans dip their

massively pouched bills into the water, scooping up prey in a frenzy of thrusting, paddling, and splashing. A pelican with a mouthful of minnows crooks its neck to let water drain from its pouch before swallowing—which is why it doesn't matter that, in the words of Dixon Merritt's famous limerick, "his bill will hold more than his belican."

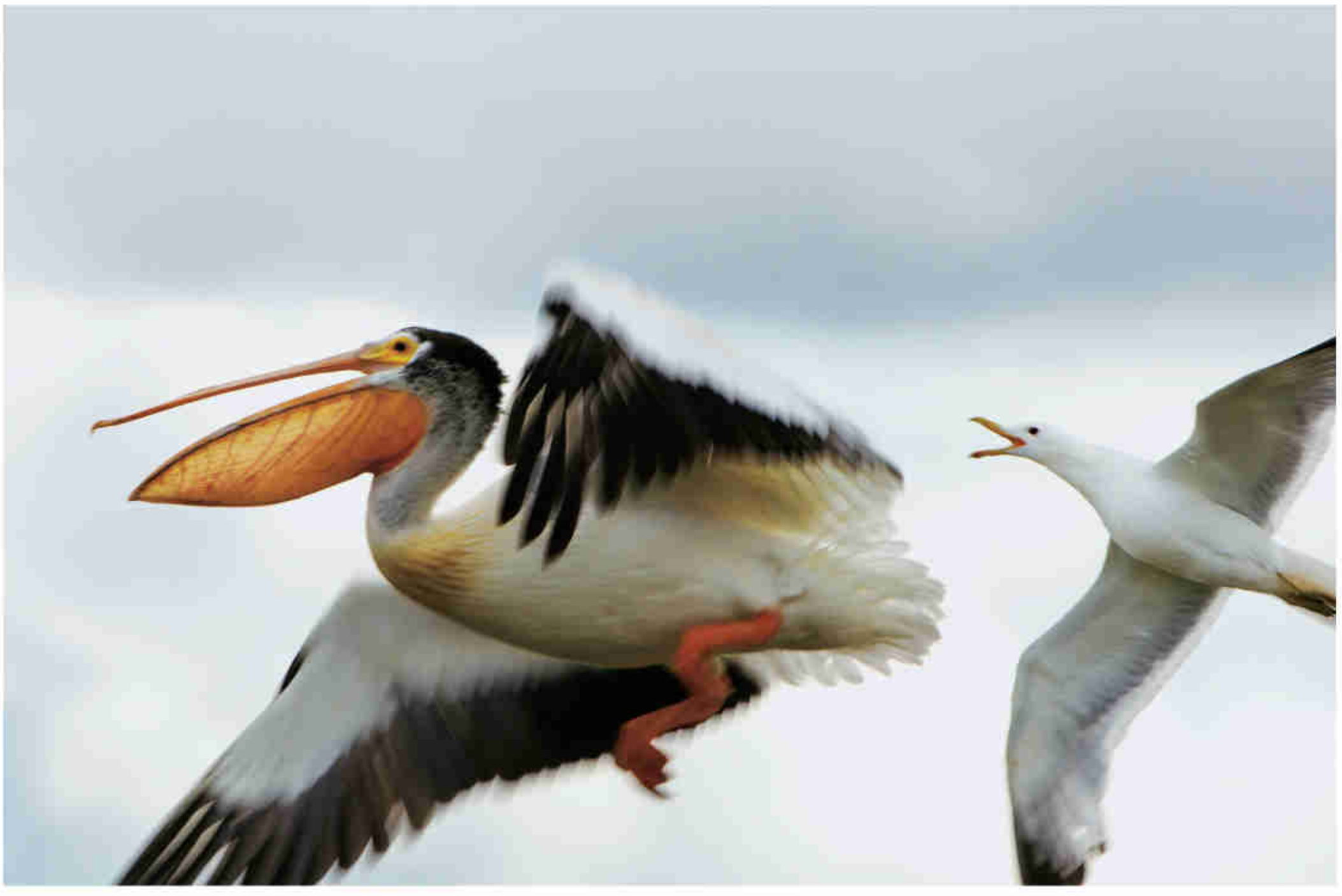
Once, American white pelicans were commonly shot by anglers who considered them competitors for fish. Government agencies disrupted nesting colonies, believing pelicans a threat to sport fisheries. The situation improved after studies showed that white pelicans catch mostly nongame species; better protection has contributed to a steady rise in numbers since the 1960s.

In recent years, though, a series of setbacks has biologists watching. West Nile virus, to which chicks seem especially vulnerable, has caused partial nesting failures in several white pelican colonies. At Chase Lake National Wildlife Refuge in North Dakota, home until recently to the largest colony in the United States, adult birds in 2004 abandoned eggs and newly hatched young for reasons still unknown. In 2005, something—perhaps prolonged cold, wet weather—caused mass mortality of young still in the nest. Two seasons that could have produced 15,000 or more pelicans on the refuge may have seen only a few hundred successfully fledge.

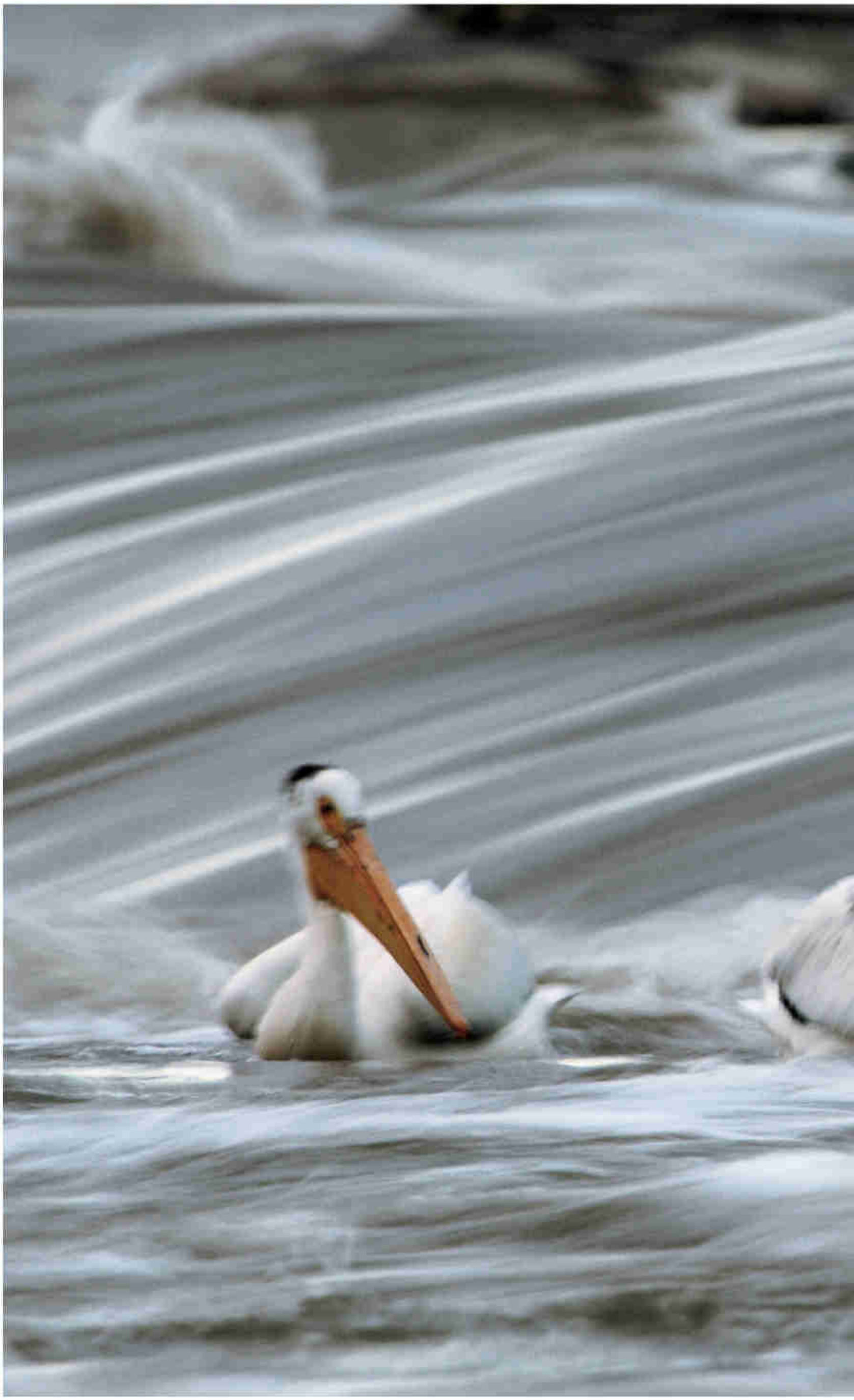
The problems may be only temporary, though, barely significant for a species that lives about 20 years. The genus *Pelecanus,* which encompasses all eight of the world's pelican species (or seven, if a certain Peruvian pelican is only a subspecies), has existed in more or less its present form for around 20 million years—far longer than the time since the first protohumans reared up on their hind legs to scan the African savanna. While to our anthropomorphic eye the pelican seems both goofy clown and graceful flier, the truth is that it's simply going about its business the way it always has, fitting precisely into its unique ecological niche.

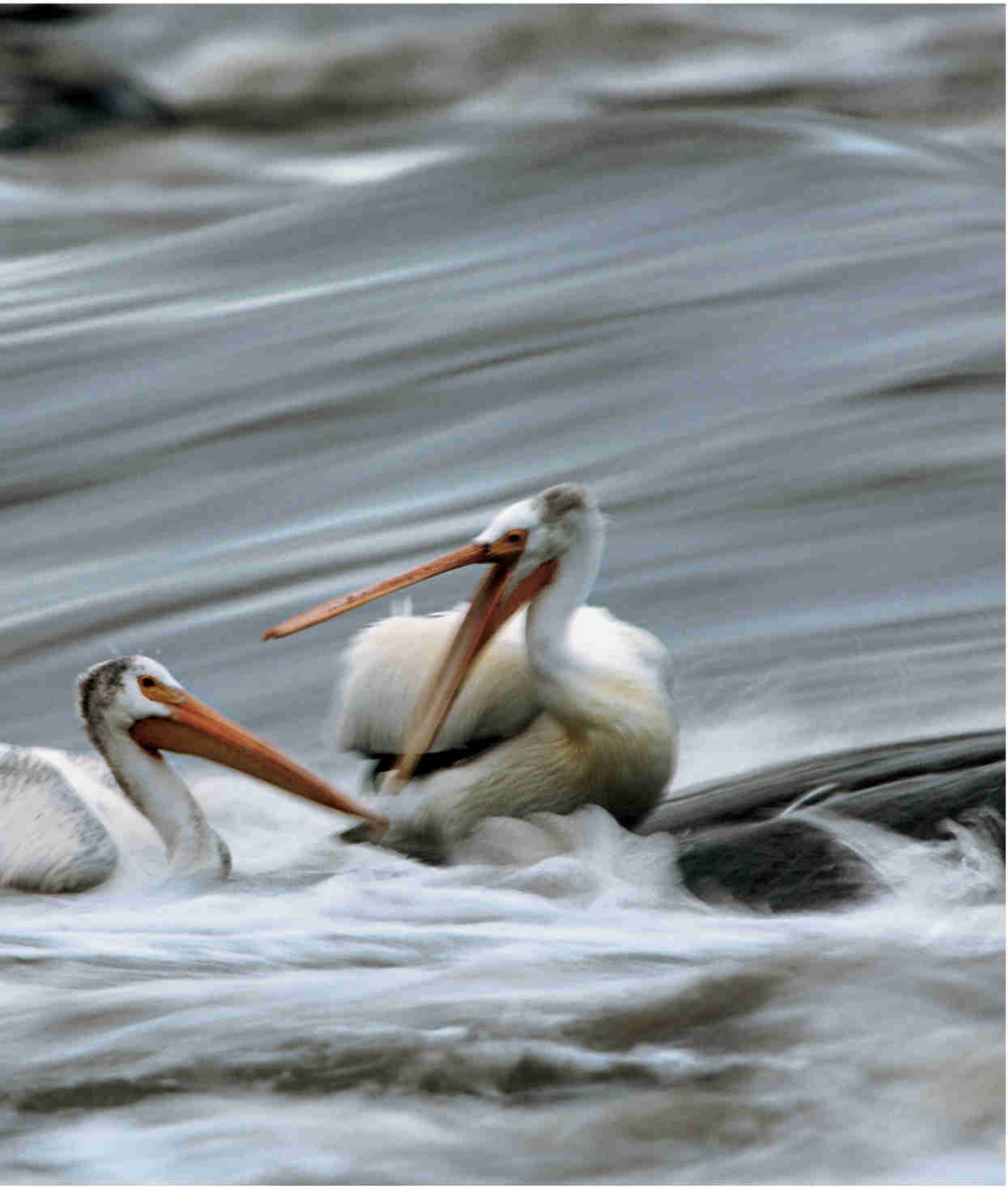
The pelican inspires laughter and wonder, and, maybe even more, a kind of affectionate empathy: After all, who among us hasn't at times felt awkward and unlovely, and yet imagined that—given room to stretch our wings—we just might be beautiful?

American Beauty Decorate your desktop with these majestic birds. Then view more pelicans in an online-exclusive photo gallery at **ngm.com/0606.**



In the fast-flowing waters on this stretch of the Slave River, pelicans that usually fish in groups must go it alone. Real estate in the rapids is hard to come by, and the bird on the right warns two others away from its foothold. The birds generally nest near quieter water.





American whites, such as these birds along the Slave River, can weigh up to 18 pounds, making them among

the largest of flying birds. Air sacs beneath the skin add buoyancy in the water.

Dawn breaks at Medicine Lake on the Montana prairie. Pairs breed on islands, safe from land predators. Males and females tend the nest and feed the young. Come fall, the birds head south to winter on warm coasts with their saltwater cousins, the brown pelicans, then return north to breed again. ▯

A nanometer is one-billionth of a meter. That's like comparing the size of a marble

to the size of Earth.

Welcome to the world of nanotechnology.

BY JENNIFER KAHN · PHOTOGRAPHS BY MARK THIESSEN · ART BY KENNETH EWARD
NATIONAL GEOGRAPHIC PHOTOGRAPHER

"I sit before you today with very little hair on my head. It fell out a few weeks ago as a result of the chemotherapy I've been undergoing. Twenty years ago, without even this crude chemotherapy, I would already be dead. But 20 years from now, nanoscale missiles will target cancer cells in the human body and leave everything else blissfully alone. I may not live to see it. But I am confident it will happen." Richard Smalley spoke these words on June 22, 1999. He died of non-Hodgkin's lymphoma on October 28, 2005. The 62-year-old Nobel Prize-winning chemist was a nanotech pioneer.

A tsunami is unnoticeable in the open ocean—a long, low wave whose power becomes clear only when it reaches shore and breaks. Technological revolutions travel with the same stealth. Spotting the wave while it's still crossing the ocean is tricky, which explains why so few of us are aware of the one that's approaching. Nanotechnology has been around for two decades, but the first wave of applications is only now beginning to break. As it does, it will make the computer revolution look like small change. It will affect everything from the batteries we use to the pants we wear to the way we treat cancer.

The main thing to know about nanotechnology is that it's small. Really small. Nano, a prefix that means "dwarf" in Greek, is shorthand for nanometer, one-billionth of a meter: a distance so minute that comparing it to anything in the regular world is a bit of a joke. This comma, for instance, spans about half a million nanometers. To put it another way, a nanometer is the amount a man's beard grows in the time it takes him to lift a razor to his face.

Nanotechnology matters because familiar materials begin to develop odd properties when they're nanosize. Tear a piece of aluminum foil into tiny strips, and it will still behave like aluminum—even after the strips have become so small that you need a microscope to see them. But keep chopping them smaller, and at some point—20 to 30 nanometers, in this case—the pieces can explode. Not all nanosize materials change properties so usefully (there's talk of adding nanoaluminum to rocket fuel), but the fact that some do is a boon. With them, scientists can engineer a cornucopia of exotic new materials, such as plastic that conducts electricity and coatings that prevent iron

GLOWING POTENTIAL
Injected into a healthy mouse, nanoparticles of cadmium selenide glow when exposed to ultraviolet light. Such quantum dots can seep into cancerous tumors and help surgeons find and excise sick cells without disturbing healthy ones.

A human hair is about 80,000 nanometers wide.

from rusting. It's like you shrink a cat and keep shrinking it, and then at some point, all at once, it turns into a dog.

Substances behave magically at the nanoscale because that's where the essential properties of matter are determined. Arrange calcium carbonate molecules in a sawtooth pattern, for instance, and you get fragile, crumbly chalk. Stack the same molecules like bricks, and they help form the layers of the tough, iridescent shell of an abalone.

It's a tantalizing idea: creating a material with ideal properties by customizing its atomic structure. Scientists have already developed rarefied tools, such as the scanning tunneling microscope, capable of viewing and moving individual atoms via an exquisitely honed tip just one atom wide.

"Nano's going to be like the invention of plastic," says Paul Alivisatos, associate director of physical sciences at Lawrence Berkeley National Laboratory's new nanofabrication center. "It'll be everywhere: in the scalpels doctors use for surgery and in the fabrics we wear." Alivisatos already owns a pair of stain-resistant nanopants from the Gap, made from fibers treated with fluorinated nanopolymer. "I spilled coffee on them this morning, and it rolled right off."

On a table in a lab at Rice University, André Gobin, a graduate student, is working with two slices of raw chicken. He nudges the slices together so they touch and dribbles greenish liquid along the seam. The liquid is a solution of nanoshells: minuscule silica beads covered, in this case, with gold. Switching on an infrared laser, Gobin deftly traces the beam down the length of the green line. Tweezing the chicken up, he dangles what is now a single piece of meat.

