NATIONAL GEOGRAPHIC

From the Editor

ON A HILLTOP OVERLOOKING TEHRAN the women gathered in their traditional dark shrouds. It is customary to stay out of the house on this, the 13th day of the Persian New Year, in order to prevent bad luck.

That was good luck for photographer Alexandra Avakian, who accompanied the women to their aerie for a rare glimpse of everyday life in Iran. She and author Fen Montaigne traveled the length and breadth of the country, which has been virtually closed to free movement by Americans since the revolution in 1979.

Two decades ago this fall Americans were taken hostage at the U.S. Embassy in Tehran. This month's article marks the most extensive look at Iran by any U.S. publication since then. It is a testimony to the NATIONAL GEOGRAPHIC's long-standing good reputation in Iran—where even in the darkest diplomatic days we had members—and to the changing political climate as voices of moderation urge a tentative rapprochement with the West.

In the interest of continued exploration of Iran, it is my hope that those voices will persist. But whatever the future brings, we can be thankful that an opportunity presented itself for the GEOGRAPHIC to take another long look at this ancient land.

Bill Allen

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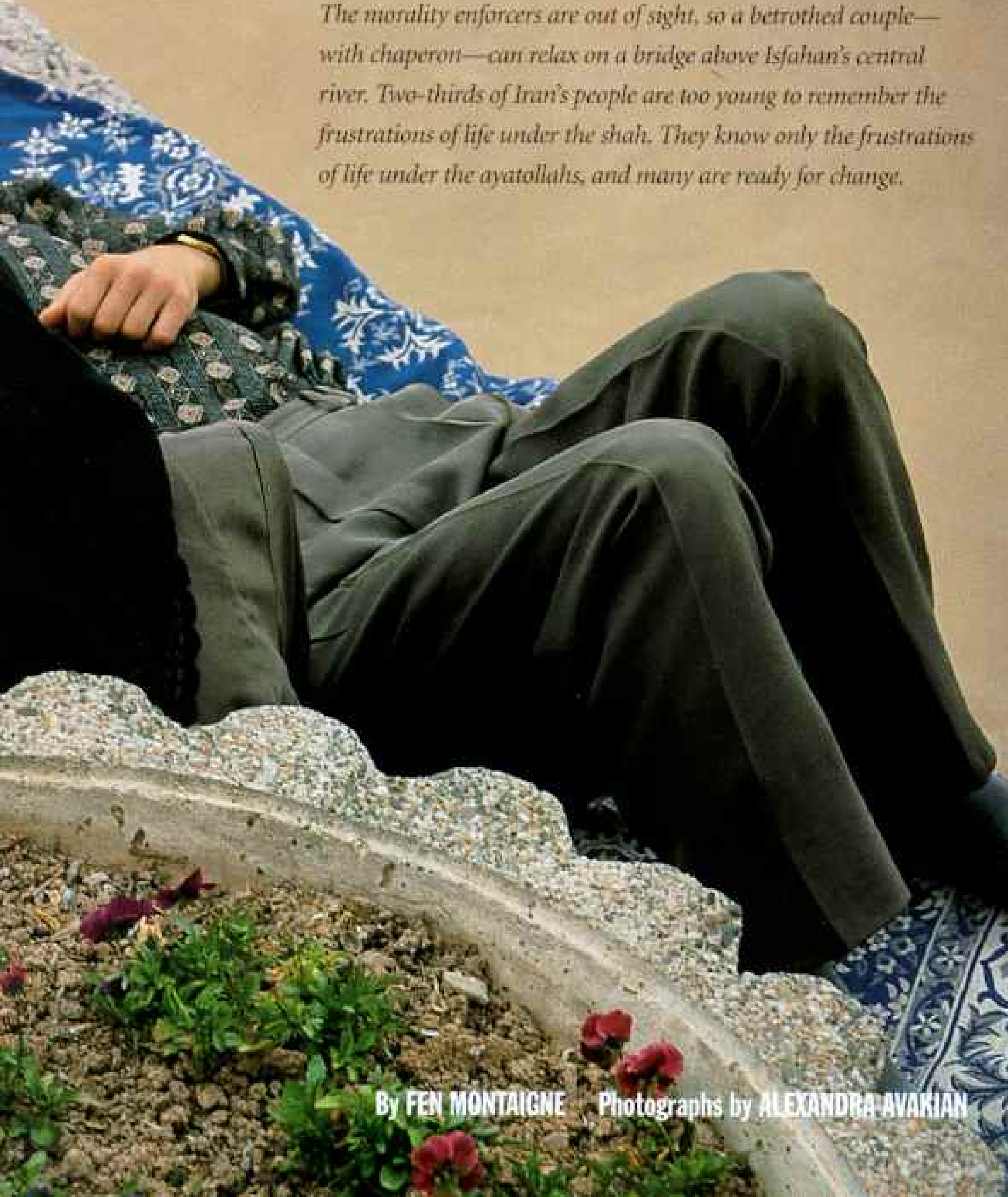
Testing the Waters of Reform

The morality enforcers are out of sight, so a betrothed couple—with chaperon—can relax on a bridge above Isfahan's central river. Two-thirds of Iran's people are too young to remember the frustrations of life under the shah. They know only the frustrations of life under the ayatollahs, and many are ready for change.



By FEN MONTAIGNE Photographs by ALEXANDRA AVAKIAN

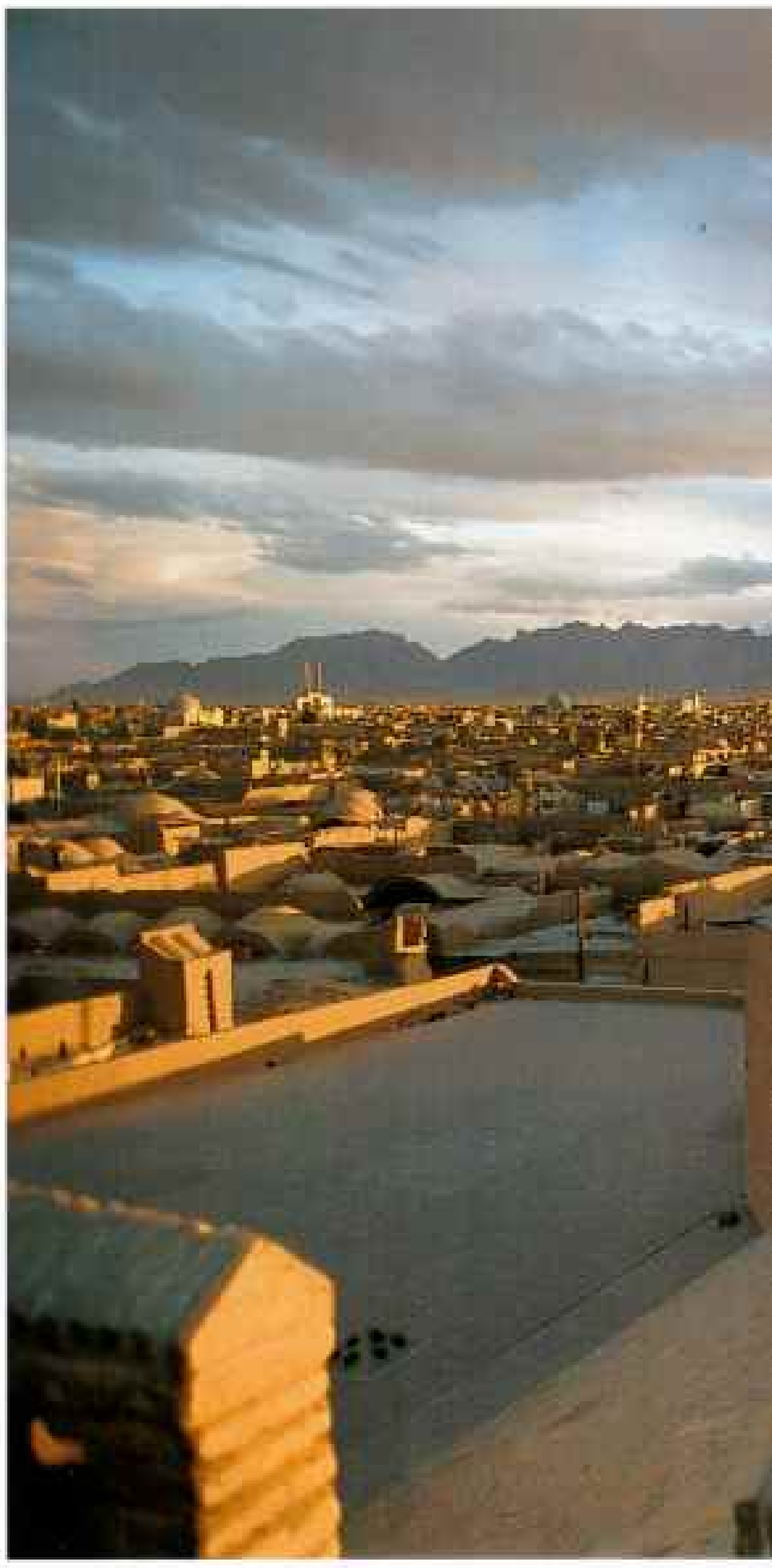
reformist president Mohammad Khatami. He won 70 percent of the vote but has limited power.

ON A SPARKLING AFTERNOON IN APRIL, three young couples climbed the steep hiking trail that follows the Darakeh River in northern Tehran. The river rushes out of the Elburz Mountains, whose snow-covered peaks form a majestic backdrop to the nondescript sprawl of the capital. At nearly 5,000 feet the area along the Darakeh is one of the few refuges from the dirty air and clamor of Tehran, and on this Friday, an Islamic day of rest, the couples were chatting easily as they strolled under willows and plane trees loaded with brilliant green buds. They passed vending stalls where merchants offered dozens of varieties of nuts and dried fruits or sodas cooled in old bathtubs filled with frigid river water. Men popped corn on propane stoves. Nearby, people paid a few hundred rials (about a dime) to a man whose parakeets told fortunes by strutting along a line of folded papers and pecking out missives that predicted wealth, long lives, and marriage.

Suddenly a stranger in civilian clothes approached one of the young men, Majid Rafiai, barking, "What are you doing? Why are you holding that woman's hand? Are you afraid someone will steal her?" In Iran, displays of affection between the sexes, however innocuous, are frowned on.

The inquisitor was a *basij*, a term often used disparagingly to describe people who, with the blessing of the authorities, act as guardians of public morals. The word originally applied to the members of a loose-knit Islamic militia, many of whom served as suicide fighters in the war with Iraq from 1980 to 1988.

The young people were indignant at the intrusion but held their tongues. Later I sat with them on a carpeted platform above the river, drinking tea and listening as they vented their anger. They said they had voted for the popular new president, Mohammad Khatami —a moderate clergyman, intellectual, and former minister of culture who ran on a platform of greater openness—precisely because they were tired of this kind of meddling from



Marco Polo *called it the "good and noble" city of Yazd, an ancient town where desert architects learned to cool buildings and even make ice by harnessing the wind. A 14th-century mosque still dominates Yazd's oldest quarter.*

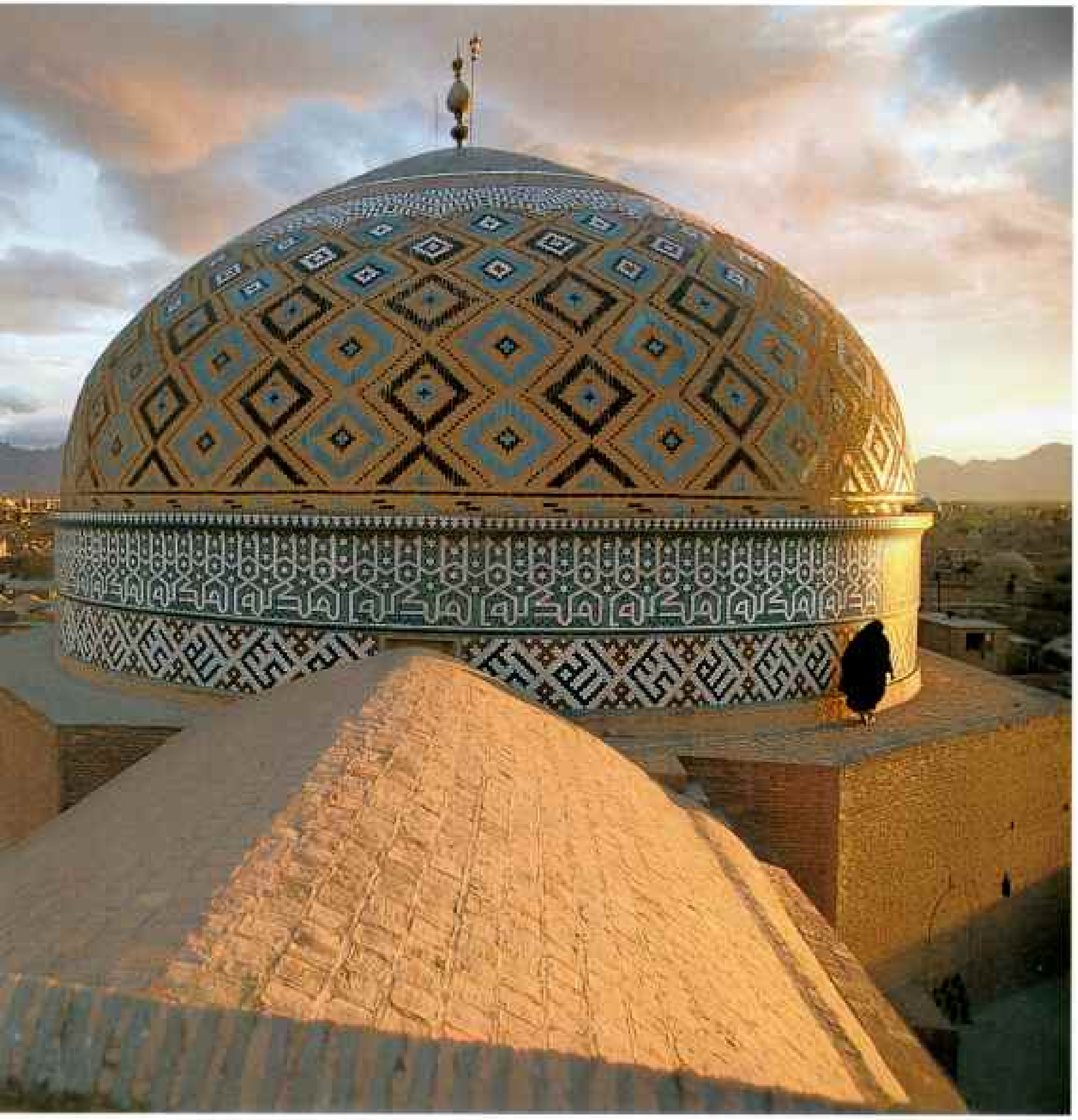
the die-hard defenders of the Islamic regime.

"The period of Khatami has come, and the period of those people is finished," said Hossein Youssefian, a 24-year-old university student, as the others nodded in agreement.

Twenty years after Ayatollah Ruhollah Khomeini and his devoted followers overthrew Shah Mohammad Reza Pahlavi—the last in a line of Persian monarchs dating back to Cyrus in 559 B.C.—and installed a religious government, many of Iran's 64 million people are fed up with the scowling clerics who have run their country and their lives. The dissatisfaction boiled to the surface in May 1997, when 70 percent of the electorate chose Khatami as president. Since his election Iran has been undergoing an uneasy transformation, a second revolution in as many decades and one that seeks to soften the overbearing rule of the theocracy.

"When I look at Iranian society, I see a society that has graduated from the school of fundamentalism," says Mohammad Jafar Mahallati, who served as Iranian ambassador to the United Nations under Khomeini and is now a professor in the United States.

As Iran struggles to liberalize its Islamic republic (no one would suggest publicly



Seven years after *censors found fault with his last film, Bahram Beyzaie, in green, is shooting*

again; he credits Khatami. Even with restricted content, Iranian films have drawn critical acclaim.

that the theocracy be scrapped), the big question is how far Khatami's geniality and popular support will carry him in his contest with the hard-liners, headed by Ayatollah Ali Khamenei, the "supreme leader" of the republic. What is certain, however, is that Iranians, after two decades of war and revolution, want some freedom and levity back in their lives.

"People are very tired," said Farideh Farhi, a political scientist. "We didn't expect so much austerity. Severity is against our nature. We like fun. We like color."

Certainly that was the country I found during a seven-week visit to Iran, a stunning land of desert plateaus, verdant Caspian shoreline, and two great mountain ranges, the Elburz and the Zagros. I had traveled in Iran in 1974, several years before anger over government corruption and the shah's pro-Western, anti-clerical policies would ignite the revolution. I arrived this time with stereotypical images of the Islamic republic in my mind: the menacing, bearded face of Ayatollah Khomeini, the 52 blindfolded American hostages, the black-robed women burning the United States flag. But these images faded as I met with warmth and hospitality, surprisingly little anti-American sentiment, and a people longing for improved relations with the West and a more prominent place on the world stage.

I also discovered that under the Islamic revolution many Iranians had seen basic improvements in their lives: Paved roads, water, and electricity in most rural areas; access to higher education for the masses, especially women; and a greater sense of unity in this richly multiethnic nation, whose population includes 51 percent Persians, 24 percent Azerbaijanis, 7 percent Kurds, 3 percent Arabs, and numerous tribal groups.

Although the mood of Iranians has shifted under Khatami, the fundamentalist laws and customs of the Islamic republic remain in place. Under Iran's constitution the real power rests with Khamenei, the orthodox heir to Ayatollah Khomeini, chosen by a council of religious leaders. Khamenei is not nearly as popular as Khatami, nor does he have the following of the charismatic Khomeini, who died in 1989 and is still revered by devout Iranians. Yet Khamenei and his allies control the army, the police, the judiciary, and the Revolutionary Guard, a volunteer unit originally created as a parallel force to the army. They also have a core of powerful supporters, including businessmen and bureaucrats tied to the regime, as well as veterans and war widows who receive government stipends.