Someday soon surgeons may be able to use a nanoshell treatment like this to reconnect veins that have been cut during surgery. "One of the hardest things a doctor has to do during a kidney or heart transplant is reattach cut arteries," says Gobin. "They have to sew the ends together with tiny stitches. Leaks are a big problem." With Gobin's nanoshell solution a surgeon could simply meld the two ends and get a perfect seal. It would make grafting veins as easy as soldering wire.

Although much of nanotechnology's promise remains unrealized, investment in the field is booming. The U.S. government allocated more than a billion dollars to nanotechnology research in 2005—more than twice what it spent on sequencing the human genome when that project was at its height. Japan and the European Union have spent similar amounts, and even smaller countries are

How the gecko gets a grip

To see what enables this reptile to cling upside down to a pane of glass, zoom in on its toes (below). Millions of hairs are split into hundreds of tips, each roughly 200 nanometers wide. At this scale a faint intermolecular attraction called the van der Waals force pulls glass and hair tips together. Multiplied millions of times this force creates adhesion that holds the gecko.

GECKO TOES

MICROHAIRS (SETAE) ON TOES

NANOHAIRS ON MICROHAIRS

ANDREW SYRED, PHOTO RESEARCHERS, INC. (MIDDLE); KELLAR AUTUMN AND ED FLORANCE, LEWIS & CLARK COLLEGE (RIGHT)

The nail on your little finger is about ten million nanometers across.

hurrying to get a foot in the door. A Korean company has used nanosilver-based antibacterials in refrigerator interiors. The same material can be incorporated in bandages. The hope is the same on all fronts: to get the jump on a growing global market that the National Science Foundation estimates will be worth a trillion dollars by 2015.

One reason for the rapid global spread of nanotechnology is that the entry cost is comparatively low. Countries that missed out on the computer revolution because they lacked the capital to build vast, high-tech factories that make silicon chips are less likely to miss the nanotech wave.

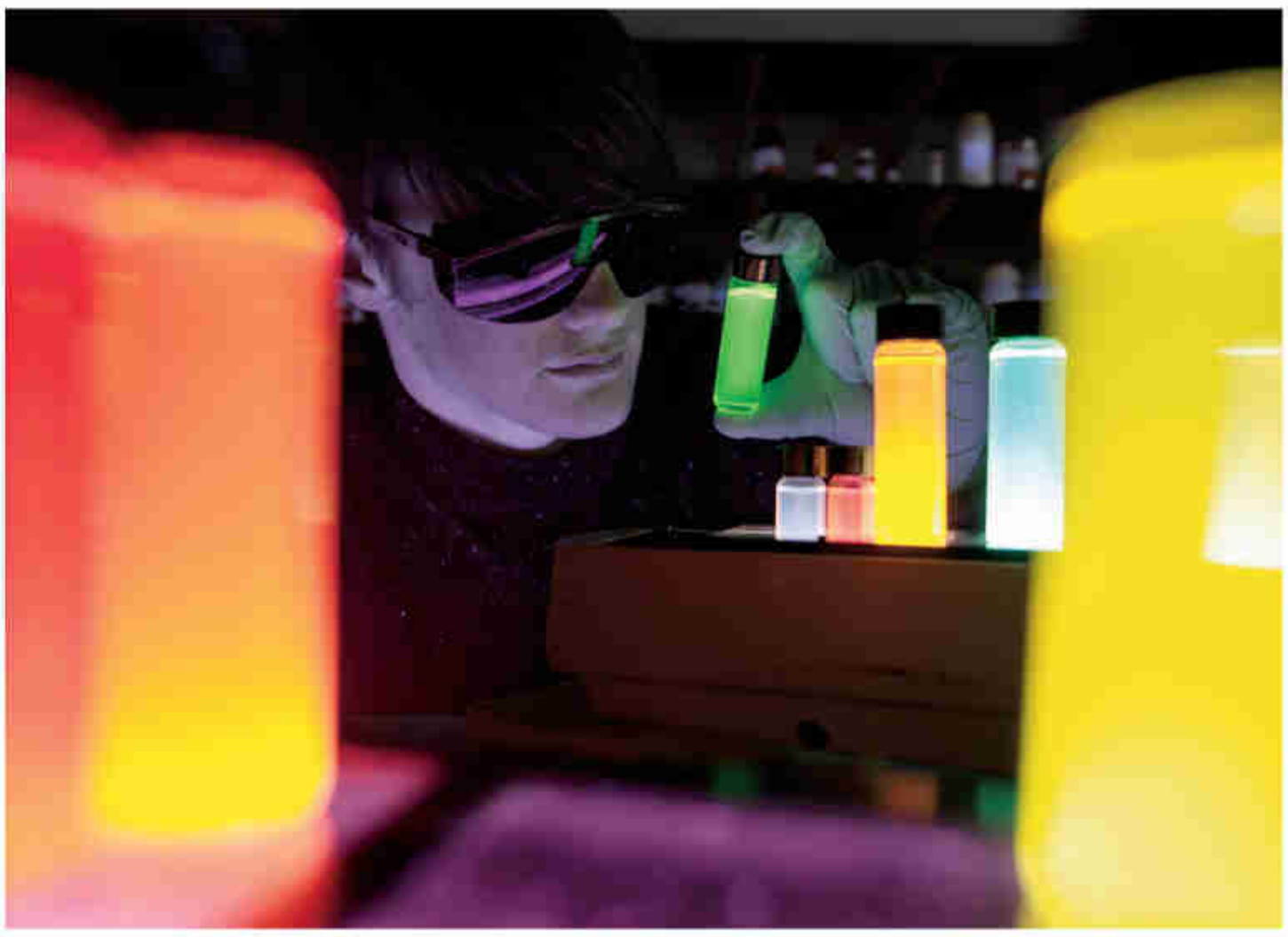
"It's science you can do in a beaker," says Stephen Empedocles, vice president of Nanosys, a company that's developing cheap solar nanostructures. Traditionally, the manufacture of solar-energy cells has required a multimillion-dollar fabrication facility that cooks sheets of glass at extremely high temperatures until the atoms order themselves into a receptive lattice-work. Solar nanostructures, on the other hand, grow like rock candy. You can "mix them up in a beaker with a hundred dollars' worth of starter chemicals," Empedocles says, and then paint them on window glass to turn an entire building into a solar-energy generator. Or, they might be embedded in the plastic body of a cell phone or laptop computer.

For a hundred dollars, in fact, anyone can buy nanoparticles—specifically a gram of carbon nanotubes—online. Place the order, and you'll receive a small ziplock bag of what looks like soot tucked inside a cardboard FedEx envelope along with some safety instructions. (They recommend gloves to keep the carbon slivers off the skin and a respirator to keep the tiny black specks from entering the lungs.)

There's not much you can do at home with a thimbleful of carbon nanotubes. But some of their mysteries are revealed in another Rice University lab, where Matteo Pasquali holds up a test tube containing a few dark threads so stiff that they seem to have been starched and ironed. These are fibers spun from carbon nanotubes—several billion of them—which, in theory, should be stronger than Kevlar, the material in bullet-proof vests.

For now, however, the threads are only about as tough as the acrylic found in an ordinary sweater. The reason the threads are weak, Pasquali believes, is because some portion of the billion nanotubes bundled together have hidden breaks. A photo taken through a microscope shows fibers that look like pale gray hairs, some perfectly straight, others frayed and curling.

END OF THE RAINBOW
Exposed to ultraviolet light, quantum dots of cadmium selenide look blue, green, or yellow when two to four nanometers wide; slightly larger dots appear orange or red. Because some materials change physical characteristics at the nanoscale, scientists and entrepreneurs are scrambling for a stake—and profits—on the technology's rapidly expanding frontier.



Killing cancer cells

While cancer treatments such as chemotherapy, radiation, and surgery are invasive or debilitating, nanotechnology promises treatment with barely a touch. Researchers, including Naomi Halas of Rice University, have engineered spheres of silica coated with a thin layer of gold that are about 120 nanometers in diameter (right). Injected into the bloodstream, they can infiltrate tumors. When an infrared laser is then focused on the tumor, as illustrated above, the intense light passes harmlessly through healthy tissue but heats up the nanoshells, which kill the malignant cells while leaving adjacent tissue unharmed. In laboratory tests, mice have remained healthy and tumor free more than 90 days after such treatments.

150 nanometers (nm)

SCANNING ELECTRON MICROSCOPE IMAGE (SEM): FELICIA TAM, HALAS NANOPHOTONICS GROUP, RICE UNIVERSITY

Shaquille O'Neal is 2,160,000,000 nanometers tall.

"We have split ends," Pasquali says with a sigh. "We need a nanotube conditioner."

Carbon has proved a useful element in nanotechnology. One of the science's building blocks is a molecule that contains 60 carbon atoms arranged in a sphere. A molecule of C_{60} looks like the geodesic dome invented by Buckminster Fuller, thus its nickname: buckyball.

Richard Smalley and colleagues discovered the buckyball in 1985, and in 1996 Smalley and two others earned a Nobel Prize in chemistry for the deed. Until his recent death, Smalley was a bucky fanatic. He renovated his house, close to the Rice University campus in Houston, with a glass skylight shaped like half a buckyball, with precisely proportioned steel struts representing the bonds between atoms.

Smalley was openly proselytical about the merits of buckyballs and a particular fan of their relatives, carbon nanotubes. ("Fifty to a hundred times stronger than steel and one-sixth the weight!" he often pronounced as though reporting the achievements of a precocious child.)

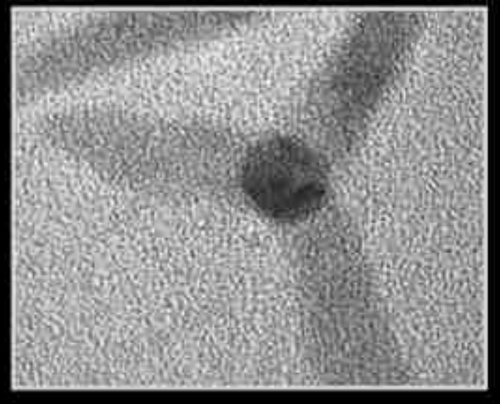
Because of their light, stiff composition, merely sprinkling carbon nanotubes into epoxy strengthens the glue by more than 30 percent. The tubes have also begun turning up in high-end sporting equipment. They strengthen tennis rackets, mountain-bike handlebars, frames for racing bikes, and golf-club shafts. Carbon nanotubes also show promise for use in transparent conductive films for displays on computers, cell phones, PDAs, and automatic teller machines.

Smalley was also an ardent advocate of nanotubes as a solution to the world's impending energy crisis. His plan was to replace old copper and aluminum power lines with wires spun from carbon nanotubes. Nanotubes can carry far more current than traditional metal wires—over a billion amps of current per square centimeter—and, unlike metal wires, they lose very little of that energy as heat. In theory, the nanotube power lines would carry electricity over thousands of miles. Rather than relying on local coal-fired power plants, cities could use energy generated by giant solar farms in deserts or by wind farms off coasts. "This is the great getting-up morning of nano," Smalley said. "If Mother Nature allows it, we could restring the electrical grid of the world."

Not everyone is so sure. Carbon nanotubes come in three types. They all conduct electricity, but only one does it especially well. And so far no one has come up with a way to make those nanotubes very long. Right now, the

CATCHING THE SUN
Solar energy panels like this prototype made by Nanosolar of California are more flexible than conventional solar cells and cheaper to make. Sheets of metal foil are run between spinning cylinders that apply a layer of nanocrystals. Houses sided with such nanopanels might lighten the load on existing electric grids, especially at peak usage times when outages occur.

A new kind of power grid



Nanocrystals—the tiny towers of power in thin-film solar panels—can be made cheaply in a lab beaker. The ones illustrated above generate electricity when photons from sunlight hit the crystals, exciting electrons and initiating a flow in the crystals' four arms, each one roughly 20 atoms wide (right). The flow through the arms and a polymer substrate creates a current. But such tetrapods convert only 3 percent of the sun's power into electricity, whereas traditional solar cells convert 9 percent. Nanosolar's SolarPly (opposite) claims 12 percent efficiency. "The challenge ahead is to modify the crystals' structure to improve efficiency even more," says Paul Alivisatos, a research director at Lawrence Berkeley National Lab.

TRANSMISSION ELECTRON MICROSCOPE IMAGE: STEVEN M. HUGHES, ALIVISATOS GROUP, UNIVERSITY OF CALIFORNIA, BERKELEY

One nanometer is to an inch what one inch is to 400 miles.

longest electricity-conducting nanotube in existence measures a fraction of an inch.

At the root of the problem is the fact that there are two ways to make nanoparticles: "top down," where a bulk material gets chopped down into nanosize bits, and "bottom up," where molecules grow under controlled conditions, as in crystals, and then snap together into particular configurations based on their charge and molecular chemistry.

Bottom-up constructions—which long carbon nanotubes would require—are where the real power of nano lies. But they're also far more complicated, subject to all the laws of bonding that limit the ways atoms and molecules can be arranged. Getting carbon to curl into a perfectly aligned tube rather than a thick, twisted scroll is exceedingly complex.

Scientists are still relatively ham-fisted when it comes to the finer points of bottom-up assembly, particularly compared with a far more prolific nanofactory: the human body.

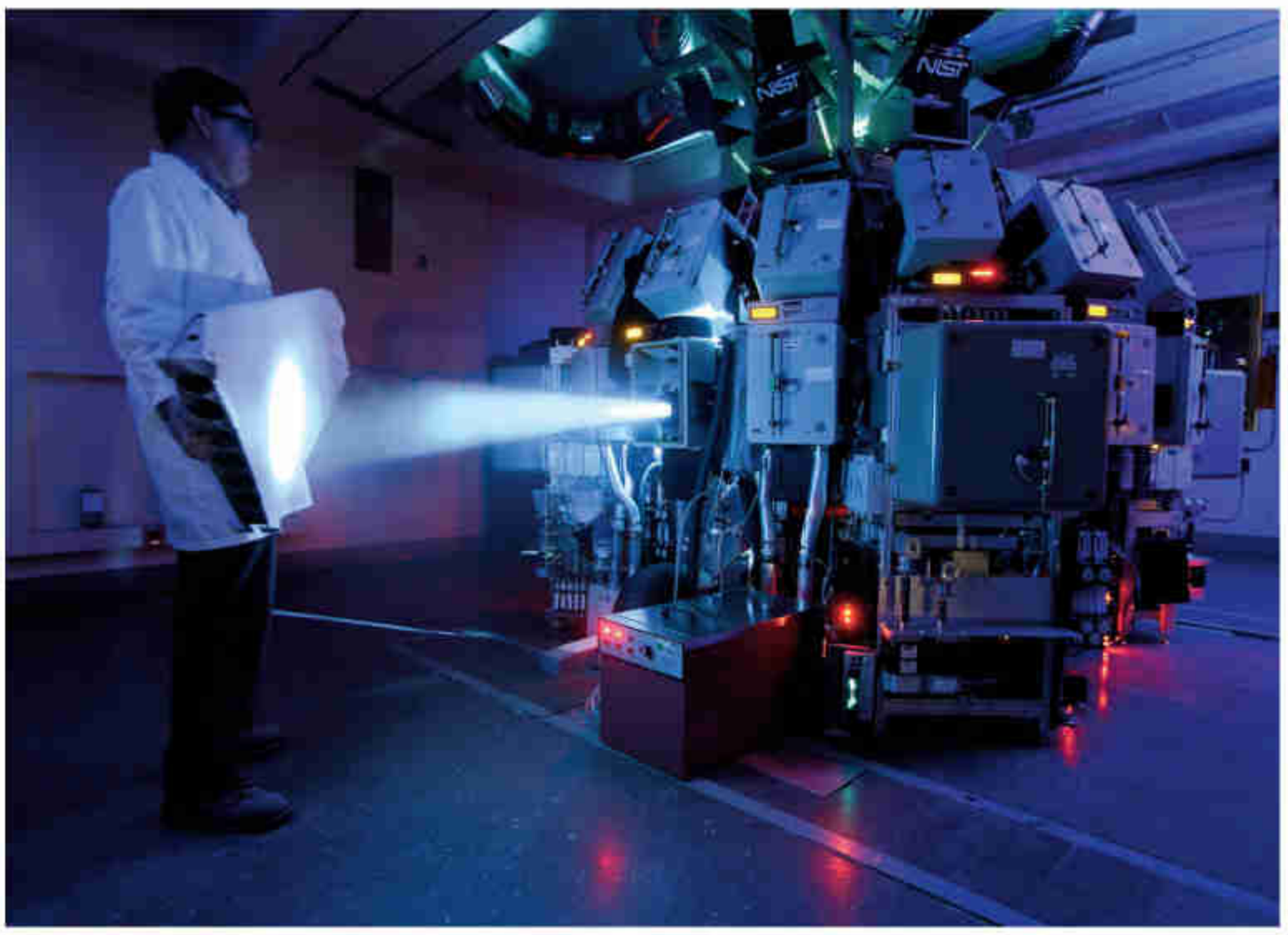
The human body makes quick and constant work of assembling raw materials like calcium and keratin to create elaborate structures like bones and skin. Compared with the work a blood cell does, scientists are "pretty much inept," admits Jim Heath, a Caltech chemist who is developing nanoscale sensors capable of detecting and diagnosing cancers. "But we're learning. We've come a long way in the past two years."

Heath's goal is to identify cancers early, when they are still just a few thousand cells strong and far easier to treat. Unlike HIV or malaria—viruses that produce unique antibodies identifiable from a simple blood test—cancers are difficult to spot. Nonetheless, they do leave what Heath calls a fingerprint: a change in the number and type of proteins that regularly circulate in the blood.

Determining which combination of proteins makes up the unique signature of a particular cancer is an ongoing project. "To diagnose one cancer reliably in the early stages, we probably need to measure 20 or 25 different proteins," Heath says. "So to develop a test that would identify 20 different cancers, we'd need about 500 measurements. And we would want to be able to do that easily, with just a finger prick of blood."