Today the struggle between the two sides overshadows everything else, and change comes in fits and starts. Newspapers proliferate, exploring the limits of the allowable, and then are shut down; reform politicians, such as Gholamhossein Karbaschi, Tehran's mayor, are convicted on dubious corruption charges; five critics of the regime are mysteriously killed, and the government announces that rogue agents of the Intelligence Ministry have been arrested for the slayings.

I SAW FIRSTHAND how fluid the situation is when I interviewed Mashallah Shamsolvaezin, the editor of *Society*, one of the country's new, rambunctious newspapers. Shortly after the revolution Shamsolvaezin was the first editor of a militantly Islamic newspaper. But he had mellowed, and in early 1998, encouraged by Khatami's brand of *glasnost*, he founded *Society*, located in a house in central Tehran. Shamsolvaezin, a chain-smoking intellectual, smiled as he recounted how his newspaper had broken new ground by printing mildly critical stories about the government and by publishing two front-page color pictures of women—one in tribal dress, the other in a Western-style wedding gown.

"We have freedom of speech in Iran," he joked. "But it's what happens after we speak that becomes a question."

He would soon find out. The increasingly bold editor published several tough stories, including an interview with an opponent of the regime who had been jailed for 15 years and tortured. In June 1998 a court that oversees the press ordered the paper closed. Shamsolvaezin opened another paper, *Tous*, which published a number of controversial articles and was shut down on vague charges of undermining national security. Authorities then tossed Shamsolvaezin in jail for several weeks. Undeterred, he started a third newspaper.

Atlanta-based writer FEN MONTAIGNE wrote about the Trans-Siberian Railroad for the June 1998 magazine. ALEXANDRA AVAKIAN gained unprecedented access to Iran for this coverage. Her photographs last appeared in the September 1998 article about Romania.

Millennia of political *and religious change haven't stamped out No Ruz, the Persian New Year that celebrates spring's new life, symbolized in Iranian homes by goldfish. Hearts turn to mourning in the Islamic month of Muharram. On the tenth day, when performers reenact the martyrdom of the Prophet Muhammad's grandson Husayn, people weep for the dead, including martyrs from the 1980s war with Iraq.*

As the larger struggle has unfolded in Iran, many citizens have watched quietly, hoping Khatami and the reformers will prevail.

"We are a very complicated people," said Shahla Lahiji, a publisher and advocate of women's rights who lives in Tehran. Lahiji is a handsome woman with pale skin, prominent cheekbones, and a deep, infectious laugh. "We always live two lives—one outside the home and one inside. Obedience was always for the outside. Disobedience was for the inside. Outside we don't trust anyone. It is the reason for our survival. We had all these invasions, but we still have our language, and we still have our land. We obey the invaders, then change them."

Iran's 2,500-year-old civilization has survived invasion by Mongols, Turks, Afghans, and many others. Lahiji's unspoken message,

U.S. pop culture *and Japanese electronics fill stores in Kish, one of Iran's free-trade islands in the Persian Gulf. People come to buy, to relax, and to enjoy things forbidden elsewhere—men in shorts, women on bikes, love songs in cafés.*

Roughly half the size of India, Iran has 64 million people—twice as many as 20 years ago. Half are of Persian descent, and one fourth are ethnic Azerbaijanis. Iran hosts almost two million refugees—more than any other country in the world—mostly Afghans and Iraqi Kurds.

My traveling companion, Farokh Mostofi, editor of *Shekar-o-Tabiat*, a nature magazine based in Tehran, and I were exploring outposts along an old camel caravan route from Yazd to Tehran. We drove along the edge of the desert on a dirt track in Mostofi's four-wheel-drive. To the north, for several hundred miles, lay the empty Kavir, a brown waste dotted with rocks and shin-high, sagelike shrubs. Dust cyclones skittered across the landscape. A half mile away, a shepherd led his sheep and goats home under an enormous blue sky across which sailed gray-bottomed clouds.

We decided to spend the night in Ashin, a hamlet consisting of a dozen or so domed mud houses perched on a hill at the southwestern edge of the Kavir. Only two families were in residence, the others having abandoned the hard life of shepherding and farming for jobs in larger villages and cities. The holdout families tended a green-and-khaki-colored patch of wheat, cumin, and fruit trees at the base of the mountains, a lush oasis fed by a stream.

As the sun set behind clouds and a full moon rose in the eastern sky, Mostofi and I sat on a rough carpet outside one of the houses, eating and talking with the two families. By the light

I surmised, was that the harsh regime of the ayatollahs has become alien in its own land, forcing millions of Iranians to express their true feelings only behind closed doors. So I was surprised, on my travels, at how willing people were to criticize the government.

I had one such encounter on the edge of the Dasht-e Kavir, an austerely beautiful scrub desert broken by occasional high sand dunes.

of a hissing kerosene lamp, a gaunt man with sunken cheeks covered in white stubble relaxed with the gregarious Mostofi and spoke freely.

"Islamic government is a myth; it's propaganda," said the man (whom I'll leave nameless), echoing a widely held sentiment that the ruling clerics and their families have become nearly as corrupt as many of the shah's top officials were known to be. "I doubt these people are working for Islam. They're just collecting money for themselves."

He also doubted whether the president could get much done in the face of intransigent hard-liners. "Khatami has good policies, but he can't challenge the powers against him," he said. "He can't even move a glass of water from here to there." Indeed, understanding the intensity of his opposition, Khatami has moved very slowly on reforms.

That night I unrolled a thin sleeping bag on the flat mud-and-straw roof of one of the abandoned houses. The hard bed made for a fitful night, but the discomfort was offset by the sight of the moon creeping across the sky, suffusing the rugged desert landscape with an ethereal light.

THE HIGH HOPES Iranians had for Khatami have been tempered by time and the slow pace of change. But two years ago his candidacy stirred passions that caught the fundamentalist regime utterly by surprise. One of four presidential candidates approved by a religious council, Khatami delivered a restrained, often populist message that caught on like a prairie fire. He emphasized respecting people's privacy and guaranteeing their "civil rights and freedoms." His gentle demeanor, as much as his words, won over the Iranian people.

"Everybody was depressed," said Shahla Lahiji, the Tehran publisher. "It seemed that laughing was forbidden. Khatami had a huge open smile. He showed he cared about people."

His election also showed that the yearning for change cuts across Iranian society: women, resentful of inequities and restrictions; journalists, intellectuals, and artists, chafing under government censorship; workers and businessmen, weary of the economic stagnation brought on by the government's mishandling of the economy; and, most of all, the young. In Iran 40 million people are younger than 25 years old. Comprising two-thirds of the population, they are the baby boom that followed the 1979 Islamic revolution. Many of them have no memory of either Ayatollah Khomeini or the birth of the Islamic republic.

In the small town of Zagh Marz on the Caspian Sea a fisherman in his early 30s, Abadin Salimi, invited half a dozen teenage girls to chat with me one evening. Sitting on the floor of Salimi's home, the young women said they wanted to retain Iranian and Islamic traditions, such as tightly knit families and respect for elders, but the theocracy's steady drumbeat of anti-American propaganda had done little to blunt their keen interest in the West.

When I asked one of them, an 18-year-old teacher who declined to give her name, what appealed to her about life in America, she talked of the freedom to enjoy simple pleasures in mixed company. "Things like riding a bicycle or swimming," she said. "We have wishes for enjoyment and a different lifestyle, but with this government we can't achieve them."

Throughout the country, state-controlled radio and television do their best to weed out "corrupting" Western influences. But the Internet and surreptitious satellite dishes are beginning to shred the Islamic curtain with which the authorities have sought to shield Iran.

Interest in the West has also been heightened by the close contact between Iran and its diaspora. An estimated one million Iranians, many of whom fled after the revolution, now live in the U.S., Canada, and Europe. I saw the effect of these expatriates at a wedding one evening in a middle-class neighborhood in Tehran.

A dark-eyed beauty of 22 named Toktam, wearing a bare-shouldered, Western-style wedding dress, was marrying 31-year-old Hossein, who runs a rental-car agency. Her family had lived for years in San Jose, California, and the ceremony, attended by several dozen guests, was a blend of American and Persian traditions. A mullah read the vows to the couple as older women in chadors looked on. But before the ceremony the mullah had to avert his eyes from female guests who were dancing provocatively in sexy gowns.

For sheer brazenness, none of the women could match Toktam's 18-year-old sister, Azadeh, who had long dark hair and black eyes. Azadeh, whose name means "freedom" in Persian, spent the first 12 years of her life in

On a goodwill mission *President Khatami addresses a gathering of Kurds (above), whose separatist yearnings have long been repressed by the Iranian government. To its credit, Iran has accepted thousands of Kurd refugees from its erstwhile foe, Iraq. Finally greeting loved ones at Tehran's airport, a former prisoner of war (below) is one of hundreds that Iran and Iraq exchanged in 1998, ten years after their war's end.*

Men and women *mix openly on the slopes of Shemshak, a ski resort in the Elburz Mountains.*

At the less liberal Dizin resort, morality enforcers insist that the two sexes ski on separate slopes.

northern California. She wore a tight, royal blue dress that spectacularly violated the Islamic dictum against showing curves. Dancing around the room, she showed a lack of inhibition that seemed, well, un-Persian. She told me she chafed under the restrictions of the Islamic government and had been a rebel at her all-girls school in Tehran.

"I don't like it here . . . I can't wait to go back to America," said Azadeh. "You can't walk down the street without someone bothering you. How can you be a teenager here? You're always 50 or over. . . . I'm really trying to take the best of American culture, like being honest and direct, and mix it with the best of Iranian culture, like the way families are so close, and become a better person." In the authoritarian atmosphere of Iran, Azadeh was a fresh breeze of freedom and irreverence.

Young women like Azadeh demonstrate that patience with the sexually discriminatory laws of the Islamic republic is dwindling. Women's rights advocates say inequities still exist in Iranian family law, citing statutes that allow a man to have several wives and to divorce more easily than a woman and that give fathers preference in custody battles. Despite the constraints, women are more integrated into Iranian society today than they were under the shah, mostly because higher education is more accessible.

Iranian women are, in fact, among the most educated and accomplished in the Muslim world. Before the revolution 35 percent of women were literate; now the rate stands at 74 percent. In the shah's time about a third of university students were women; now women make up fully half of new admissions. Better education is paying off professionally: Today one in three Iranian physicians is a woman.

Shireen Ebadi, a lawyer and former judge, whom I met in her office in central Tehran, explained this seemingly paradoxical progress. "Before the revolution many traditional women would not go to university or work. But because the revolution made these places so accessible, conservative families let their daughters go to university and into the workplace." But this had an unintended consequence. "With the revolution, many women came out of the kitchen. Women who emerge into society cannot be oppressed anymore."

Iranian women have indeed begun testing the limits of freedom. Women are still required by law to observe the *hejab*, the Islamic dress code, by covering their hair and the curves of their bodies. But in Tehran and other cities it is now common to see young women showing hair under their scarves and wearing makeup.

In the hinterland, where the roots of Islam go deepest, women are emerging more slowly. Climbing above the scorching plain of the Dasht-e Kavir, I visited Khvor, an emerald green oasis of plum, apricot, and walnut trees tucked into the folds of the barren, dusty brown mountains. Other than its renowned orchards and walnut crop, Khvor's mainstay is carpet weaving.

In one house I watched as Tahereh Salmani, 20, and her two sisters, ages 16 and 17, wove a carpet. Sitting erect behind the vertical carpet frame, Tahereh—who has been weaving since she was 11—deftly threaded wool through the string guides and fired off instructions to her sisters. Asked how she liked her work, Tahereh, who wore glasses and a white print chador, replied, "If we didn't like it, we wouldn't do it."

In nearly every household in Khvor young women like Tahereh make carpets to sell to dealers in nearby Tabas. The carpets usually bring from $300 to $1,000, a handsome sum in a place where the average monthly income is less than $150. The village school ends at fifth grade, which is when most girls drop out to begin weaving. While some families send their sons to middle school in Tabas, they prefer to keep their daughters at home under sheltering parental wings.

Standing beside the girls was their father, Mohammad Salmani, a balding, retired laborer dressed in a T-shirt and baggy trousers. He has ten children, so the extra money his daughters make is important. He said he will use it to help pay their dowries, which could amount to $2,000 each. "They are the hardest working girls in the village," he said proudly.

No matter where you go in Iran, people seem preoccupied with making ends meet. Leaving the desert, Mostofi and I headed to the Caspian Sea plain on the north side of the Elburz Mountains. After the scrubby, khaki-colored vistas of the desert, it was a relief to be in a forested landscape once again.

Driving past brilliant green rice fields, we saw a man the width of a door puttering down the road on a motorcycle, the back of which

Behind closed doors *morals become personal. At a wedding party in Tehran, guests of the Iranian-American bride remove their veils and dance, while the groom's more conservative kin remain covered and still. High above Tehran (below), a family celebrates the 13th day of No Ruz the traditional way: outdoors. Throughout the year city dwellers head for the hills to seek refuge from smog and scrutiny.*

Diverse Faiths

Lamb's blood (above) commemorates the A.D. 680 martyrdom of Imam Husayn, a figure revered by Iran's Shiite Muslim majority. Iran is more tolerant of religious minorities than many Mideast countries, attested by the presence of synagogues where Jews instruct their children (top right) and temples in which Zoroastrians practice their ancient Persian faith (right). But human rights groups charge Iran's Shiite government with violating its own constitution by subjecting non-Muslims to varying degrees of discrimination and persecution. The most egregious cases involve devotees of the Baha'i faith, considered heretics, and evangelical Christians, distrusted for their ties to churches in the West.

was piled high with leafy branches. "Mulberry leaves," said Mostofi. "Food for his silkworms."

The motorcyclist's name was Ali Akbar Shafei, and with his permission we followed him to his home in Now Deh, a village of brick and concrete houses set on winding streets in the foothills of the Elburz.

Shafei, a 32-year-old whose 220-pound body, fierce black mustache, and week-old stubble belied a gentle disposition, pulled into his courtyard and hauled the pile of branches into a room attached to his brick house. There he was fattening up 20,000 white silkworms, whose cocoons would produce fibers for carpets and textiles. He would sell the silkworms to a local middleman, netting about 500,000 rials, roughly $165. Not a bad sideline for a man who earns about a hundred dollars a month as a security guard and who grows half a ton of rice a year to help feed his family.

"I cope, I survive," said Shafei, who has a wife and two children, as we sat on his front stoop drinking tea. "I live in a village and it's cheap, but you couldn't survive without growing something. Inflation is just killing us. It's crushing us. We don't save anything."

At the time we spoke, inflation was running around 20 percent a year. Falling oil prices

A mirror's many facets *reflect a uniform reality in Qom, where women approach their entrance to a shrine. With some 30,000 theology students, Qom has supplanted An Najaf, Iraq, as the world's center of Shiite scholarship.*

(from $36 a barrel in 1981 to about $11 in 1998) and production problems in Iran have caused a slide in oil revenue from 22 billion dollars in 1976 to 10 billion in 1998—a huge setback considering that oil is Iran's number one source of export earnings.

Since the inception of the Islamic republic the economy has suffered other blows as well: the flight of many of the country's business and technical elite, the protracted war with Iraq, trade sanctions by the U.S., a doubling of the population. The regime worsened matters by nationalizing all the major industries; spending more than 11 billion dollars a year to subsidize the prices of gasoline, bread, and electricity; discouraging foreign investment by confiscating businesses; and allowing shady government foundations to dominate such important areas as real estate.

President Khatami's allies say he understands the need for reforms, but it's a huge challenge in a country riven by ideological splits and ruled by clerics with little understanding of economics. In late 1998 his government proposed raising the price of state-subsidized gasoline, which, at 12 cents a gallon, is the world's cheapest. That proposal was shot down by the conservative parliament, which preferred to continue popular policies.

As a result of all this, families like the Shafeis are having to make do with less. The average income of Iranians in 1999 dollars has fallen from about $2,600 in 1976 to $1,800 today. Even so, Iran is not an impoverished nation. Indeed Iranians have a living standard many times higher than those of their central and south Asian neighbors, such as Pakistan, Afghanistan, and India.

While the ailing economy and heavy-handed religious rule have eroded support for the supreme leader, Ali Khamenei, he retains a core of ardent followers. This conservative bulwark is closely tied to several phenomena: devout Muslim faith, continuing belief in the revolution, and the war with Iraq.

To feel the fire of devotion to the regime, one need only visit Khorramshahr on the Iraqi border. The city suffered more than any other during the war, which began on September 22, 1980, when Saddam Hussein invaded Iran to reclaim what he contended was Iraqi territory. The war dragged on for eight years, killing an estimated million people all told.

Near the northern end of town, close to the Shatt al Arab waterway—the border with Iraq—is a neighborhood where date palms once grew in profusion among the mud and brick houses. Flattened during the war, the palm trees and old houses have been replaced by rows of two-story, beige stucco apartments.

Such rebuilding has encouraged people to return to the city, and the population is climbing back toward its pre-war level of 150,000.

Habib Eqbalpour, 70, and his wife, Zinat Parvaresh, 63, live in one of the new apartments. Two of their sons were killed fighting in and around Khorramshahr, and they spoke with passion about the martyrdom of their boys in defense of the Islamic republic.

"We are proud we lost our children, Allah be praised," said Mrs. Parvaresh, pulling a black chador over her chin as we sat on the carpeted floor of their living room. "We hold our heads high, thanks be to Allah."