Heath has already developed nanosize sensors called nanowires that can electronically detect a few protein molecules along with other biochemical markers that are early signs of cancer. Heath's strategy is to coat a collection of nanowires with different compounds, each of which binds to one particular marker. When the marker, which can be a protein, an antibody, or

BATTERING BEAMS
Researchers call it the Death Star, but formally it's known as the SPHERE, or Simulated Photodegradation by High Energy Radiant Exposure. At a government lab in Maryland, SPHERE is used to test the strength and durability of new nanotech materials by bombarding them with intense ultraviolet light. (Actual tests are conducted with the light chamber sealed.)



Want tough? Go tubular.

A chunk of carbon, squeezed long and hard enough, becomes a diamond. Massage it at the atomic level, and carbon morphs into a material equally mesmerizing: nanotubes (illustrated above). To make them, Ray Baughman and his team at the NanoTech Institute at the University of Texas at Dallas grow a forest of carbon strands (vertical lines at right) by heating acetylene gas on an iron-coated wafer. Then they touch the tubes with adhesive tape and pull, which realigns the nanotubes into longer, stronger ropes (horizontal lines). Carbon nanotubes are 50 times stronger than steel wire and can carry a thousand times more electricity than copper wire. “The bottleneck is how to arrange trillions of these tubes into an ordered material,” says Baughman.

SEM IMAGE: MEI ZHANG, NANOTECH INSTITUTE, UNIVERSITY OF TEXAS AT DALLAS

HOW STRONG ARE THEY?
In holding up a ladybug, carbon nanotubes stretched between copper wires support—at each contact point—more than a million times their own weight. Just four ounces of this unwoven material would cover roughly an acre.

A nanometer is one-tenth the thickness of the tinted coating on a pair of sunglasses.

DNA, latches on, it changes the conductivity of the nanowire, creating a tiny but measurable alteration in current. Heath has combined tens of thousands of these sensors onto a single chip, which allows him to detect cancer-signifying molecules in blood while their concentration is still low. The chips also allow him to identify what types of cancer are present. Currently, Heath reports, his chip can detect between 20 and 30 relevant biomolecules. He plans to begin using the chip to detect brain cancers this summer.

Richard Smalley was one scientist who followed Heath's progress carefully. Smalley's non-Hodgkin's lymphoma was a relatively slow-moving cancer, but even when he was in remission, between a hundred million and a billion cancer cells circulated in his body (a number that doctors consider relatively low).

One of the advantages of treating cancer in an early stage is that the cells are less likely to have mutated and become resistant. Drug resistance is one of the trickiest things about cancer, which adapts so rapidly that medications can rarely keep up. "You don't want a killing mechanism to be fancy," Smalley said. It needs to be fast and thorough.

But targeting a brute-force treatment is difficult, says Jennifer West, a bioengineer who is treating tumors in mice using gold nanoshells. Difficult because things that kill cancer cells typically kill healthy cells as well. "That's what we'd like to avoid," West says. Her approach relies on the fact that tumors grow blood vessels so quickly to keep up with the rapidly multiplying tumor cells that they don't have time to knit tightly and instead leak like rusted pipes. West's gold nanoshells are about 120 nanometers in diameter—a cancer cell is 170 times bigger. So the nanoshells are minute enough to seep through the cracks in the tumor capillaries and become lodged in the tumor.

To kill the tumor, West activates the shells with infrared rays that pass harmlessly through the skin but heat the gold, killing the adjacent tumor cells. Because the cancer cells die, they don't develop the resistance that can plague drug-based cures.

Moreover, because the nanoshells lodge only in the tumor and are nontoxic unless activated by infrared light, West expects her treatment to be nearly side-effect free—particularly compared with treatments like chemotherapy and radiation. As part of the FDA approval process, West has injected mice with increasingly large doses of nanoshells. Not a single mouse has died. "We

INDUSTRIAL MUSCLE
Fire-resistant glass (left) contains a layer of silica nanoparticles that help panes withstand temperatures of up to 1800°F for more than two hours. At an ExxonMobil oil refinery in Louisiana (right), a white layer of nanocrystals made with zeolites works like a filter. Crude oil forced through the filter turns to diesel fuel. Changing the zeolites' nanostructure changes the by-product.

SHADES OF THE PAST
Medieval artisans could not see the nano realm, but they saw its power: Nanoparticles of gold incorporated in glass produces colors from yellow-orange to ruby red to purple. That metamorphosis helped artists create heavenly stained glass, and it still guides craftspeople today.

The head of a pin is a million nanometers wide.

haven't even been able to induce any adverse effects," she says with a shrug. "If we had injected these mice with the same amount of table salt, they would have keeled over long ago."

Unfortunately, the very thing that makes nanoshells such a promising therapy—their ability to move easily through the body and to interact with different cells—is a downside when it comes to the problem of nanoparticle pollution.

In 2004 Eva Oberdörster, a toxicologist at Southern Methodist University in Dallas, reported that largemouth bass exposed to water containing buckyballs at a concentration of 500 parts per billion suffered brain damage. And people are similarly vulnerable. After exposing lab-grown human skin and liver cells to an even weaker solution—a mere 20 parts per billion—Rice University chemist Vicki Colvin found that fully half the exposed cells died.

Results like these are troubling, in part because of the rapidly growing number of products already on the market that contain nanoparticles. "With nanomaterials, it's not enough to look at the properties of the bulk material," Colvin warns. "Whether you're working with gold or lead, the toxicity will be hard to predict." There is some evidence, for example, that the nanoscale particles of titanium dioxide used in sunscreen, depending on the way they are nanosized, can produce high amounts of free radicals when exposed to sunlight. Free radicals can damage cells, making some more likely to turn cancerous.

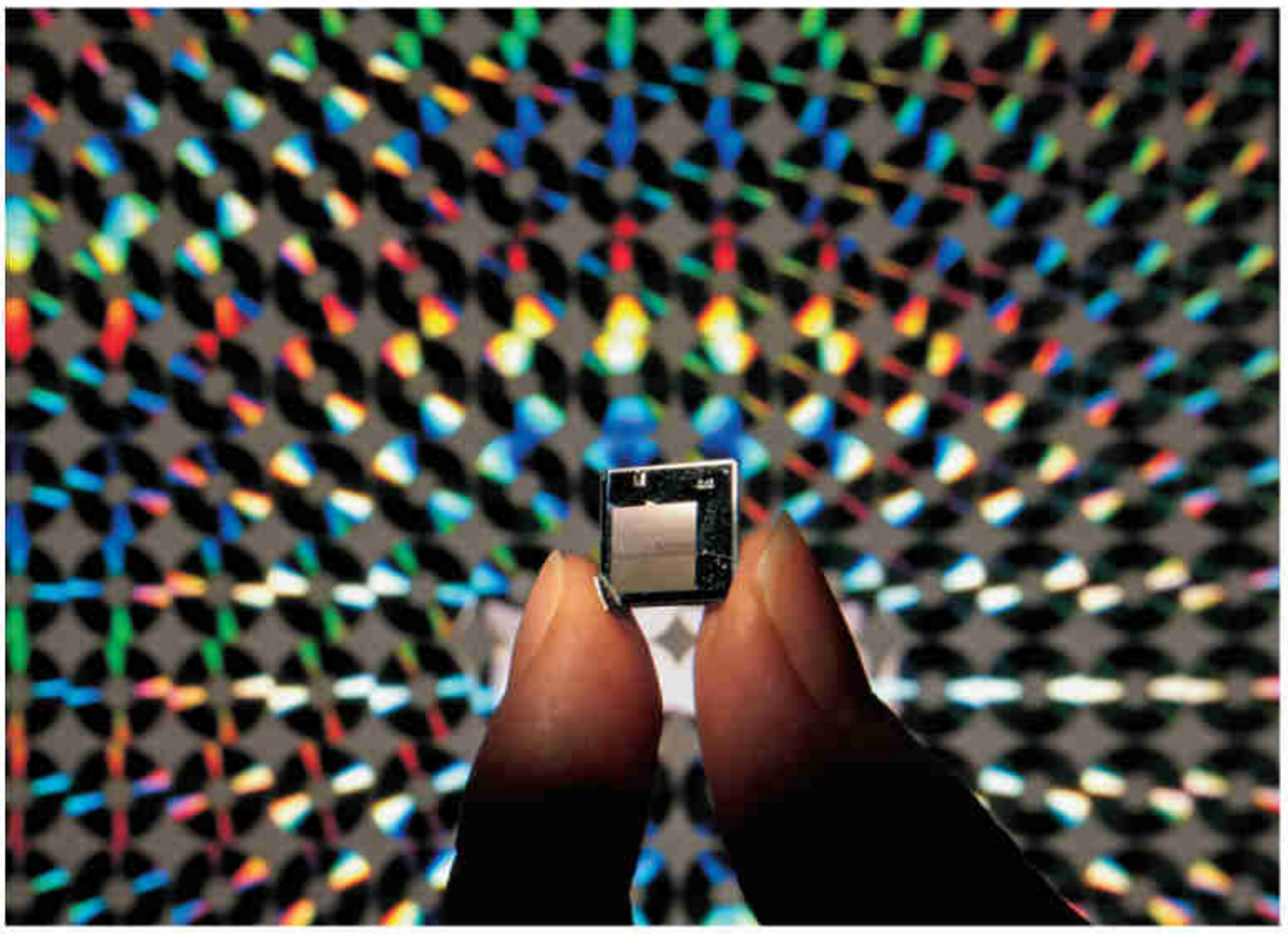
Colvin's concern is that companies are currently optimizing their particles for processability rather than for human health. A recent study found that buckyballs could be made less toxic fairly easily—by attaching inert molecules known as hydroxyl groups. The more hydroxyl groups attached, the less dangerous the buckyballs became. For the most thoroughly coated, the safe exposure level went up by a factor of ten thousand.

But it's hard to get funding for this kind of research, Colvin says. "Funding managers want a sexy story at the end of the day. They want to be able to say that they're helping to cure cancer. It doesn't sound as glorious when your finding is that a certain particle you were hoping to use ought to have hydroxyl groups put on it in order to be safe."

Still, researchers are making important advances. They are finding new ways to use nanosize sensors in water purification systems that will filter everything from bacteria to industrial pollutants like arsenic. The key feature of the new filters is the fact that nanoparticles have a vast

MAKING IT FIT

How can information from a dozen compact discs fit on a storage medium that's no bigger than a postage stamp (right)? At IBM's Probe Storage Group in Zürich, Switzerland, scientists are radically rethinking and shrinking the hardware that reads, writes, and erases data. Dubbed Millipede, it's a prototype with nanosize legs (opposite).



Memory's endpoint (for now)

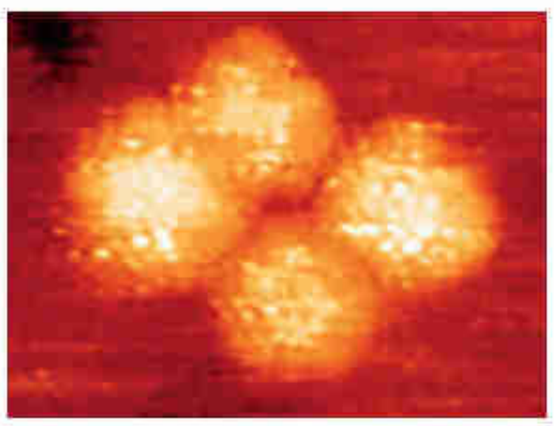
The mechanical synapses of IBM's Millipede memory device form a grid—a 64-by-64 array of cantilevers, each one equipped with a silicon tip (right) that narrows to only a few nanometers in diameter. To write data, the tip heats up and, as the cantilever darts back and forth, pockmarks a thin polymer sheet. To read data, a separate sensor (glowing rectangles) detects the presence or absence of a pit. And to erase data, the silicon tip gives a hole a second hot tap, which seamlessly eliminates the pit. "Do you remember the computer punch cards from the 1960s?" asks Evangelos Eleftheriou, manager of IBM's Probe Storage Group. "This is a similar idea, though we can erase data. And there's still room to make this even smaller."

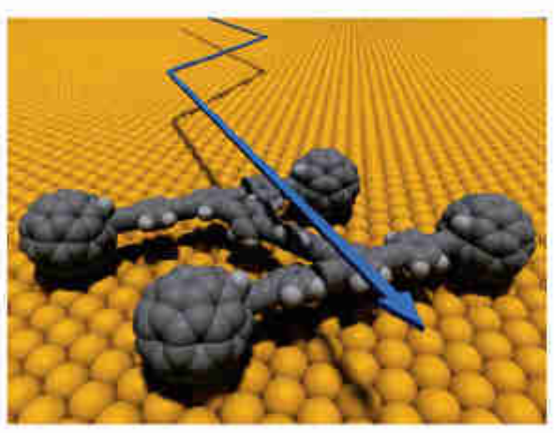
SEM IMAGE: IBM RESEARCH, ZÜRICH RESEARCH LABORATORY

A dollar bill is 100,000 nanometers thick.

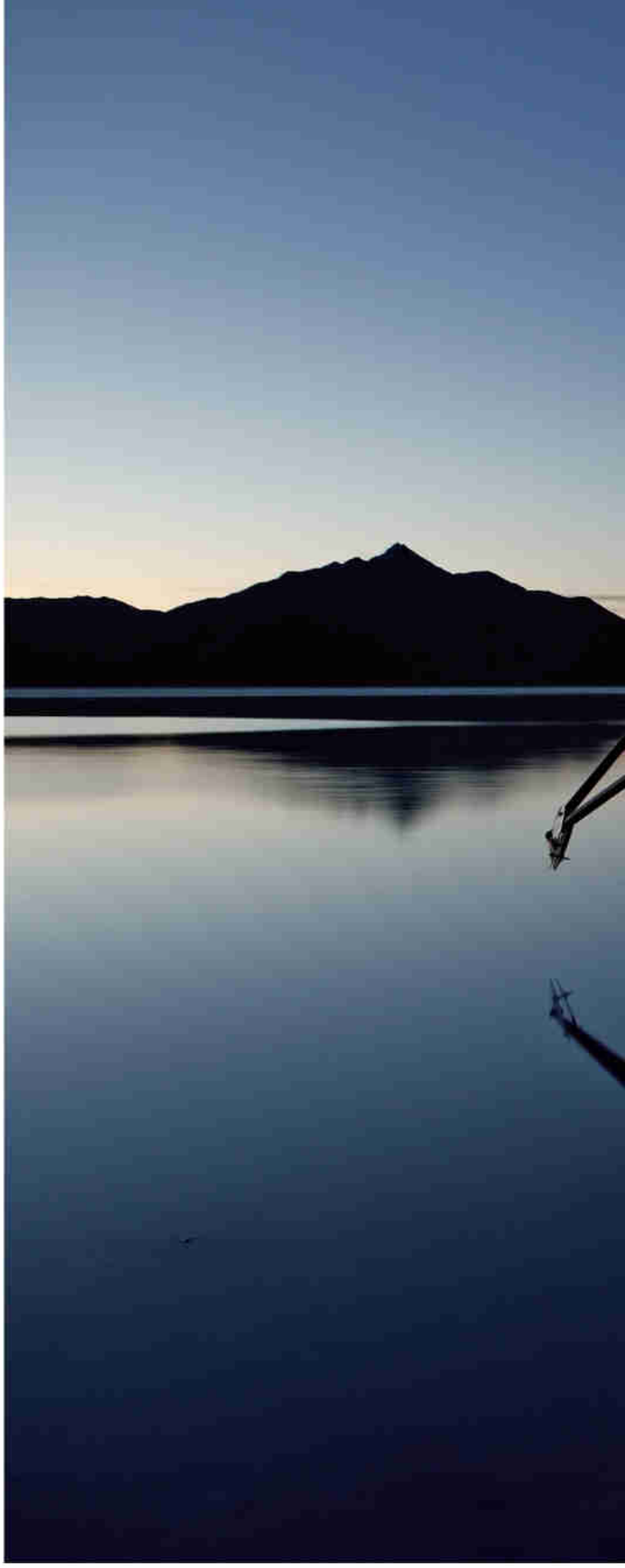
SMALLEY WONDERS

He was weakened by cancer, but Nobel laureate Richard Smalley was still eager to pull on rubber boots, wade into water with a light tube, and pose before a model of a molecule he discovered—all to make his point: Nanotechnology can help us. In 1985 Smalley and his team discovered a remarkably strong molecule made of 60 carbon atoms and resembling a geodesic dome; they dubbed it a buckyball (after Buckminster Fuller, who invented the dome). The discovery spurred Smalley's interest in carbon nanotubes, the most efficient electrical conductors ever made. Smalley envisioned a power grid laced with nanotubes that would distribute electricity from solar farms, thereby reducing our use of fossil fuels. At Rice University, researchers used buckyballs to make the wheels of a nanocar (upper), the world's smallest rolling vehicle (model, lower).





If nanotechnology one day revolutionizes cancer treatment, it will be too late for Smalley. But he died believing that small things are part of a bigger picture. In 1999 he said: "The technology of our 20th century is fantastic, but it pales when compared to what will be possible when we learn to build things at the ultimate level of control, one atom at a time."



amount of surface area for their weight: One ounce of nanobeads, for instance, contains a staggering 300,000 square feet of surface area. Because the chemical reactions that neutralize pollutants take place on the surface of the beads, the greater the available area, the more effective the filter.

The potential impact of nanofilters is substantial. Many regions in China have drinking water that contains dangerously high levels of arsenic and other industrial pollutants. Because of this, Colvin predicts that Asia will be a test bed for point-of-use water treatment systems that utilize nanoparticles to eliminate toxic chemicals. "Right now, nanoscale iron is a bit too expensive to be used to treat wastewater," she says. "But it's the best way to clean up concentrated arsenic, and I expect the cost will come down soon."

Because nanotech applications are so potentially useful, Colvin doesn't think research should be stopped, or even slowed. But she does think that a larger proportion of government money should be directed toward safety and related questions—like whether nanoparticles could accumulate undetected in the water and food chains.

Such safety issues are key, given the speed with which the nanotech tsunami is moving.

KEVIN KELLY AND ANDREW OSGOOD (UPPER) AND YASUHIRO SHIRAI (LOWER), RICE UNIVERSITY

Corporations will invest more than four billion dollars in nanotech this year alone, and a recent nanotech conference in Japan drew a crowd of 30,000.

Meanwhile, commercial applications continue to spread. Homeowners now have the option of installing windows manufactured by PPG Industries, a company that uses nanoscale particles of titanium dioxide to make glass that doesn't streak and never needs washing. Food companies have begun experimenting with nanopackaging that changes color when food spoils or contains bacteria like *E. coli.* The prefix has even trickled over into popular culture, where it's the advertising hit du jour, with GM hawking a "nano" Hummer, and Apple its iPod Nano digital music player.

"What's amazing is how quickly this is evolving," Colvin says. "Even ten years ago, a lot of these applications would have seemed pretty unrealistic."

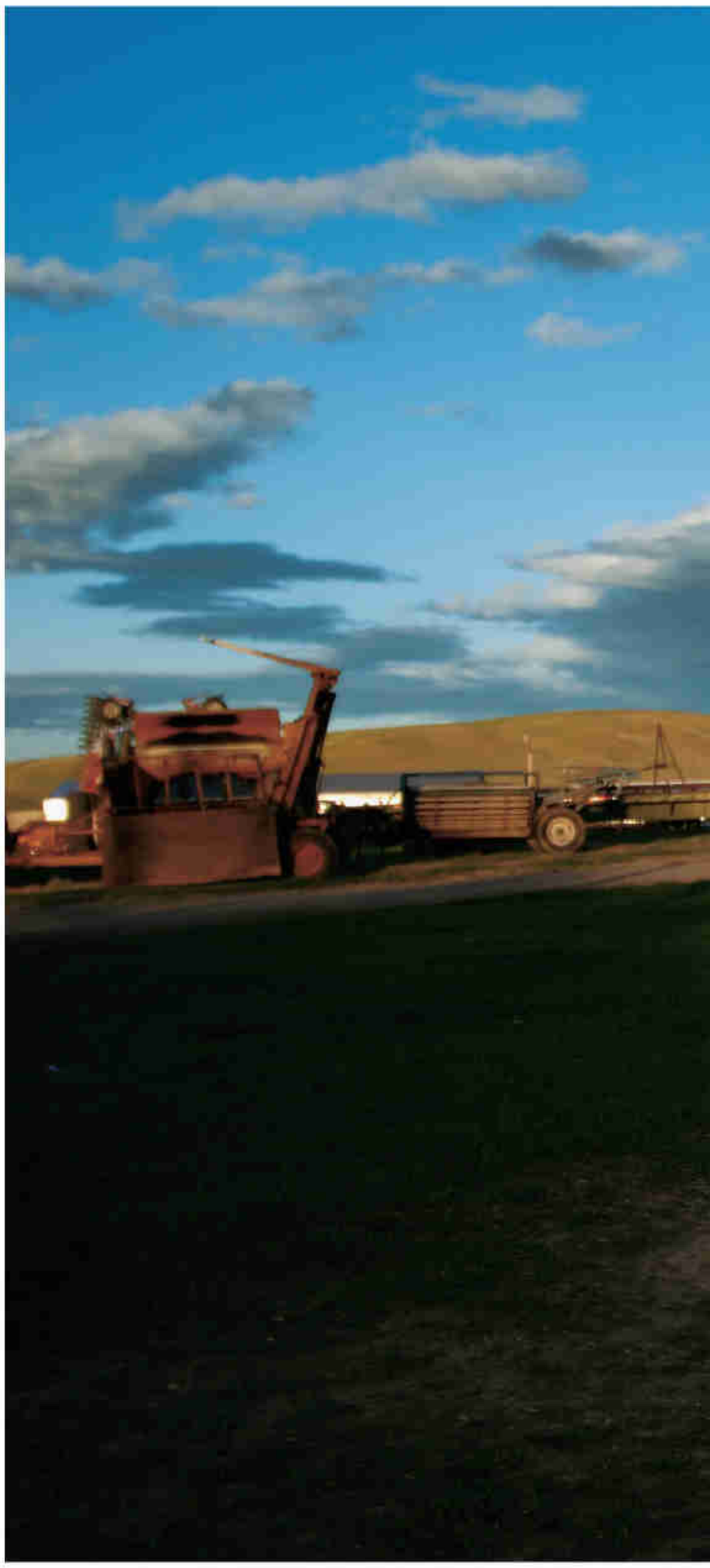
The boom left Richard Smalley downright nostalgic. "Nano is a baby that's all growed up," he mused shortly before his death. Perhaps, but we've still got some interesting years ahead. ▯

Capturing the Future Learn how Mark Thiessen made these otherworldly images in a video interview, and find related links at **ngm.com/0606.**

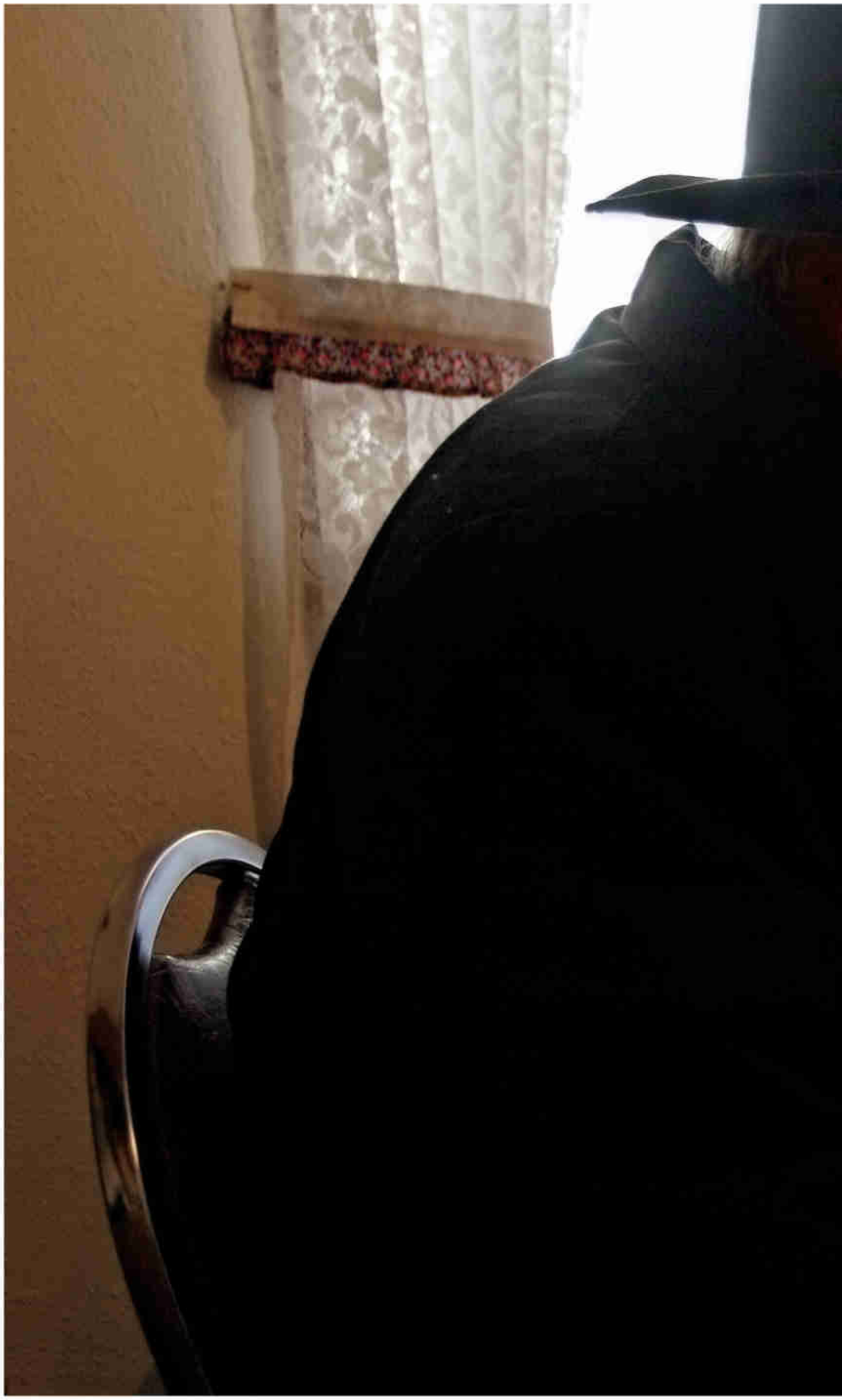
SOLACE AT SURPRISE CREEK

BY
WILLIAM ALBERT ALLARD
NATIONAL GEOGRAPHIC PHOTOGRAPHER

Thirty-seven years ago I went to the grasslands of Montana to photograph the Hutterites of Surprise Creek Colony. I found a place where people practice what their elders have preached for centuries: Live simply, share everything, and trust in God. Now I find myself returning to the comfort of my lifelong friends.

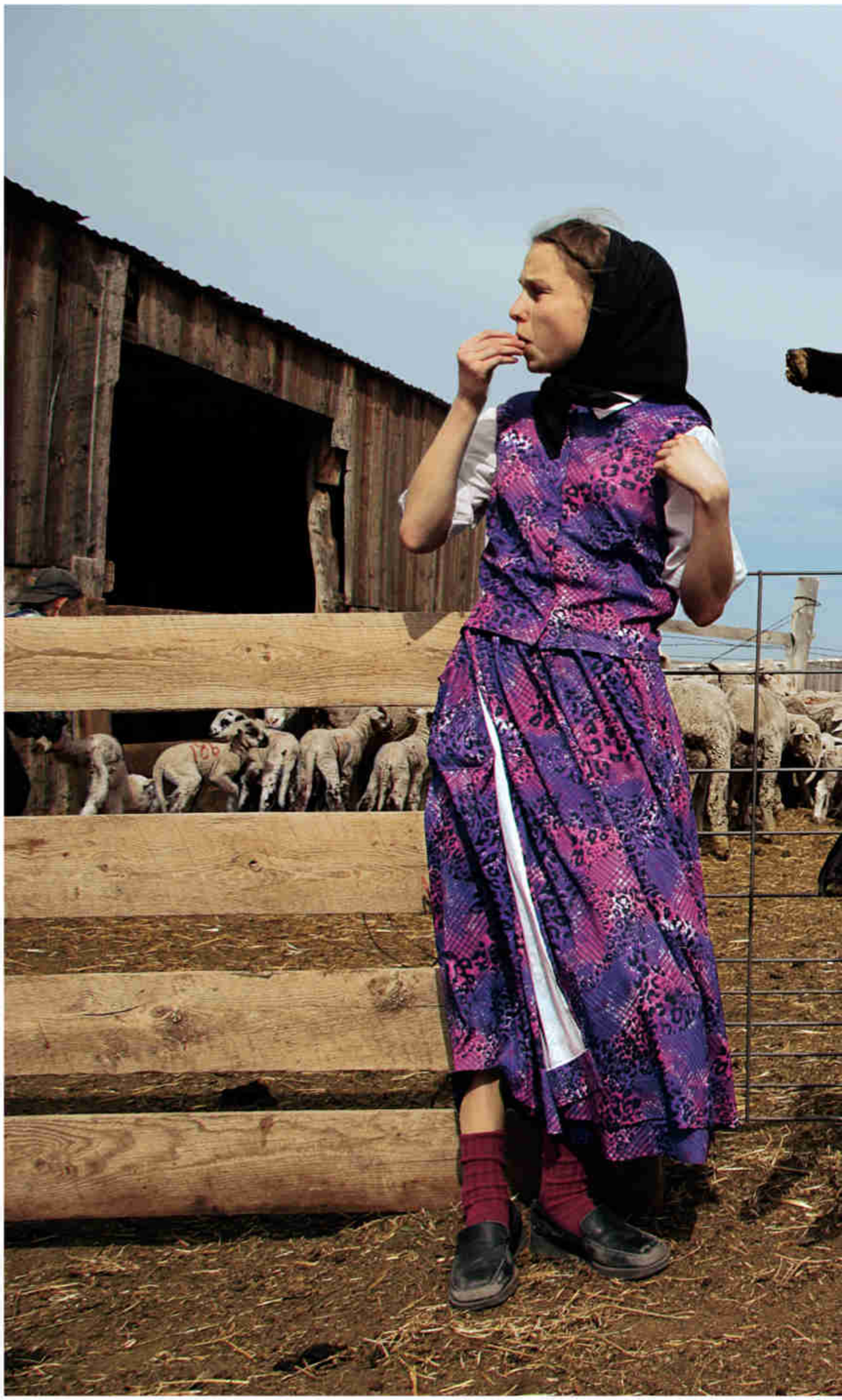


When I look at this photograph of Stephanie Stahl, I always wonder what she had on her mind.



I've spent so much time in the kitchen with Darius Walter. He and his wife, Annie, have made their home my home. Most mornings preacher Sam Hofer, in the black hat, and Darius meet. These two are the colony leaders. They speak in Low German, so it's difficult for an outsider to understand. Usually they talk about families and finances.

When Annie Walter, at right, and other Walter women bake orange rolls in the communal kitchen, there's plenty of chatter. Darius says they sound like a "bunch of geese." I love watching the women cook—sometimes we swap recipes. They never seem to stop working. "You have to be born a Hutterite to keep up with Hutterite life," Annie says.



The kids can't wait for the April day when lambs are gathered for ear notching and tail docking. These group activities and the security of faith and communal care keep most Hutterites in the fold for life. A few rebel. Stephanie Stahl, center, thinks she knows why one of her six sisters ran away to Canada: "She wanted to be different."

SUMMER 1969

There is a man on the moon, thousands of young people are swarming to Woodstock, and thousands more are protesting the war in Vietnam. I'm in central Montana, documenting the lives of a pacifist religious group, the Hutterites, who live in a colony called Surprise Creek. Their lives are far different from mine, and probably yours. And yet this Hutterite assignment will result in a friendship that lasts my lifetime. I'm a young man, married, and the father of four children—two sons, two daughters, all about a year apart in age. Scott, our firstborn, is nine.

FALL 2004

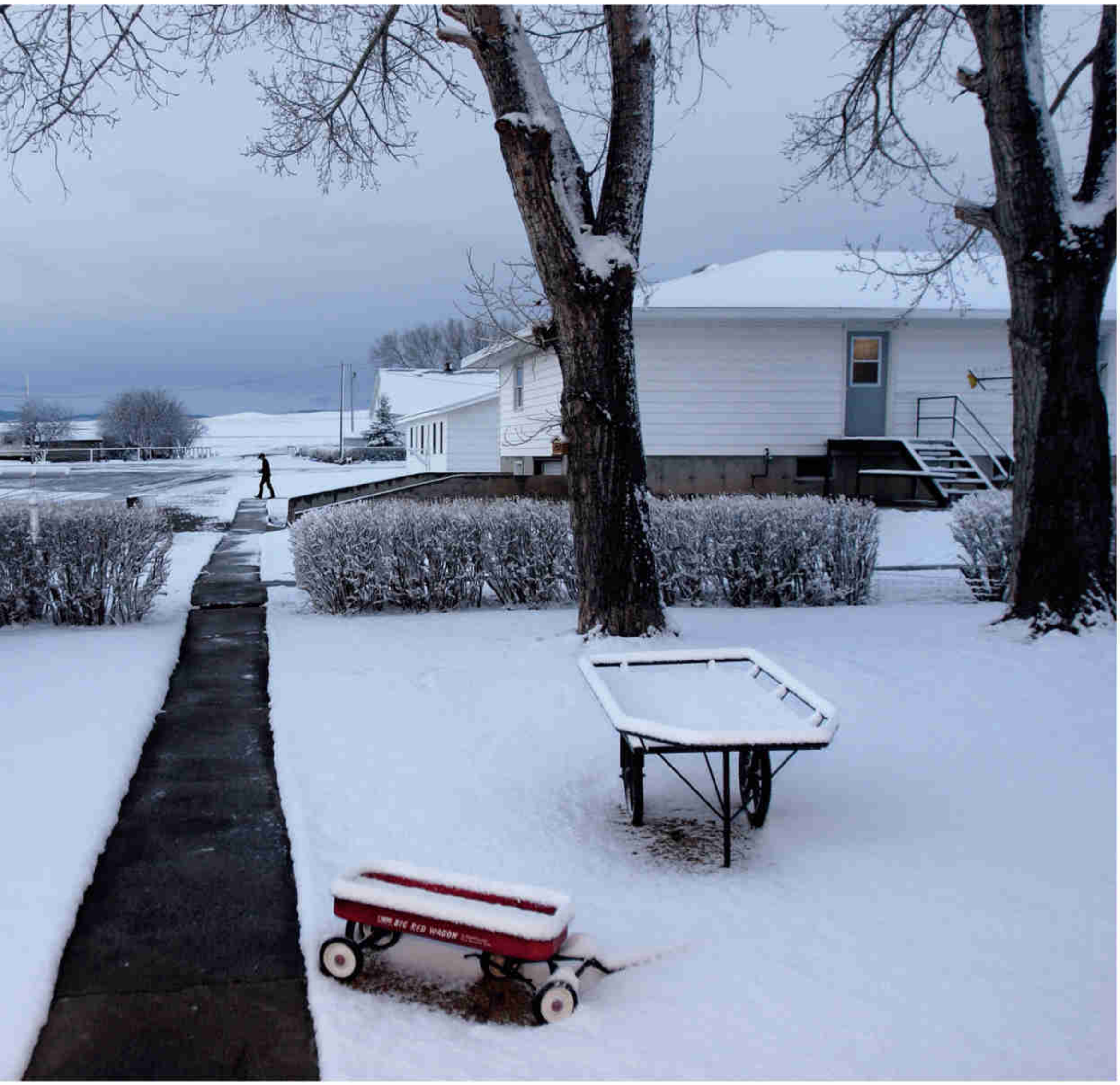
We're not going to the moon now, there's a new war on, and the joke about Woodstock is that if you remember being there, you probably weren't. I'm no longer young, and I have another marriage and another son. Scott is 44 now and beginning to die, but we don't know that yet. At least we try not to think about it.