They likened their sons to Imam Husayn, the grandson of the Prophet Muhammad. Husayn is central to the religious fervor of many Iranians, some 90 percent of whom are members of the Shiite branch of Islam, not the Sunni one, which predominates in the rest of the Muslim world. In A.D. 680 thousands of Sunni warriors from present-day Syria killed Husayn and scores of his followers at Karbala, in what is now Iraq. The battle deepened the schism between Shiite and Sunni Islam, and to this day the martyrdom of Imam Husayn inspires in devout Iranian Shiites a sense of the nobility of sacrifice in the face of oppression and threats to the motherland.

"My sons are following in the path of Imam Husayn, and when they are in the other world, they are helped by Imam Husayn," said Mrs. Parvaresh, whose boys were 17 and 21 when they died. Because of the family's loss, government foundations, including the Martyrs' Foundation, provide them with a free apartment and pay them a stipend of 360,000 rials a month (about $120).

THE WAR is still a palpable presence in Iran: Thousands of city streets are named after martyred soldiers, martyrs' cemeteries with flapping green-and-red flags (green is the color of Islam and red signifies the martyrs' blood) exist in virtually every village, and gigantic murals of well-known martyrs are painted on billboards throughout the country. Every year in observance of the martyrdom of Imam Husayn, Iran marks Muharram, a month of mourning in which people march through towns and cities, flaying themselves with chains and reciting tales of the nobility of his sacrifice.

I was in Isfahan on Ashura—the tenth day of the month, marking the moment of Husayn's death—when the ceremonies became a pep rally to cheer conservative political forces and attack the United States. The focus of Ashura in Isfahan is Imam Khomeini Square, a stately quadrangle flanked by several great monuments of Persian architecture. Among them is the Imam Mosque, completed in 1638, which rises above the low-slung skyline of central Isfahan, its cerulean dome and beige trim matching the desert sky and sand.

Thousands of mourners filed through the square, including members of the Revolutionary Guard. Barefoot, many of them wearing the red-and-green bandannas signifying their desire to make the ultimate sacrifice for Islam, the mourners trotted en masse past the reviewing stand, chanting and pounding their chests. Standing just a few feet from these die-hard defenders of the republic, feeling the concussive thump of hundreds of fists on chests, I felt a wave of awe—and fear—run through me.

The speaker, referring to the American and Western culture that was creeping back into Iran, praised the demonstrators and declared, "These are fighters for Islam! Yesterday they were at the war front fighting the enemy. Today they are fighting a cultural invasion!"

The bearded men ran in rows through the square. "We are going to blind those who love the United States," they chanted.

The zealotry was an unnerving reminder of the Iran that President Khatami seeks to moderate. As the men filed out of the square, I hurried after them, wanting to find out if their personal opinions were as fierce as their public slogans.

"Whenever relations between a wolf and a sheep become good, then we can have good relations with the United States," Hamid Reza Salimian, a 30-year-old computer technician, said, as his cohorts nodded in assent and pressed in on me. One man warned me not to twist what they were saying; others heaped scorn on the U.S. government. Quietly my translator urged me to leave, and we squeezed through the marchers and disappeared into Imam Khomeini Square.

A few miles from ancient Persepolis in rural Fars Province, Behnam Fallahi and other farmers pay little heed to demonstrations in Isfahan or nearby Shiraz. *(Continued on page 30)*

A clean street *makes a lively playground in south Tehran (above), but poverty is close at hand. Inflation and unemployment in Iran run around 20 percent. In the southwestern province of Khuzestan (below), Nahid and Hussein Saboee collect salt after school to sell to bakers. The good news: 85 percent of Iran's children go to school, and 80 percent of the population is literate, versus less than half before the 1979 revolution.*

An Economy at Low Ebb

Iran has 9 percent of the world's proven oil reserves, most of it in Khuzestan (left), a primary target of Iraq during the eight-year war. Iran depends on oil for 80 to 85 percent of its export earnings, and as prices have fallen through much of the 1990s, its economy has struggled to stay afloat. Famed Persian carpets help, as do pistachios, the third largest export. Despite increasing competition, Iran remains the world's largest producer of the nuts—many grown in Rafsanjan (below). Iran is hoping to encourage fresh markets by developing a new "silk road," a rail line between Central Asia and Iranian ports on the Persian Gulf, such as Bandar-e Abbas (bottom left).

Despite government efforts *to force them to settle, Qashqai nomads still hew to their own*

ways. Thousands roam Iran's southwest, tending sheep and goats and spinning wool for carpets.

(Continued from page 24) In the shadow of high brown cliffs where ancient Persians left carvings of battles fought against Roman invaders, farmers toil to produce the 25 or 30 tons of wheat needed to support their families from one year to the next.

When I met Fallahi, a slight man of 27 in mud-splattered clothes, he and two other farmers were clearing debris from irrigation channels in a plot the size of several football fields. As we talked, a hot, dry wind rippled the wheat. "It's 100 percent better now," he said. "We can decide things for ourselves, talk for ourselves. In the old days nobody could say anything. They were really under pressure from the landlords."

He was referring to the landed aristocracy, which until the 1960s ruled Iran like a fiefdom, with prominent families owning entire villages. The last shah began a major land redistribution, and after the revolution the Islamic authorities continued to break up large properties and give the land to peasants.

Other changes are visible throughout the wide, irrigated desert valleys, dotted with buttes and flanked by rocky slopes. Nearly every village has new paved roads or telephone lines, electricity or irrigation pumps—all part of a program for rural areas under the auspices of a government ministry called the Crusade for Construction.

In Shiraz the head of the Fars Province branch, Abdul Karim Razavi, ticked off the accomplishments of the Islamic republic. In Fars the regime has paved 1,631 miles of roads, graded 2,463 miles of dirt roads, built 4,465 feet of bridges, installed new drinking water systems in 1,340 villages, and increased the number of villages with electricity from 324 to 2,044—89 percent of the rural population. These gains, he said, are representative of progress throughout Iran.

"Before the revolution we can say that the government led from the top down," said Razavi, who wore the look preferred by officials—neatly trimmed beard, dark suit coat, no tie. "Now people participate. Before, people living in rural areas thought they should migrate to the cities. It wasn't economical to stay in villages. Now it is."

One reason life is better in the countryside is that the Islamic republic has managed to slow a population boom that has severely strained the country's social and economic fabric. After 1979 the regime exhorted people to reproduce for the motherland. The average Iranian woman had six children, and the country was growing by more than a million a year. Today, thanks to public education, free contraceptives, and publicity campaigns emphasizing the advantages of having fewer children, family size has been halved. (At the same time life expectancy has risen from 60 to 72 years, and infant mortality has been reduced from 90 deaths per 1,000 births to 26.)

"Each Muslim has the right to good health care and proper food, clothing, and education," said Mohammad Ansari, the physician at a health clinic in Segzi, a small town near Isfahan. "If people with large families are not in a position to provide those, then we need family planning." Ansari invoked the words of Imam Ali, son-in-law of the Prophet Muhammad. "He himself said that the fewer the children, the more peace of mind."

THE INVOCATION of an ancient Islamic figure to further the modern goal of population control is but one example of how the current regime is attempting to reconcile the old and the new, the religious and the secular.

Further evidence of this can be seen at Qom, home of a renowned religious seminary where Ayatollah Khomeini and many of Iran's religious leaders studied. There, amid the tranquil turquoise-and-green mosaic-tile seminary buildings and gold-domed mosques is an incongruous operation: the Computer Research Center of Islamic Sciences.

"Islam encourages us to use technology and knowledge," said Assadollah Moslemifar, the deputy director of the center. He accompanied me to a long basement room where turbaned scholars and students sat behind banks of computers, dissecting holy texts using Windows 95 or training to become software engineers. The center's staff members, all mullahs, produce illustrated CD-ROMs of the Koran and other religious products, which are sold worldwide.

"With the Internet all human beings will improve themselves," said Moslemifar. "I think there are ways to avoid corruption on the Internet and take the positive points." The government permits numerous companies to provide citizens with access to the Internet

American tourists *again revel in ancient Persepolis (above) and rave about their welcome across Iran. Most Iranians dismiss "Great Satan" rhetoric, and even some demonstrators try to soften it. For 1998's anniversary of the U.S. embassy takeover, students planned to burn an Uncle Sam puppet instead of an American flag—to bash America's government, not its people. But diehards won out and Old Glory burned.*

but requires that sites deemed unsuitable be blocked, an increasingly difficult task.

Outside, in the seminary courtyard, I met a young man who was undergoing the rigorous course of religious education, which can take a dozen years. He was sitting on a stone wall in the shade of a eucalyptus tree.

Ali Safaryan, a tall 26-year-old with gold-rimmed spectacles and a gray robe, said he was a student of Islamic law. He spoke forthrightly of his belief that the revolution has made Iran truly independent of foreign powers.

"I prefer to live one hour in this era than a lifetime before the revolution." Bracing myself for a revolutionary harangue, I was taken aback by Safaryan's answer when I asked him about President Khatami.

"He is ideal in all respects. He talks about Islamic democracy. He brings us this gift of dialogue between cultures. And he has improved the view Iranians have of Americans."