Today I'm in my pickup truck, my English springer pup beside me, headed for Montana to do a new story about the Hutterites of Surprise Creek. On the way, I stop outside Minneapolis, where Scott lives with his wife and two kids, to spend time with him.

I'm having second thoughts about the Hutterite story, and driving back to Scott's house after a Twins game, I talk to him about it. "Am I going back to the same well by doing a Hutterite story again?" Scott has melanoma; the worst kind. He turned bald early in life, but beneath his Twins cap tonight he has plenty of hair on the sides and back of his head. He still has eyebrows and looks healthy and handsome. "Dad," Scott answers, knowing how close I am to the Hutterites, "when will you ever again get a chance to do something so personal?" "Yeah," I say. "That's true." Just how true neither of us can possibly know, and I leave in the morning for Montana.

Days later in Darius and Annie Walter's tidy frame house at the colony, I feel at home. I've returned to the colony many times over the years, sometimes flying out with my dog Sarah, to bird hunt and visit. I've always stayed at the Walters'. My daughter Terri calls the Hutterites and the Walters "your other family."

Darius, 65, is sitting in his place at the kitchen table. A couple of years my junior, he's one of my best friends. Bearded, as married Hutterite men must be, Darius wears the suspenders Hutterite males of all ages wear. He's heavier than he once was, and more flushed in the face, but he has the full head of silvery hair and the twinkling eyes, warm smile, and keen sense of humor of his late father, Eli, the colony preacher when



I first arrived. From his kitchen seat, Darius can look out white-curtained windows across the lawn to a bird feeder and clotheslines. Women's long dresses, skirts, and white blouses, and men's black pants, white socks, and plaid shirts—and all of that again in children's sizes—billow in the fall breeze. Just beyond the yard is a dirt road that threads past the colony's frame houses and nicely appointed trailer homes, the community kitchen and dining room, the church. Running parallel to Surprise Creek, it passes gardens,

I wake at first light to the quiet beauty of a snowfall at Surprise Creek, home to 28 families. Since my first visit in 1969, the colony has almost tripled in size. Darius and Sam say they eventually plan to move half the residents to Prairie Elk, a new colony 300 miles away.

weathered wooden sheep barns, and stubble fields touched with the first green of winter wheat, then points toward the distant Little Belt Mountains, their upper reaches white with snow.

Darius is gripping a wireless phone, one of two phones in colony homes; the other is in the home of preacher Sam Hofer. On the other end of the line is a man from Texas who has called several times, persistently seeking to join the colony. It's rare for an outsider to become a member; Hutterites don't encourage converts. "You're wastin' your time," Darius says gruffly into the phone. "It's hard enough if you're born a Hutterite. I got guys breakin' the rules all the time. We don't do it and that's that. There don't need to be any 'How come?' "

"How come?" does not apply to the Hutterite world. There's little place here for individualism in dress, thought, or other personal rights most Americans treasure. The colony owns all assets, so there's no private property, no personal bank accounts, few personal belongings—and little privacy. On the other hand, everyone is clothed, fed, and given a sense of belonging.

The Hutterites are one of the oldest communal groups in North America today. Rather than losing young people, their population is growing. Since I first came to Surprise Creek, it has grown from about 50 to 125 members. Now it's branching out. A new colony, Prairie Elk, is being established about 300 miles away in northeastern Montana. Eventually, decisions will have to be made as to who stays and who packs up to start fresh at Prairie Elk.

Darius is proud of the new place—7,000 acres along the south side of the Missouri River. The colony paid 3.2 million dollars for the land, and he tells me the water rights alone are probably worth the investment. He seems more relaxed when I see him at Prairie Elk. When I first met him, he was a farmer. Then, when the old boss at Surprise Creek died in 1994, Darius was voted in to replace him. It's not an easy job. He's the enforcer of many rules and the overseer of colony debts. Every morning he sits in his office just off the kitchen, paying bills, assigning jobs to the men, and managing colony affairs. Sometimes the pressure shows, and I wonder if he'd have been happier staying a colony farmer.

It's late afternoon, and I've fed, watered, and crated my pup in the grass behind the Walter house. I'm surrounded by some of the smallest kids in the colony, boys in homemade caps and jackets, girls in long dresses and the head scarves that cover their braided hair. The little kids address me by my full name when they have a question, and they usually have many.

"Bill Allard, is that Sarah?" It's seven-year-old Rene asking about my dog. "No," I say. "Sarah died. This is Buster." Respectful silence follows, but I know it will end. "Bill Allard," says Gregory, six, "can Buster hunt pheasants?" "Well, he's just a pup. But I'm going to find out." "Bill Allard," it's nine-year-old Ryan this time. "When you go hunting, can I go with you?" "No, not today." They know what I'm always going to say to that question, but they have to ask anyway. I guess I'd miss it if they didn't.

HUTTERITES IN AMERICA

Hutterites arrived in North America in the 1870s, fleeing persecution in Europe. Since then, their faith has sustained them through droughts, blizzards, prejudice, and the temptations of worldly culture. Along with fellow pacifists, the Amish and Mennonites, Hutterites emerged from the Anabaptist movement of 16th-century Europe. From an initial three settlements, Hutterite colonies now number some 460 in the western U.S. and Canada, with 46,000 believers in three sects.

Men do the killing. One day they're chopping the heads off poultry, another they're butchering a hog, all for the largely self-sufficient colony. Everyone wears Old World dress, and they believe the Bible says that males are dominant. For all that, the colony is up-to-date in farming know-how, buying the best equipment and making as much money as possible from selling grain, calves, and other farm products.

Outside one of the barns, I made a portrait of Kelle Hofer, 13, proudly straddling an all-terrain vehicle with his cow dog, Cactus. "I love being with the cows, shoveling feed and straw," Kelle says. Boys prefer farmwork to the colony school, which goes through eighth grade. For high school, the kids take correspondence courses.

They're going to butcher 300 turkeys this cold morning. There's a lot of killing at a sustenance colony like Surprise Creek, most of it done for colony consumption. Almost everybody helps with butchering. Inside the slaughterhouse, the floor is shiny and slippery, splotched with red. The sweet smell of blood mingles with the smoky odor of wet feathers. Outside the slaughterhouse, young women with long wooden poles stir headless turkey carcasses in a large steel trough of steaming water. Rita, the handsome young mother stirring the trough, has a thin streak of blood crossing her cheekbone, almost like a scratch. It's turkey blood. A splatter. I think of taking my handkerchief and wiping it from her face, but of course I don't.

SPRING 2005

In Minnesota, Scott is undergoing treatment. His hair and energy are gone. He can't eat much or keep down what he does eat. He's in pain and can't sleep. The pain lessens and sleep comes when doctors start the morphine. I'm with him for a week in early May on my way to Montana again. We go back and forth to the Mayo Clinic in Rochester a couple of times. In his living room I massage his swollen legs and feet as we watch a ball game on television. When I hug and kiss him goodbye, I say I'll see him on my drive home in June.

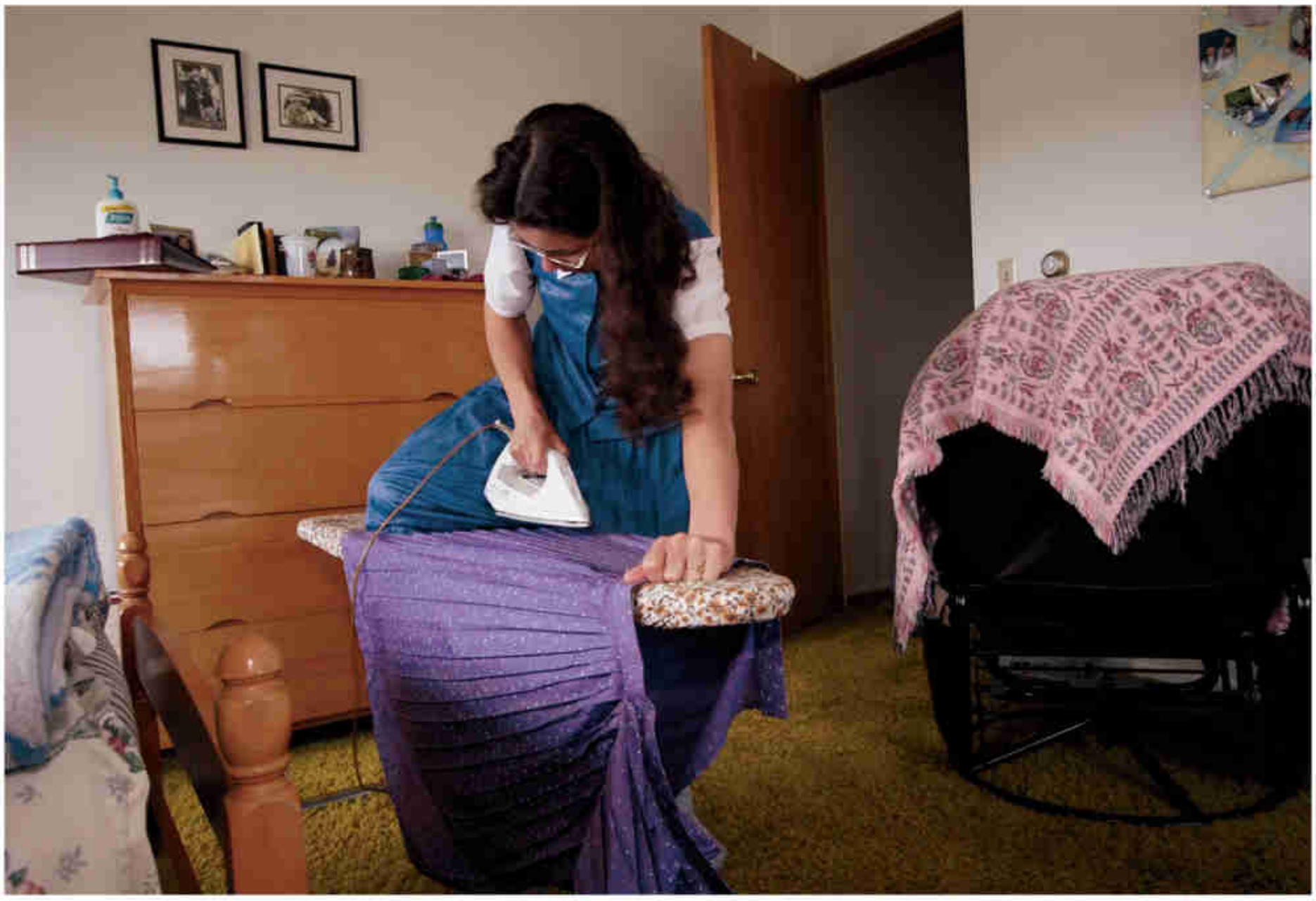
In Montana, the spring rains have been generous to the Judith Basin, and it rolls out fresh and green. Square Butte and the Highwood Mountains rise off to the north of Surprise Creek. In the Walter house Debbie is going out to shake the small rug that lies in front of the kitchen sink. I hear the soft padding of her stocking feet as she crosses the floor that always looks spotless. Darius is sitting at his usual place by the kitchen window. "What the hell you holler so loud for?" he's saying to his brother Paul, who's come in to talk about work at the new colony. Many of the men in the colony talk loudly, and there's plenty of arguing, good-natured usually, about the best way to do a particular job—about almost anything, really. Paul and some of the other guys sometimes accuse me of just wanting to hang out with the pretty girls and attractive women and take pictures of them. I suppose they're right in some ways. The women don't talk as loudly, for one thing.

Although women don't have a vote in colony affairs—only the baptized men, the "brothers," do—they share a community among themselves. Their camaraderie may be even stronger than the men's. When the women are gardening or cooking together (they do it all), they often sing. You aren't likely to hear songs from the men in the fields or the cow barns. I sense no female opposition to male domination at Surprise Creek, but maybe I just don't know enough of the women well enough. I ask Annie Marie, Darius's unmarried, 35-year-old daughter, if she resents the fact that women have no say in colony affairs. "No," she says, "I wouldn't want to take the blame if something goes wrong."

The breakfast bell breaks the dawn silence, and dogs commence to bark. By seven, all those who want breakfast are seated. Expressionless faces stare into coffee cups, and there's little movement, even less talk, as the room waits for Darius to say grace. "*Wir werden beten*"—we will pray—he says, in the Low German that Hutterites typically speak to each other. Somebody coughs on the women's side of the dining room. Silence predominates, broken only by the sound of shifting plates, sliding of bowls, and soft clatter of utensils. Another brief grace from Darius ends the meal and clears the tables of men.

Out in the chicken barn, bare bulbs cast a dim but warm light. David Hofer is feeding the 3,200 laying hens. For 17 years David has worked in this strong-smelling barn, not the most pleasant of places. It may be better than the hog barn, but just barely—both places make your clothes stink. When I'm here in the fall, David sometimes hunts with me. He tells me stories and makes me laugh, and I need that now. "I love it when you come out here," David tells me. "It gets me away from the chicken barn for a while."

Every male at the 10,000-acre colony has a job to do, farming the fields or tending the poultry, sheep, beef cattle, dairy cows, and hogs. In truth, there's not enough work to keep all the men busy and productive. That's the main reason Surprise Creek is branching out. But who will go and who will stay? Ben Walter, who sometimes walks around with dissatisfied eyes—the opposite of



In the privacy of the bedroom, Linda Walter, her hair tumbling down, irons the dress she'll wear for her brother Billy's wedding. At least twice a day she and her older sister Annie Marie (below, at right) twist their hair into buns to fit under their head scarves. Neither makeup nor jewelry is allowed in the colony. "We should be humble in all we do," says Annie Marie.

Soft light falls beautifully on the face of Rachel Hofer as she reads the Bible during daily German class. I saw the instructor lay a leather strap on his desk to make sure the kids behave. The class is held in the church, where there's a male and a female side. During Sunday Mass and evening prayer sessions, all praying is done in High German.

his daughter Rose Ana, who always seems to be smiling—tells me, "My daughter's game, but I ain't gonna go. My wife don't wanna go. There's gonna be a battle. I can smell it."

Late this afternoon there's a baseball game going on in a makeshift field behind the colony school. The field is mostly in shadow, but behind the backstop the conical metal grain bins catch the lowering sun and stand like giant chess pieces touched with gold. Boys and girls of mixed ages play. As usual, no score is kept, and the game goes on until other demands halt it. Today a couple of outfielders have to leave to memorize verses for German school. The catcher has to go help unload potatoes.

Colony members sometimes watch ball games on TV in one of the bars in nearby Stanford, and once in a while the two non-Hutterite teachers from the county school system who teach the younger kids bring a television to the school. No radios are allowed in trucks or vans, although radios are found in most homes to listen to news, weather, and the occasional ball game. Some men have cell phones, but these might not meet the approval of the Hutterite elders in Canada. They watch over the behavior of the colonies in their sect and sometimes reprimand bad behavior. Years ago, when local game officials caught a few Surprise Creek young men illegally selling elk meat, the elders came down unannounced and demanded that every gun in the colony be put in a pile. The barrels were bent to uselessness.

Colony life works for most because children are indoctrinated at a young age to believe that every member must submit to the rules of the church. Sometimes a member can't take this life of submission and leaves, but most "runaways" eventually return. I ask one young Hutterite woman, not from Surprise Creek, if she's ever considered leaving. "Many times," she admits. "There must be more in life than this." Then she tells me something quite surprising—she has always wanted to be an FBI agent.

On the last Sunday in May, there is to be a wedding at the colony. Billy Walter, 27, Darius and Annie's youngest son, is marrying Karen Hofer, 28, from a nearby colony. As the wedding day draws near, I take a room at the Sundown, a mom-and-pop motel five miles out on Highway 87. The Walters need space for guests from other colonies. I hear that Billy's sister Linda is not happy with the wedding cake. She says thinking about it kept her from falling asleep last night. I've been having trouble sleeping, too.

Scott died this afternoon, the day before the wedding. I know in the morning he is going to leave us because of a phone call from my daughter Terri, who is with him. His condition worsened so suddenly that it is impossible for me to get to Minnesota in time. I speak to Scott by phone several hours before he passes away, surrounded and comforted by his wife and children, his mother, sisters, and other loving relatives. There will be no funeral; a memorial will be held in two weeks. Now I face the choice of going back to the colony and the pre-wedding activity, or grieving in whiskey and solitude at the Sundown. I call Annie Walter and tell her about Scott. I say I'll be at the colony soon.

When I get there, the house is full of visitors. Annie, always calm and soft-spoken, tells me to go into Darius's office to see the wedding gifts that have filled the room. No one else is in there, and I've seen some of these gifts earlier—linens, various appliances, dishes, cleaning buckets and bottles of detergents, a garden hose—practical items for a practical life. I turn to leave and Darius is behind me like a wall. His eyes are brimming. "I'm so sorry, Bill," he says softly, embracing me. I can barely get my arms around him. I feel his beard against my cheek. For a moment, my heart lurches and my legs want to quit me. I lean into his embrace. Then I have to leave the house to go outside.

In the yard, I see the bird feeder where this morning there were yellow finches. Balloons are tied to the wooden posts alongside the house, and little Carolyn Walter in her new shoes and cool sunglasses is parading among the guests. Her face glows. The broad sky is a brilliant blue with clouds scattered above the horizon like white pillows strewn at random. It's such a beautiful day.

This evening there will be a shivaree—a big meal, singing, beer drinking—but I can't go. Not tonight. I stay for supper and, finally, I go to the Sundown to do what I didn't want to do before. *(Continued on page 145)*

The wide-open country of the new colony, Prairie Elk, grew on me—a change from the old colony's windy, mountain-circled world. Here, women plant tomatoes in a five-acre garden at the new settlement. At the mother colony there's not always enough work for everyone. Maybe Prairie Elk is the future for Thomas Stahl (below), who says grace in the kids' dining room at Surprise Creek.

It's a delight to watch the girls swing with abandon. As on most summer days, there's also a baseball game going on. The kids are great at entertaining themselves. That's good, since TVs and computers aren't permitted in homes. But the kids are hardly clueless: On Halloween one girl dressed as Britney Spears, another as a New York Yankee.

Word is that Marvin Hofer, 22, and Linda Walter, 24, are going to get married. I saw their affection at a Surprise Creek party. To wed, they need permission from their parents and preacher, and they must be baptized, a sacrament given only to adults judged of strong faith. "There's no divorce here," an elder told Marvin. "You'd better be sure."

Carolyn Walter's smile brightens a terribly difficult day for me. My son Scott died this afternoon, as all of Surprise Creek welcomed guests before a wedding. Too far away to reach Scott in time, I decided to stay with my friends and photograph the reception the next day. It was a joyous occasion, especially when groom Billy Walter, youngest son of Darius, leaned in to kiss Karen Hofer, his bride.

FALL 2005

"I'm not gonna let 'em split up," preacher Sam says to me as we watch the ducks in the Surprise Creek reservoir. It has yet to be decided exactly how, when, and which members of the mother colony will move to Prairie Elk. "They wanna split up," Sam is saying, "but I'm not gonna let 'em. When you're apart, you're apart, and nobody wants to help the other. First we got to get them debts for the milk barn paid," he says. Surprise Creek is building a new million-dollar-plus barn. Then Sam adds, "Maybe in a couple of years we'll split up."

I'm headed to Prairie Elk on my way back to Virginia, but before I leave Surprise Creek, I have dinner with Sam Stahl and his wife, Bertha. Several years back, their 23-year-old daughter, Kimberly, left in the middle of the night to marry a Hutterite runaway from Canada. As we finish dinner, Sam says, "I told her, 'Sweetheart, he left the colony. What has he to offer you? What's the future?' " Sam's voice lowers to a whisper. "Why couldn't it have been some other way instead of heartbreak and tears and everything else?"

"You know, Bill," Bertha tells me the next morning before I leave for Prairie Elk, "Sam and I were thinking last night that we talked all about our daughter, but we never said anything to you about losing your son. I'm so sorry we didn't." I assured her that was fine. We both know about heartbreak and tears. And everything else. There really isn't much you can say.

Prairie Elk Colony is in northeastern Montana, the Big Empty, the Big Dry. Summer temperatures cross the hundred-degree mark regularly. And in winter it is seriously cold, forty below at times. By late afternoon I'm at the kitchen window of the main house, looking out on the Missouri River, flat and shimmering. On an earlier visit, when Darius and I were in his truck parked by the river, he had said, "Just look at that, Bill. Dirty old Missouri. We have four miles of river." That's a lot of water in country where water is precious.

For now the colony is in the hands of various members of the Walter family. Billy Walter has been farming the new place. He and his bride, Karen, have just moved into their trailer. Joe Walter, who's serving as colony boss for now, and his wife, Annie, live in another trailer. Annie Marie is living in the main house, cooking at the colony kitchen and tending to the needs of some of her brothers and cousins when they're at the colony. Attractive, personable, hardworking, Annie seems like a prize waiting to be found. I tell her I hope she'll find a boyfriend worthy of her. "Sometimes I think maybe I'm just as well off without one," she says.

The young people seem to like it here, with fewer eyes on them. And the locals appear to accept them. The Hutterites' large land purchase could have caused resentment—it has in the past when Hutterites acquired large tracts. "People either like 'em or dislike 'em," says Bill Rathert, the co-owner of a car dealership in nearby Wolf Point. "The rumor is that some of the young guys drink, but that's the same as the rest of the country. I feel sorry for the women, though, 'cause they're kind of confined. But the Hutterites will do anything for you. They're not afraid of working. They're good people."

They are good people, I think, alone in the main house on my last day at Prairie Elk. I see the *Corn and Soybean Digest* perched on the armrest of the living room couch, and on a small table in the corner are eight well-worn German prayer books, the bindings of several strengthened with tape. Most have the names of the owners: Paul and Rachel Walter, Darius and Annie Walter. . . .

I pull away from Prairie Elk with Buster stretched out on the seat beside me. Geese are coming up off the river, black against gray in the surly sky. The last day at Surprise Creek, when I was saying my goodbyes, I came across five-year-old Jaden Walter playing outside the kitchen. "Bill Allard, where are you going?" he asked. "I'm going home," I told him. As the truck warms up and my road music plays, I think, yeah, that's right. I'm going home—leaving one for another. I'm pretty lucky. And I know I'll be back.

Visit with the Hutterites of Surprise Creek Colony in Sights & Sounds and find out why photographer Bill Allard considers them family. Then view images from his 1969 Hutterite assignment at **ngm.com/0606.**

All the things that keep Darius awake—how to pay the propane bill, how to split the colony, how to stay on his diet—fall away as another day for my friend ends early on his couch. In the next year two of his daughters will marry. I'll be back for the weddings. I wouldn't want to miss them—and Darius will be expecting me. □

World-famous conjoined twins Eng and Chang Bunker lived their entire lives linked by a band of flesh. Originally from Siam (now Thailand), the two spent years in the public eye, then settled in rural North Carolina, where their descendants still reunite.

ZIP USA | MOUNT AIRY, NORTH CAROLINA 27030

Together Forever

Chang and Eng gave the world "Siamese twins"—and brought a small town an enduring legacy.

HULTON-DEUTSCH COLLECTION/CORBIS (FACING PAGE)

BY CATHY NEWMAN NATIONAL GEOGRAPHIC SENIOR WRITER
PHOTOGRAPHS BY PENNY DE LOS SANTOS
ORIGINAL RESEARCH BY HELEN ZIA

You never know what's sitting in the family tree. Take the Bunkers of Mount Airy, North Carolina. The clan, which has more branches than a loblolly pine, is descended from twin brothers, Chang and Eng, who settled near Mount Airy in 1839. The brothers married sisters from a local family and had 21 children. So far, unexceptional. But Chang and Eng, the original Siamese twins, connected at the chest by a six-inch-long tube of flesh, were totally exceptional. Born in Siam (today's Thailand), they gave their name to the anomaly known as conjoined twins.

Their descendants—some 1,500—have scattered across the country, but many still live in Mount Airy, a town of 8,000 north of Winston-Salem, where the slow roll of the Piedmont plateau lifts to the Blue Ridge Mountains. In Mount Airy, a common form of address is "Honey," the soft drink of choice is Cheerwine, spiritual tastes run to Baptist and fundamentalist, and the day starts with radio obituaries on WPAQ ("Brought to you by Moody's Funeral Home").

Here, events have encouraged enterprise. Because textiles have lost their status as economic mainstays, Mount Airy has latched on to new opportunities, such as growing grapes for wine and—because it's the birthplace of TV star Andy Griffith—promoting its Mayberry connection.

Chang and Eng, who could move gracefully in tandem, do gymnastic feats, and play chess, understood enterprise. As the "Double Boys" they packed theaters and made a fortune—mostly for their promoters. At 21 they broke loose to manage their own careers. When a doctor who attended their show in New York invited them to visit the Mount Airy region, they took up the offer, bought land, and settled in as farmers.

The twins loved fine cigars, literature, and smart clothes. Eng, the calm one, liked late-night poker. Chang drank and had a temper. Today, when someone like Sherry Blackmon says, "That's just the way the Bunkers are," she's referring to that temper. "Of course, I can talk about the Bunkers because I married one," says Blackmon, whose husband, Zack, is a great-great-grandson of Eng. Bunkers can turn reticent, too. "They might talk to you. Then again, they might not." They are noted for honesty, for being loving parents, and, sometimes, for holding grudges. "They

The twins took up tobacco farming in the hills of the Blue Ridge Mountains (left), near North Carolina's border with Virginia. They added the surname "Bunker" when they became U.S. citizens.

don't argue; they just might not talk to you for 20 years," another relative explains. The twins, you see, produced a perfectly normal family.

Chang and Eng Bunker, extraordinary by being on the wrong side of genetic odds, longed for the ordinary. When they met the Yates sisters, who lived down the road, Chang decided it was time to marry. "We are not responsible for our physical condition, and we should not have to die childless on that account," he told his brother. Chang successfully courted Adelaide; Eng followed suit with sister Sarah. "May the connection be as happy as it will be close," observed the *Carolina Watchman* on the occasion of the double-double wedding.

After 14 years of living as a foursome, strain overtook family harmony. The twins split their property, built separate houses, and arranged to spend three days in one house with one family, then three days in the other. Stewarts Creek defines the boundary between properties, and today, at least one Chang relative refers to Eng's people as "the other side of the creek."

Eng's house burned down 50 years ago, but Chang's house is owned today by Kester Sink, whose late wife, Adelaide, was a Chang granddaughter. Sink, a successful businessman who owns the largest remaining chunk of Bunker land, does not suffer fools, and ferociously protects the Bunker legacy. "They were not freaks," he says with a stare that dares you to think otherwise. "They were human beings who had a tremendous physical adversity to overcome. They left their home in Siam, their mother and family, and immediately picked up the language, mores, and manners of their adopted country. They were gutsy, smart, and self-confident."

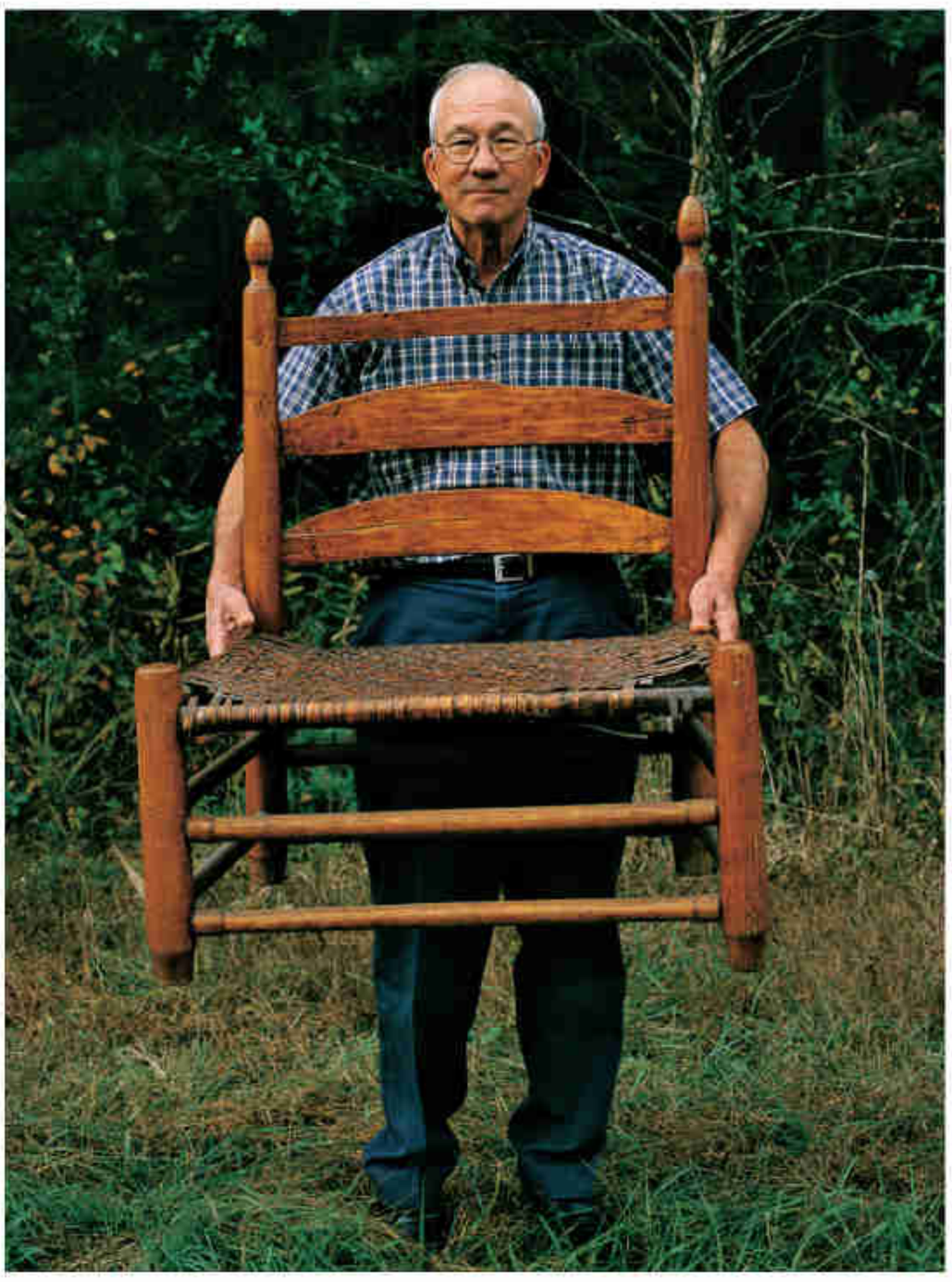
Open admiration for the twins was not always a given. The older generation preferred a tight-lipped approach. Jessie Bunker Bryant, the 79-year-old grande dame and the force behind the annual family reunion, tells of the Bunker bride

The twins married sisters (above) and fathered 21 children. Two of Eng's great-grandsons, also named Chang and Eng Bunker (left), were the first of the family's 11 sets of twins, none conjoined.

who didn't know about her famous relatives until the night before her wedding. "Your fiancé may not want to go ahead with this," warned her mother after disclosing the family secret. Happily, the revelation charmed the groom-to-be.

Attitudes loosened over time. "I am just so proud. Why, I wouldn't be here if it weren't for them," says Betty Bunker Blackmon, while June Ross Bunker of Richmond, Virginia, once opined that "it sure beats having horse thieves in the family." Since everything is relative, the fuss mystifies some. "Why, they was just normal family," says Virginia Bunker, a Bunker by marriage.

All families have disagreements, and the



The twins were fine carpenters, hunters, and horsemen. "They were handicapped, but it didn't bother them," says Eng's great-grandson Jasper, holding a chair they made.

Bunkers are no exception. In Mount Airy, unlike the TV town of Mayberry, all problems are not resolved in 30 minutes. Most arguments concern who owns what Bunker land and who owns —or doesn't—certain artifacts, particularly when the family relic falls into the hands of a Bunker by marriage, not blood. It did not sit well with some when a gold watch chain owned by the twins ended up with a brother-in-law.

Jasper Bunker, who runs a sewing machine store in town, owns a double-wide chair made by the twins. The caned seat has double impressions where the twins sat. Although an uncle left the chair to him, another family member who had it on loan seemed reluctant to surrender possession. Finally, Jasper's wife, Jane, a sturdy determined woman with a mission, called the relative up. "I told her I was coming for that chair in two minutes and showed up at the door." The heirloom was handed over.

Succeeding generations have produced 11 sets of twins, all normal. The first born since the original set were Eng's great-grandsons, also named Chang and Eng Bunker, now 65 years old. They are fraternal, not identical, and bear some of the Asian traits of their ancestors. "We'd get teased all the time when we were in school," Eng recalls, adding softly that they gave as good as they got. "After all, it was four fists against them instead of two."

Most visitors come to Mount Airy searching for the nostalgic simplicity of Mayberry, unmindful of its connection to the Siamese twins. But seven years ago, a pediatric surgeon from England was directed to Tanya Blackmon Jones, who runs the Surry Arts Council, the town's cultural center. The surgeon, it turned out, specialized in separating conjoined twins. In the 19th century Chang and Eng had no such option. Although they consulted many famous doctors, all advised separation would be fatal.

"The surgeon sat in my office and wanted to talk," Jones recalls. Most of all he wanted to talk about one of his cases: conjoined sisters with organ sets that seemed perfectly intact and separate. The surgical team waited until the twins were old enough to withstand the operation. When separated, one twin died. Her weaker heart couldn't tolerate the surgery. The doctor looked stricken. "Just because we can separate them, does it mean we should?" he asked.

Tanya Blackmon Jones, great-great-granddaughter of Eng Bunker, the original Siamese twin, didn't have an answer. □

Family Album See more images of Mount Airy's famed Bunker clan at **ngm.com/0606**.