Safaryan sought to minimize the tug between the forces of reform and reaction, contending that a majority still supports the basic ideals of a theocracy. Back in Tehran, Ibrahim Yazdi, head of the opposition Freedom Movement of Iran, said the country's political forces now find themselves in a healthy stalemate.

In Shiraz, *famous for its gardens, Ayatollah Majdeddin Mahallati earns respect not with proclamations but with charitable projects like orphanages. Iranians value such practical piety and hope for a new flowering of tolerance.*

"In Iran no single faction can annihilate the competition," said Yazdi. "This is a very promising situation. This is the progress of democracy. You have a delicate balance of power."

On May 23, 1998, the first anniversary of Mohammad Khatami's election, the soft-spoken president and tens of thousands of his supporters—most of them young, many of them women—took part in a rally unlike any seen in Tehran in the two decades of the ayatollahs' rule. This time no one burned Uncle Sam in effigy. Instead the marchers flowed down Vali-ye-Asr street under the shade of the plane trees calling for an end to the religious regime's stranglehold on power.

"The enemy of our society is prejudice and monopoly," shouted a line of young women in long black chadors. Demonstrators carried banners reading "Freedom of the Press," "The Military Should Be Reformed," "Freedom of Thought Is Everybody's Right."

Onlookers stood on balconies and in shop doorways, many of them nodding or smiling in approval. As I hustled alongside the rows of marchers, listening to the chanting and taking in the expressions of hope and excitement on the demonstrators' faces, I was reminded of the pro-democracy, anti-communist marches I had witnessed in Moscow in the waning years of the Soviet Union.

The marchers converged on the Friday Prayer pavilion at Tehran University, a place where Iran's revolutionary leaders have traditionally spit fire and led chants of "Death to America." Khatami, dressed in a light gray robe, black loafers, and the black turban that marks him as a descendant of the Prophet Muhammad, faced a crowd that spilled out from under the pavilion and onto nearby sidewalks and streets. For more than five minutes his supporters whistled and cheered and pumped their fists in the air. At last Khatami succeeded in quieting them.

"The future of religion is that it has to cope with freedom; otherwise it has no future," he told the crowd. "If religion confronts freedom, then religion will suffer."

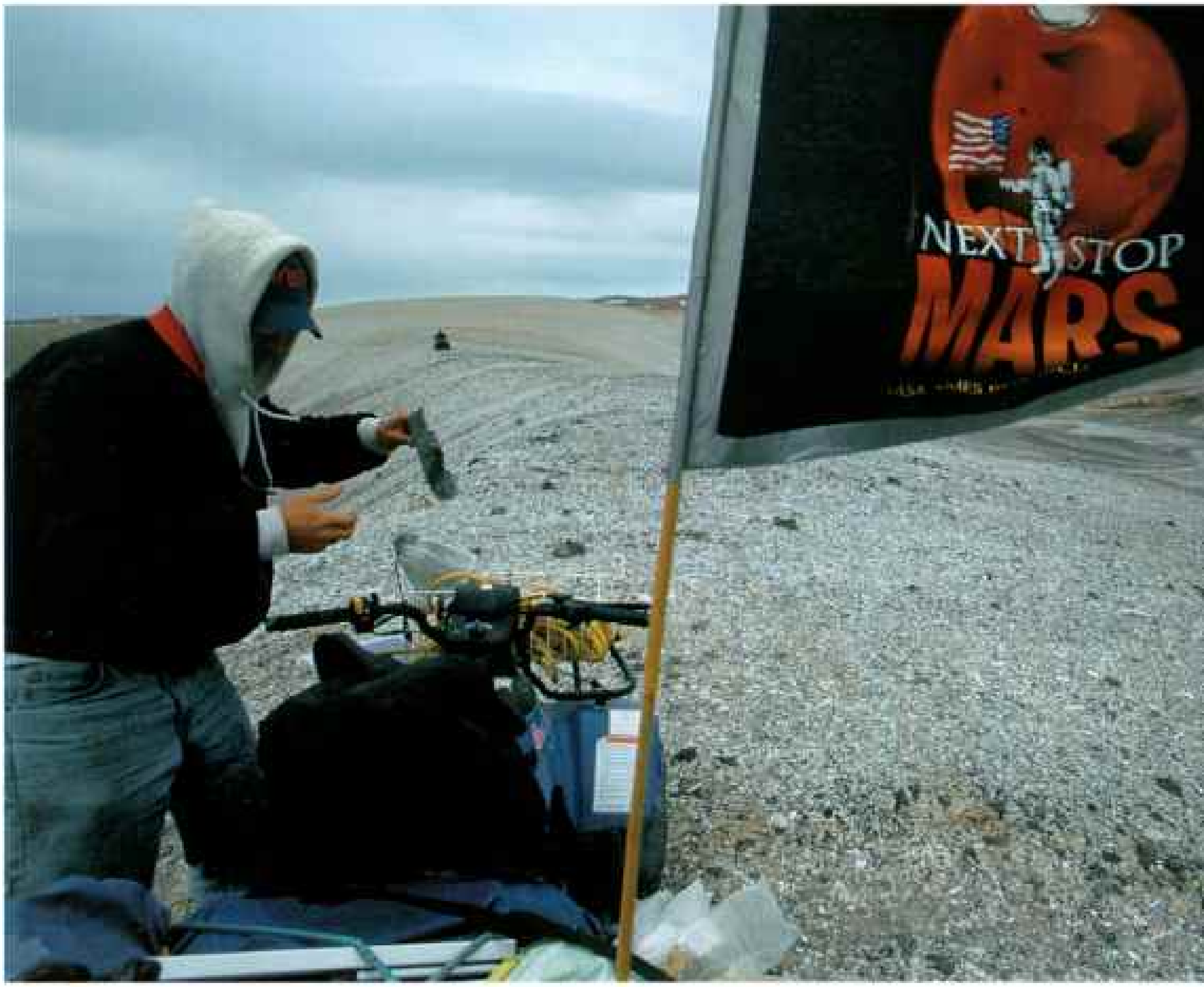
As he continued speaking, a small group began chanting "Death to America!" They were soon drowned out by louder chants of "Death to Monopoly!" For a moment Khatami stood quietly, the late afternoon sun filtering in golden shafts onto the speaker's platform. Then he uttered a remark that silenced everybody. "I prefer," said the President of Iran, "to talk about life, not death." □

What does Iran's future hold? Share your thoughts online at *www.nationalgeographic.com/ngm/9907*. Also tune in to "Iran: Behind the Veil," airing July 28 on National Geographic EXPLORER.

MARS

Light snow and the other-worldly glow of an Arctic summer night lend an alien aura to Haughton Crater on Canada's Devon Island. Deemed similar to craters on Mars, Haughton has become a proving ground for future missions to the red planet.

ON EARTH



By **Michael E. Long** Photographs by **Peter Essick**

THE METEORITE slammed into the island in what is now the Canadian Arctic at 40,000 miles an hour. The resulting thousand-megaton blast of energy was nature's equivalent of a nuclear catastrophe.

Excavating a crater 15 miles wide, the explosion and shock wave pulverized the island's rocky innards, ejecting shards of dolomite, gneiss, and granite thousands of feet high, while ruptured mains of groundwater gushed into the depression. The rock rained down, accumulating into hills of jagged remnants called breccia. Hot breccia mixing with groundwater brewed cauldrons that boiled and hissed. Within a radius of perhaps a hundred miles, plant and animal life ceased to exist.

Twenty-three million years later Haughton Crater, named for an Arctic geologist, still pockmarks Devon Island on Lancaster Sound, the seaway of disappointment for 19th-century British mariners seeking a Northwest Passage. Devon is now populated by polar bears, musk oxen, caribou, arctic hares, and snow buntings. The crater's rim, worn like old molars, encircles the breccia hills and the ancient lake beds covered with hummocked tundra. Treeless, windswept, rock strewn, and otherworldly, the terrain is eerily akin, some experts believe, to that of craters on Mars.

Scientists, mostly from the National Aeronautics and Space Administration (NASA), are gathering here under the midnight sun of Arctic summer to examine Haughton Crater's rocks, drill into its lake-bed deposits, peer

No strangers to working in rugged terrain, writer MIKE LONG and photographer PETER ESSICK last teamed up to report on the Grand Canyon in the July 1997 issue.

A fluttering banner heralds the goal of planetary scientist Pascal Lee, leader of two dozen researchers who spent a month last summer on Haughton's rocky hills. Dry, cold, and barren, the crater has been an ideal Mars stand-in for experiments in lake-bed core sampling, robotic mapping, ground-penetrating radar—even group dynamics. Says Lee, "Everybody feels like an astronaut here."

RESEARCH PROJECT

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beneath its surface with radar, and conduct other experiments to assess the crater and its environs. They are preoccupied by two questions: What can Haughton tell us about water on Mars? About life on Mars?

At Resolute on nearby Cornwallis Island, I join a group of scientists boarding a de Havilland Twin Otter. Crammed with more than a ton of passengers and cargo, the twin-engine vaults into the air after a short takeoff roll and settles into the 45-minute flight to the crater. We pass over Devon's precipitous headlands and deep, fjordlike valleys, and we land beside the Haughton River on rock and gravel—no one would call this a runway—at camp.