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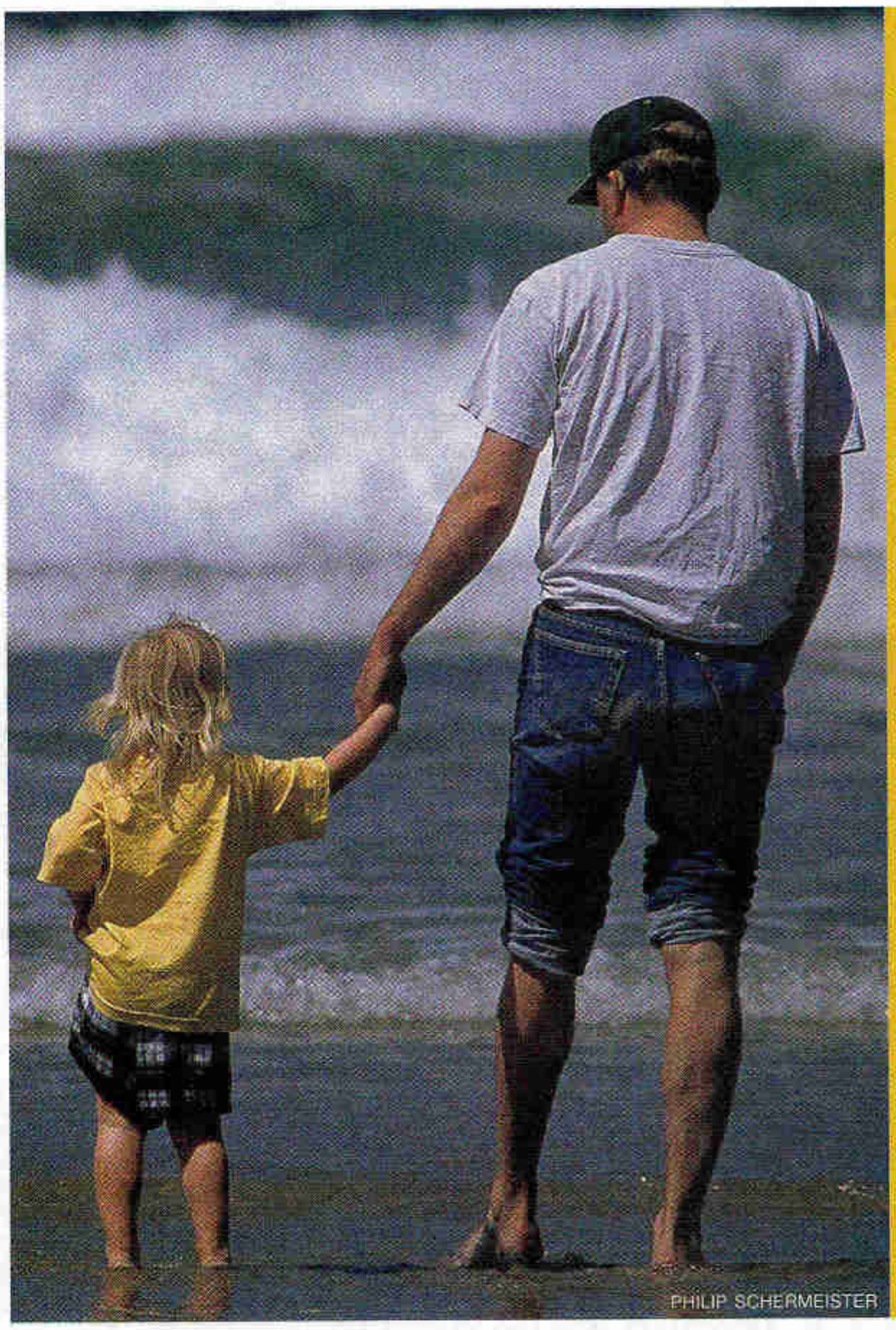

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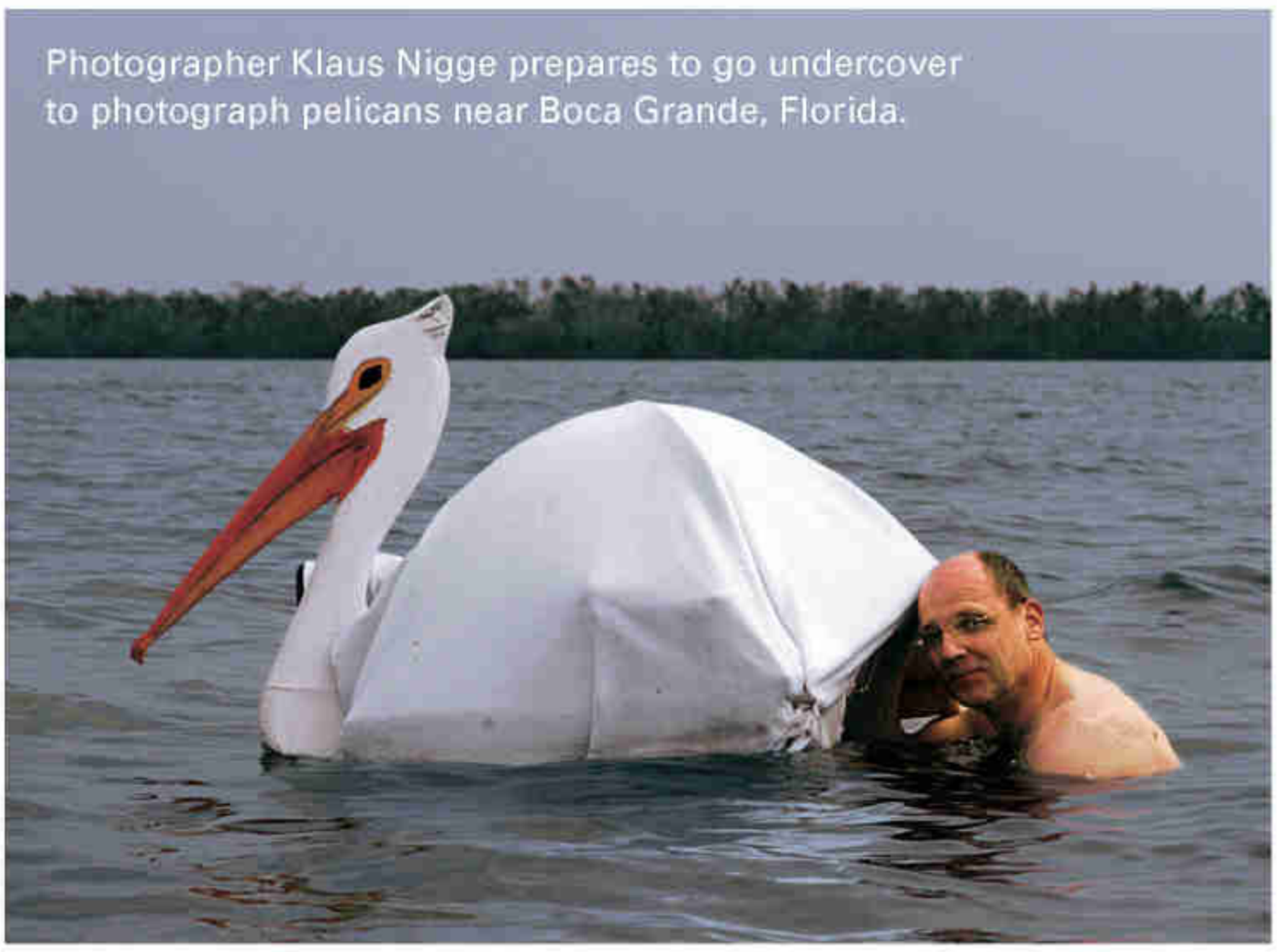
Reporter Unathi Kondile in Cape Town, South Africa

BEHIND THE SCENES **Intrepid Youth** Journalist Ellin O'Leary founded Youth Radio, a nonprofit organization that teaches broadcast journalism to high school students, in California's San Francisco Bay Area in 1992. Today its award-winning programs are heard on National Public Radio. But O'Leary didn't stop with domestic coverage. The National Geographic Society, which helped launch its environment and international desks, "encouraged us to think big," she says. Now Youth Radio's U.S.-based and international reporters travel the world. For information, go to *youthradio.org.*



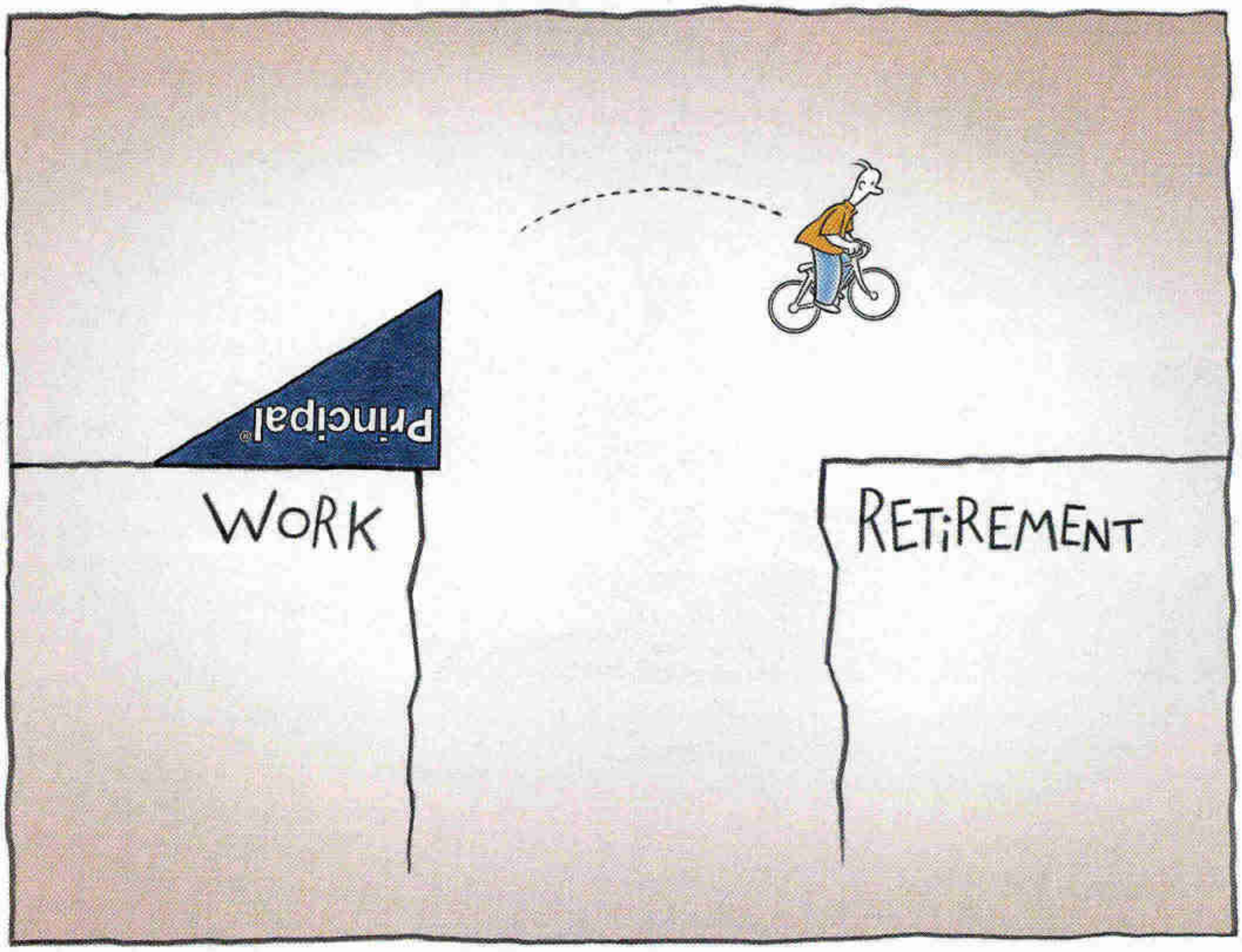
Photographer Klaus Nigge prepares to go undercover to photograph pelicans near Boca Grande, Florida.

ON ASSIGNMENT

Floating an Idea

"I wanted to get on their level, to see like a pelican," says photographer Klaus Nigge of the cloth-and-Styrofoam hideaway he made to sneak up on the birds. "I was able to get very close to them. I walked out into the water as far as I could and just stayed there until they forgot me." Some people noticed his bird during the shoot, he says. "They roared by in their big boats, scaring off the pelicans, to tell me I was scaring off the pelicans."

PHOTOS: BRENT STIRTON (TOP); ANDREA OTTE (BOTTOM)



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INSIDE GEOGRAPHIC

Glass engineered with nanotechnology shields Mark Thiessen from the flames. "It was really hot, but it didn't break," he says.

ON ASSIGNMENT

No Small Feat

How does a photographer shoot things too tiny to be seen by the naked eye? "I had to find good explainers," says Mark Thiessen of the scientists with whom he dealt. "Once things started making sense to me, I could see how to make the picture." Among Thiessen's favorite subjects was the sticky-toed gecko he photographed for page 102. "I like the idea of nanotechnology in nature, that we are finally finding out about things that have been there all along."

Contributors

Mel White
He didn't have to go far to find inspiration for his pelican story, says writer Mel White. Twenty years ago American white pelicans were rare near his Arkansas home in winter, but now they linger on the Arkansas River after fall migration. He has, on occasion, pointed out flocks of the birds to passersby, only to be assured that the fliers must be cranes or gulls since "there aren't any pelicans around here." But the author of the *National Geographic Guide to Birding Hot Spots of the United States* knows a pelican when he sees one.

Jennifer Kahn
Exhibits at Tokyo's annual nano fair ranged from unfoggable ski goggles to nano-cosmetics, according to writer Jenn Kahn, who visited during reporting on her nanotech article. "At the end of the day, though," says Kahn, "my favorite technology was the vending machines engineered to serve bottles of hot or cold sake." An article by Kahn, a contributing editor at *Wired* magazine, was included in *The Best American Science and Nature Writing 2005*.

A. R. Williams
"It's a story only an archaeologist could love," admits staff writer—and archaeologist—Ann Williams. Moche expert John Verano was working in Washington, D.C., while New Orleans' Tulane University was closed following Hurricane Katrina. He told Williams that the tattooed mummy in her Moche article looked a lot like the person known as Figure D in a sacrifice scene on a famous piece of Moche pottery. But Figure D had long been assumed to be male. Williams ran Verano's idea by other Moche experts, who were surprised—and excited. "This mummy is so different from any other Moche woman found," Williams says, "whatever information we get will provide a new window on the culture's gender roles."

Penny De Los Santos
Her first NATIONAL GEOGRAPHIC assignment was August 2002's ZIP USA story about a New Hampshire summer camp. Now Penny De Los Santos has shot the ZIP series' final feature on Mount Airy, North Carolina. Her career has taken off since its early days, "but there's a downside," she says. "I really wanted a dog, but I travel too much." Then she and her Austin, Texas, neighbors—new parents—found a solution. "They're busy too, so we have a time-share dog," she says. "She's a rescue, a shepherd-husky mix named Monica." When not traveling, De Los Santos keeps the pup. When she's away, Monica goes next door. "But there's a new downside," says the photographer, "I miss her so much when I'm gone."

Tales From the Field Find more stories from contributors in Features at **ngm.com/0606**.

PHOTOS CLOCKWISE FROM TOP: REBECCA HALE, NGS; CHRISTINA GOMEZ-MIRA; REBECCA HALE, NGS; HOPE NORMAN COULTER

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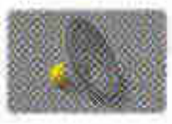

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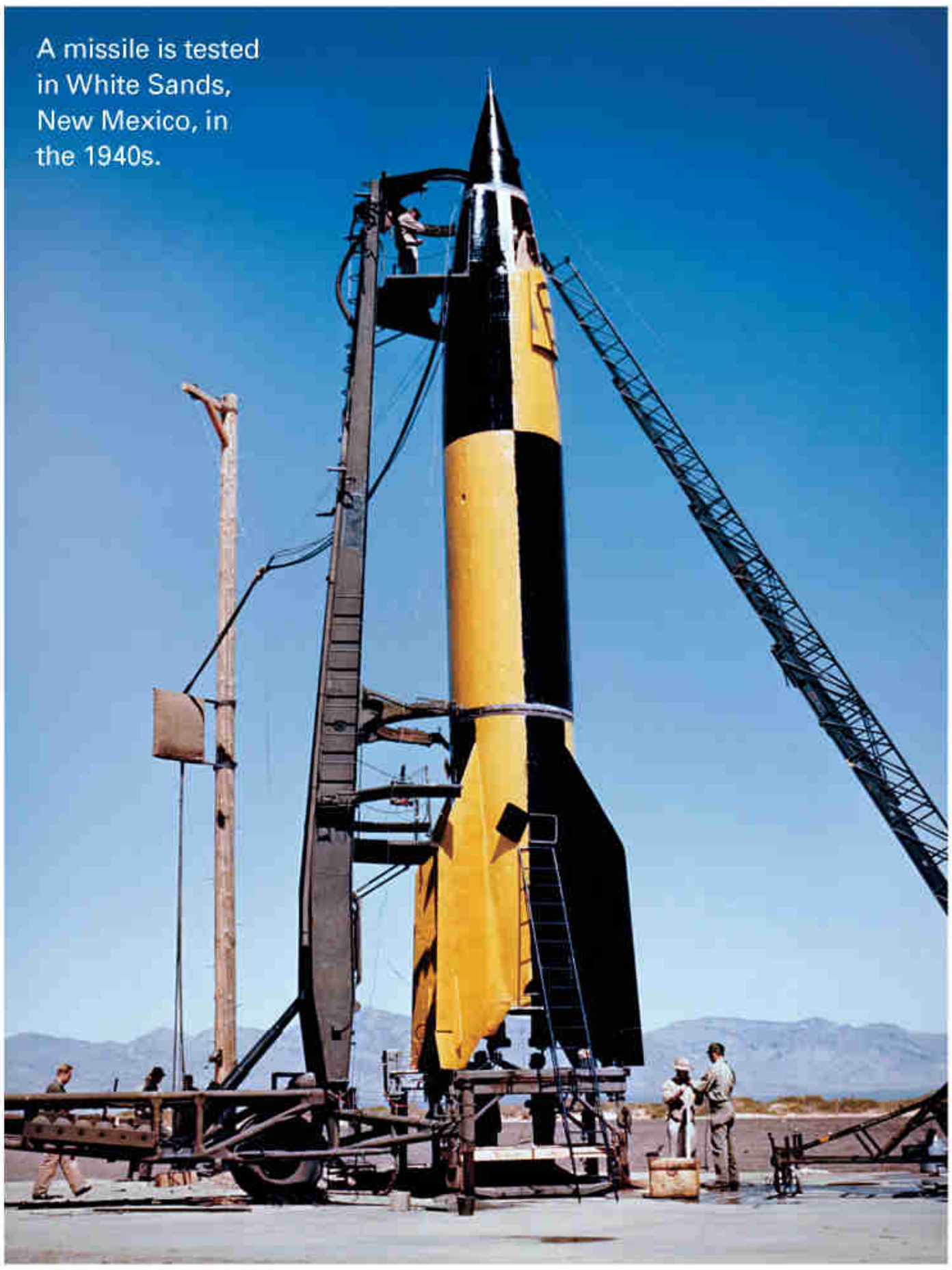
INSIDE GEOGRAPHIC



A missile is tested in White Sands, New Mexico, in the 1940s.

Space Race

A two-part event: June 4 at 9 p.m. ET/PT, June 5 at 9 p.m. ET/10 p.m. PT Scientists and spies, astronauts and presidents all take the stage in the Cold War's most gripping drama: Which superpower, the United States or the Soviet Union, will win the battle to conquer space? This two-part, four-hour special shows the rival teams competing to recruit escaped Nazi rocket scientists. The race continues through the Soviet's stunning 1957 launch of Sputnik, the first artificial satellite in space, to the final triumph of Neil Armstrong's 1969 walk on the moon.

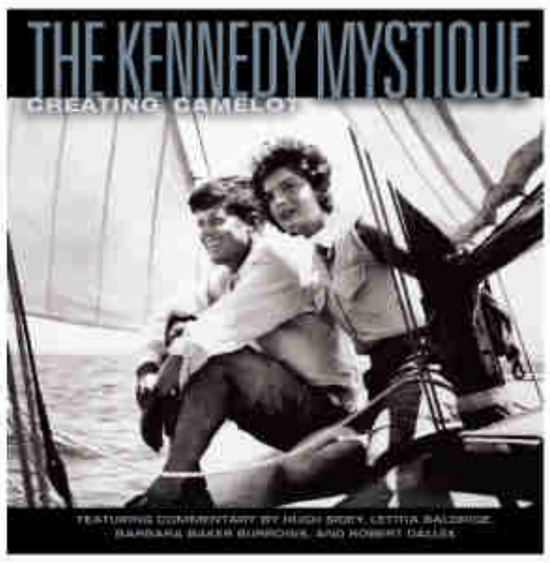
Is It Real?

Mondays at 8 p.m. ET/PT Fact or fantasy? The answer is never simple. *Is It Real?* takes a high-spirited look at bizarre phenomena across the globe. Episodes include investigations of crop circles in England and UFO sightings in Mexico and Europe. Join experts, pranksters, and true believers as they dissect evidence and search for explanations.

NG Books

The Kennedy Mystique

The family's unique relationship with the camera is examined by Kennedy insiders, including Letitia Baldrige and the late Hugh Sidey, along with historian Robert Dallek and *Life* picture editor Barbara Baker Burrows ($30).



Fields of Honor

Author Edwin C. Bearss, historian emeritus of the National Park Service, guides readers through the sites of important Civil War conflicts in *Fields of Honor*. Based on Bearss' famous battlefield tours, the 464-page book features 75 historical photos and 19 maps, and highlights battlefields from Charleston, South Carolina, to Gettysburg, Pennsylvania ($28).

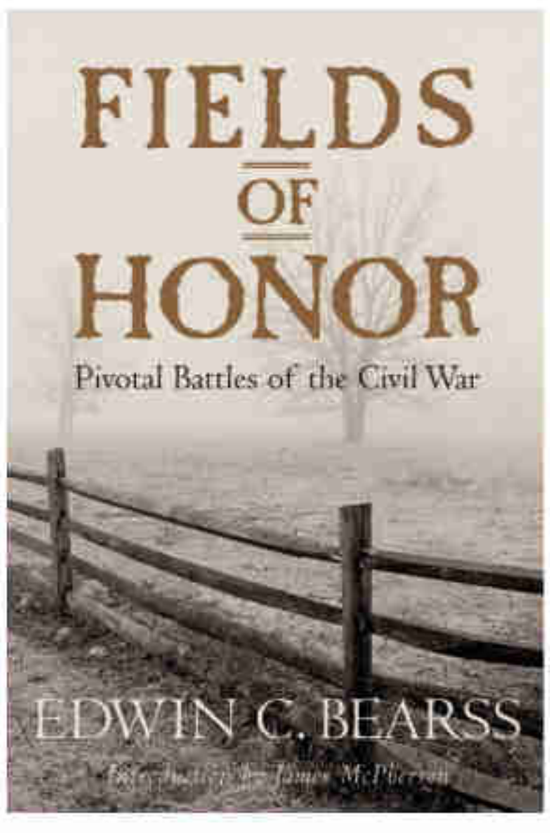
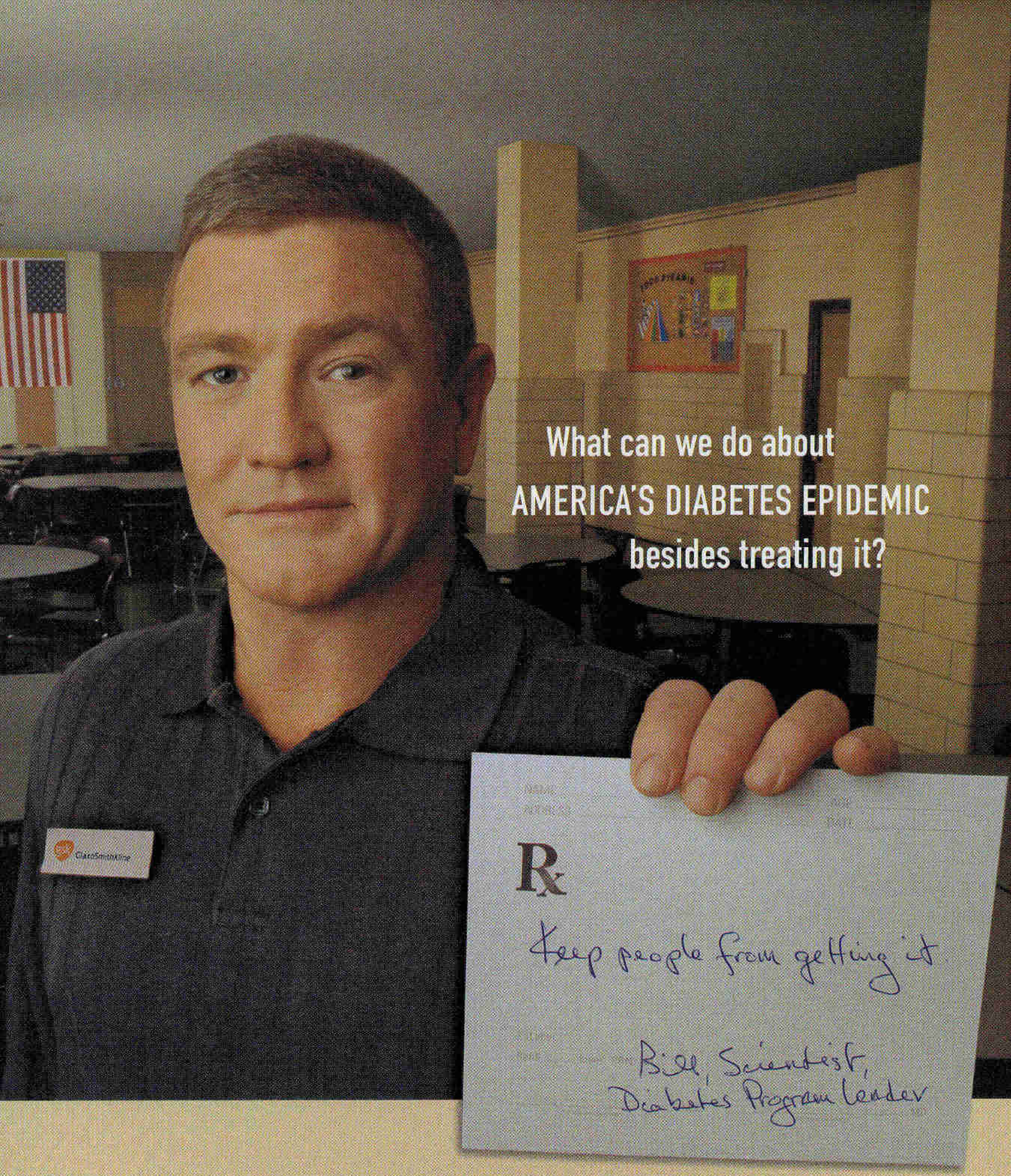


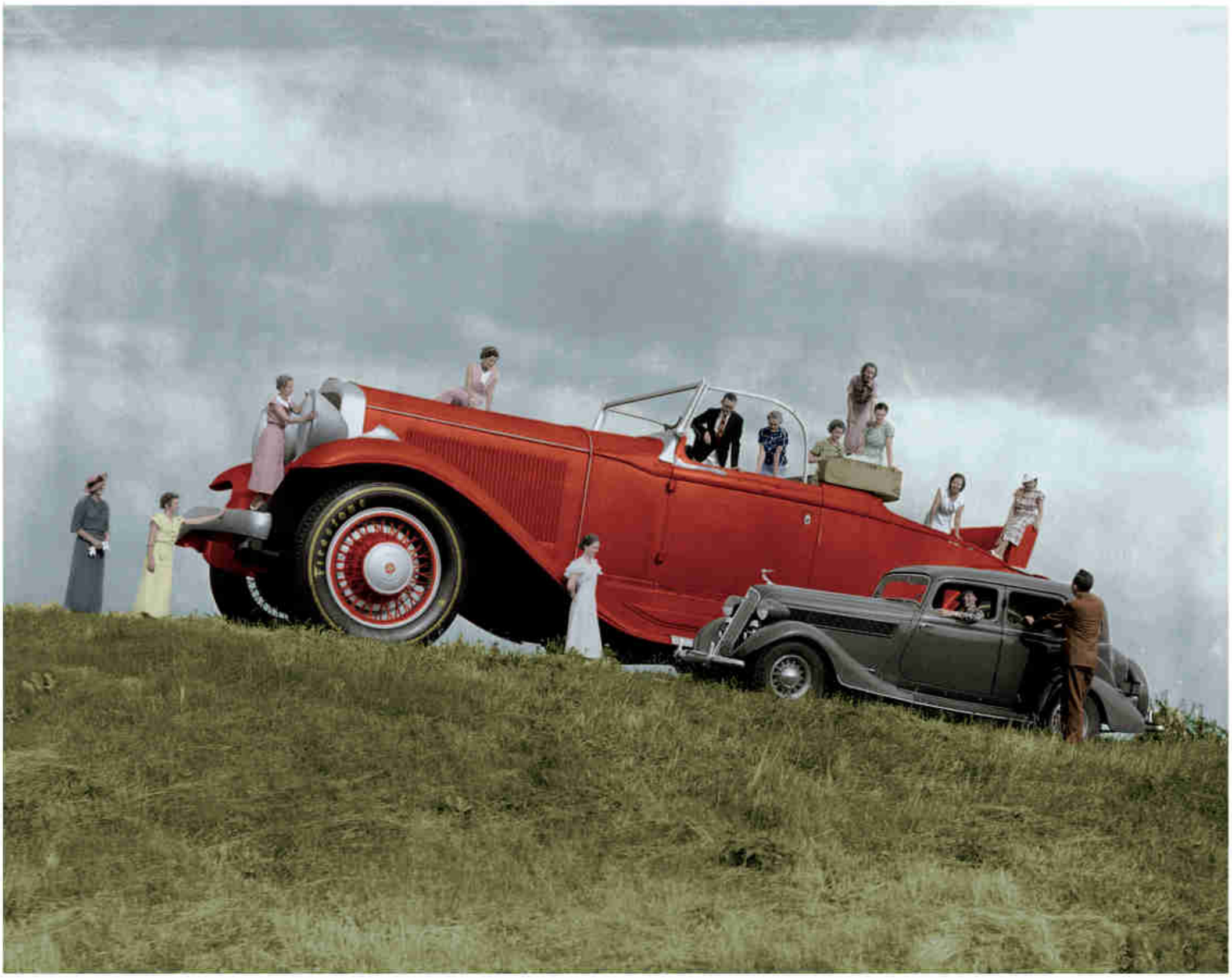
PHOTO: CORBIS (LEFT)



"I'M NOT just a scientist; I'm a diabetic, too," says Bill. "You might not think a drug company would want to prevent disease. But GSK wants to help people from ever developing diabetes. That's why we support programs that reward schools for providing healthier food alternatives – all because childhood obesity can lead to adult diabetes."

Finding a way forward. gsk GlaxoSmithKline

FLASHBACK



Not Nanotechnology Studebaker was thinking big in 1931. On the field outside the auto company's Indiana proving ground, this wooden model of the President Four Season Roadster served as both advertisement and tourist attraction. More than twice the length of a normal Studebaker, the 11,000-pound giant could fit 50 people on its running boards and occasionally hosted an orchestra—the 25-piece Studebaker Champions—in its cockpit. But by September 1936, when this photo was published in the GEOGRAPHIC, the oversize roadster was no more. "Studebaker styling had progressed to a point where it no longer bore even a passing resemblance to the big car," says Andrew Beckman, archivist at South Bend's Studebaker National Museum. "In the spring of 1936, the fender was ignited, and in less than half an hour the President was reduced to ashes." *—Margaret G. Zackowitz*

Flashback Archive All the photos plus e-greetings, in Fun Stuff at **ngm.com/0606.**

PHOTO: WILLARD R. CULVER

NATIONAL GEOGRAPHIC (ISSN 0027-9358) IS PUBLISHED MONTHLY BY THE NATIONAL GEOGRAPHIC SOCIETY, 1145 17TH ST. NW, WASHINGTON, DC 20036-4688. $34.00 A YEAR FOR U.S. DELIVERY, $6.00 PER SINGLE COPY (INCLUDES POSTAGE AND HANDLING). IN CANADA, AGREEMENT NUMBER 40063649, RETURN UNDELIVERABLE CANADIAN ADDRESSES TO NATIONAL GEOGRAPHIC, PO BOX 4412 STN. A, TORONTO, ONTARIO M5W 3W2. UNITED KINGDOM NEWSSTAND COVER PRICE £3.75. PERIODICALS POSTAGE PAID AT WASHINGTON, DC, AND AT ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NATIONAL GEOGRAPHIC, PO BOX 63002, TAMPA, FL 33663-3002. MEMBERS: IF THE POSTAL SERVICE ALERTS US THAT YOUR MAGAZINE IS UNDELIVERABLE, WE HAVE NO FURTHER OBLIGATION UNLESS WE RECEIVE A CORRECTED ADDRESS WITHIN TWO YEARS.

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One form of energy won't secure our needs for the future. It's going to take many–solar, wind, hydrogen, natural gas, and yes, oil. So we're investing $15 billion in the Gulf of Mexico to find and produce new oil and gas supplies. Recently, we announced plans to invest up to $8 billion over 10 years in a new business called BP Alternative Energy that will use a wide range of energy sources to provide low carbon electricity. It's a start.

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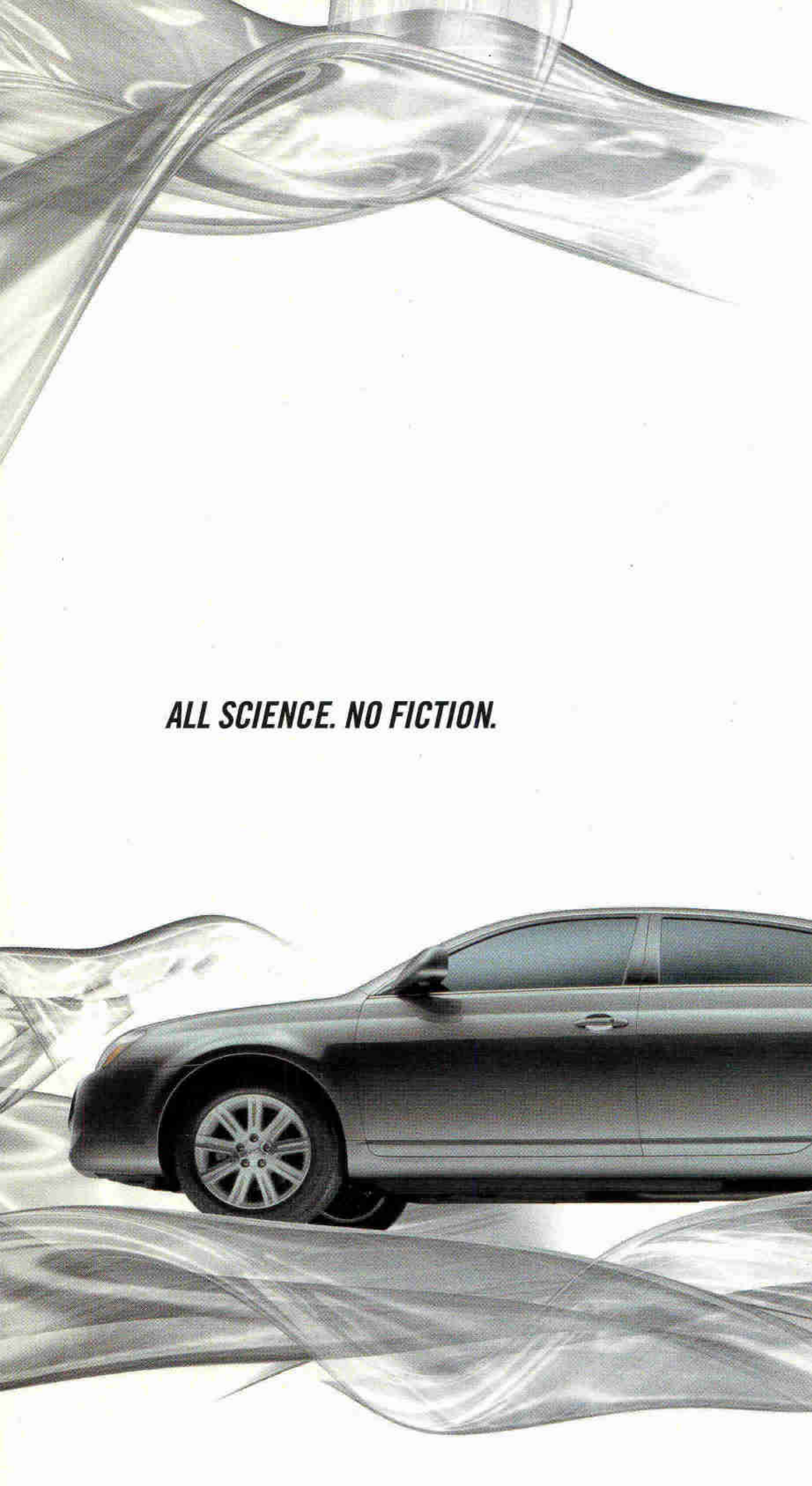

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