All pitch in to unload. Fuel drums are simply heaved out and crash to the ground. An all-terrain vehicle, or ATV, lands on its wheels and bounces, demonstrating its toughness. As I pitch my tent, I feel a profound sense of aloneness. We are 13 people on an island about the size of West Virginia.

After a pep talk from expedition leader Pascal Lee, a planetary scientist from NASA Ames Research Center near Mountain View, California, we proceed to camp routine. Geologist John Schutt briefs us on riding ATVs, our principal mode of transport, and how to handle a shotgun in the event of a polar bear incursion. Will lead slugs and buckshot stop the Arctic's largest carnivore?

I prefer to rely on our bear-early-warning dog, a massive half Saint Bernard, half husky named Bruno, veteran of several trips to the north magnetic pole and responsible for safeguarding skiers from bears. Last year he drove off a bear approaching this camp.

We squeeze into a 14-by-12-foot mess tent for dinner, sitting on freezer chests rimmed by giant cans of pork and beans, spaghetti, and chili plus jumbo cartons of tea, oatmeal, dried milk, and mashed potatoes. Geologist Jim Rice—6 feet 3 and 220 pounds—comes through the tent flap like a loose iceberg. Amid three long tables there is scant room to maneuver.

An adjacent tent of equal size is strewn with spaghetti bundles of wires, cords connecting to battery chargers, laptops that sit like opened clamshells, and other scientific paraphernalia.

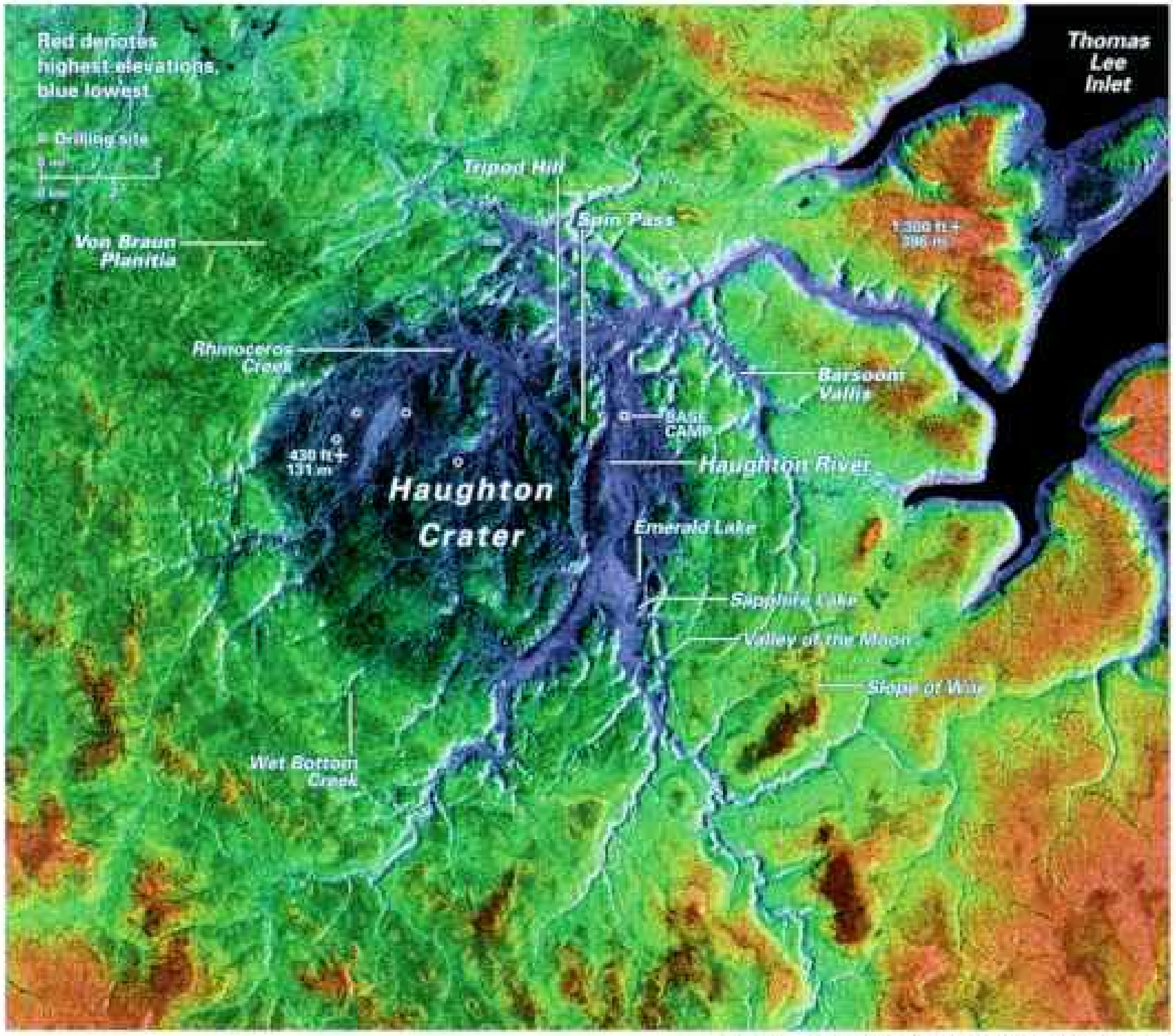
Twenty-three million years ago an asteroid or comet slammed Earth with such force that soil, sediment, and bedrock from more than half a mile underground shot skyward. The pulverized bits fell back to the ground as breccia, whose ash-gray signature marks Haughton Crater today (above). At the time of impact this was a warmer, lusher land of spruce and pine. The blow and its shock wave, heat, and debris left a 15-mile-wide crater surrounded by desolation. Groundwater immediately filled the bowl. Now dry and reduced to a 10-mile diameter by the rim's erosion, the crater lies in a polar desert, its sediments holding the secrets of a Miocene disaster.

Projectile pierces Earth's atmosphere

Birth of an impact crater

Smoldering heart of a battered land

ART BY MICHAEL CARROLL



CANADIAN SPACE AGENCY RADARSAT IMAGE ENHANCED BY THIERRY TOUTIN, CANADA CENTRE FOR REMOTE SENSING, OTTAWA

Brian Glass, a graduate of MIT, Stanford, and Georgia Tech, shows me a laptop equipped with a camera, prototype for a device that would allow field astronauts to send data and images to each other and back to their base. Low-key but passionate, Glass wants to replace the "flags and footprints of the Apollo program" with hard-core science on Mars. "Apollo was never set up with long-term science objectives. That's what we should do on Mars."

And science is what we're going to do here, with each day's news posted on the expedition's website. Next morning is sunny and cool as I join Lee and Liam Pedersen, a South African roboticist, for an ascent of the grayish breccia hills behind camp. On a steep slope my ATV stalls. Starting it up, I give the machine too much gas, and it stutters and veers sharply to the left. In desperation I leap off to the right. "Now that was spectacular," declares Lee. He proposes naming the spot Spin Pass.

Atop the hill Pedersen takes light measurements of the breccia with his spectrometer, as he will later do with other rocks and lake-bed sediments. He explains that once these spectral signatures for different rocks or sediments are known, the same rock types can be identified from satellite imagery. It's a way of exploring without going anywhere.

Proceeding west, we stop here and there to search for small pointed rocks called shatter cones. "There are only two kinds of places on Earth you find them," says Lee, "nuclear explosion sites and impact craters." Shatter cones, a product of the catastrophic shock wave that accompanies an impact explosion, exhibit fracture lines that converge toward that part of the rock exposed to the blast.

We arrive at a small, nondescript butte rising like an altar from the surrounding turf. Lee characterizes it as a remnant of a deposit of lake sediment. "This is precisely what we

Robot rotors shatter the silence as scientists from Carnegie Mellon University test a small unmanned chopper designed to create three-dimensional maps using lasers and satellite data. The system has kinks. Hills in the crater can block transmissions from satellites, which are low on the horizon at this latitude. This may have caused the blank vertical stripe on a map (right) of a ridge by the Haughton River. A perfected system may one day map Mars.

CARNEGIE MELLON ROBOTICS INSTITUTE

would look for in a Martian crater to search for evidence of ancient bodies of standing water," he says. "It would be a major finding on Mars, the holy grail, hard evidence for water."

As water is the incubator of life on Earth, its presence would argue powerfully that there could have been life on Mars. Though most scientists believe that water is locked in the form of ice at the Martian poles, its discovery at the midlatitudes, where humans would most likely explore, would be of critical importance. Water would sustain astronauts and irrigate crops in greenhouses. Broken down into its components, water would yield oxygen for breathing and hydrogen that could be manufactured into fuel for rover vehicles and for rockets to return to Earth.

That evening we dine simply on pork and beans heated on a propane burner. Occasionally the chef-for-the-day attempts cuisine, which the group appreciates but ranks behind other priorities, like ruminating about rocks and dreaming of Mars.

A SENSE OF MISSION pervades Lee's crack multinational team, eager for fieldwork in this isolated place. Trips around the crater are called traverses, as were lunar excursions by the Apollo teams. In addition to Spin Pass, other terrain features are informally christened—the Valley of the Moon, Sapphire Lake, and the Slope of Woe, for a particularly challenging hill. On one traverse, after we have forded an unnamed stream many times, Lee invites me to give it one. I call it Wet Bottom Creek.

Career goals are no secret—going to Mars. Lt. Col. George Martin, a U.S. Air Force flight surgeon, has twice been an astronaut finalist. Jim Rice once shook the hand of Neil Armstrong at a reception, then hustled to the end of the line so he could shake the moon astronaut's

Haughton's wasteland is a wonder for those attuned to the beauty of rock. With a spectrometer, fiber-optic cable, and laptop Liam Pedersen (below, at left) and David Reyes measure light reflected off rocks to determine their composition. Such data will help map the geology of Haughton and could help develop "robotic geologists" that may one day identify rocks on Mars. Will the robots find life? Perhaps. At Haughton piles of gypsum that arise from breccia (right) often house microbial algae in cracks sheltered from biting wind and cold.

hand again. "I've got my toothbrush packed; I'm ready to go in a heartbeat," says Rice, who wears orange-colored ski goggles when he's cruising on an ATV so the terrain will appear more Marslike.

These high achievers are as comfortable in the field as they are in the laboratory. Geologist John Schutt is also a mountain guide with years of experience in the Arctic and Antarctic; he has climbed 27,800-foot Mount Makalu in the Himalaya and traversed the Patagonian ice cap on skis. Charles Cockell, a British biologist, flew an ultralight over the Indonesian rain forest collecting moths, organized an expedition to Mongolia seeking long-eared hedgehogs, and, as leader of the "Forward to Mars" party, gained 91 votes in his challenge to John Major for the prime ministership in 1990. Nathalie Cabrol, a French planetary geologist, realized one day that she knew more about Martian geography than that of Earth. With barely a trace of a smile, she says, "I come from Mars."

I learn that this effort began with Lee, not with NASA administrators. Fascinated with the idea of finding a crater on Earth that could serve as a Mars analogue, he was drawn to Haughton. "It was in a polar desert," Lee says, "a cold, dry, windy impact crater, a common feature on Mars." Supported by NASA and the National Research Council, Lee and three other scientists went to Haughton in the summer of 1997 for initial fieldwork, which convinced him of the value of studying the crater.

Unfolding a map of Mars, Lee points to Northport Crater. "Coincidentally, it's roughly the same size and configuration as Haughton," he says. Lee points out the venous shapes of small valley networks near Northport and tells me that similar valleys lie just outside of Haughton's rim. "They seem to spring up from nowhere," he explains, "and they don't get wider and deeper downstream as do other

valley systems on Earth." Lee hypothesizes that the valleys on both planets could have been created by melting masses of ice.

In the evening a slanting wind turns cold and stiffens, delivering ice crystals that scrape my tent like grains of flung sand. I crawl into a sleeping bag wearing socks, fleece, gloves, and hat, wondering whether the water inside my solar shower will ever bask in the warming rays of the sun. Snow begins to fall.

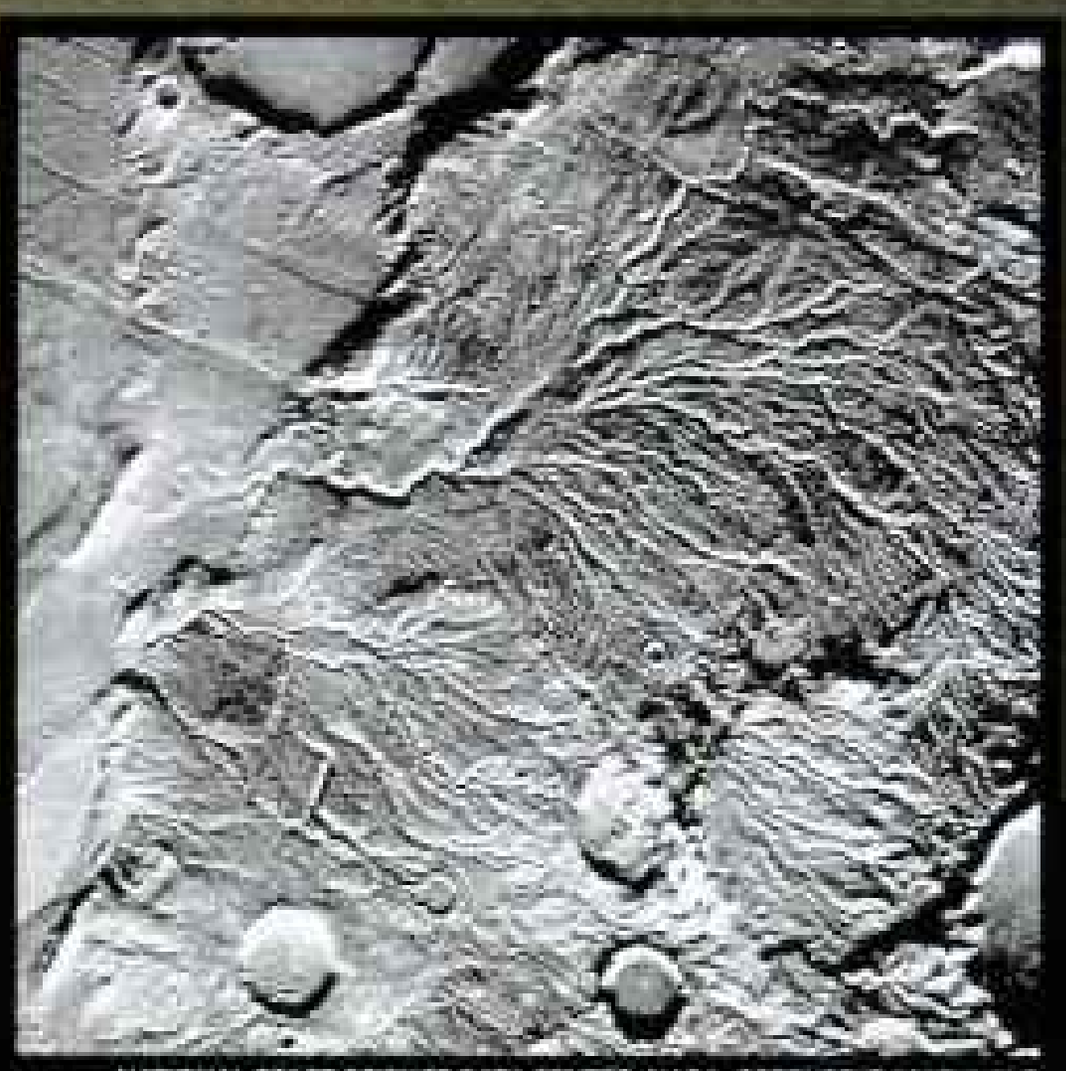
By morning the weather continues mostly nasty—temperature 29°F and a persistent 25-knot wind under a cloud-wrapped sky. Lee's lieutenants do not seem to mind. In cocoons of warm clothes they put on ski masks and mount ATVs for the three-mile ride to the lake bed to drill through ground ice for ancient sediments and breccia.

Threading sections of drill pipe while the wind spits snow in their faces, John Schutt and George Dunfield, another geologist, look like mud-spangled troglodytes. Schutt wears no gloves. His once bright rain gear is dulled by grime. Dunfield wears a half-buttoned black parka and a formerly white cap with ear and neck flaps. A perfectly hexagonal crystal fixes on Dunfield's parka momentarily and is gone.

To simulate Martian conditions, the drill has no liquid lubricants, which would contaminate the samples—and would probably freeze on Mars. A gasoline engine fires with a strident *wap-wap*, and the drill augers into the tundra, extracting cores. A similar procedure could be used to sample lake beds on Mars.

On a nearby slope Nathalie Cabrol digs out fossils of tree limbs, reminders that many millions of years ago the climate here was temperate, supporting such creatures as a primitive rhinoceros. Today the lake-bed tundra remains an oasis of life, albeit a thin one, at the 75th parallel, some 400 miles from the north magnetic pole. We see only a nesting pair of

Silvery hieroglyphs, narrow valleys filled with thawed ground ice and snow tell a tale of Devon Island's glacial past. Called small valley networks, these fingers seem to spring out of nowhere, suggesting that they were channels for meltwater formed at the edge of a shrinking ice cover. Similar shapes on Mars (right), though on a vastly larger scale, may have formed the same way—a clue to the planet's climatic past.



NATIONAL SPACE SCIENCE DATA CENTER, NASA, GREENBELT, MARYLAND

Haughton's mess tent offers barely enough room to share both food and ideas. "The exchange of information during meals was invaluable," says roboticist Alex Foessel, at left. The chow wasn't bad either. "There's no reason you can't have good coffee in the field."

Canada geese. Two adult musk oxen with a calf. A solitary jaeger circles overhead, prowling for lemmings. There are occasional caribou, such as the two grazing placidly a few hundred yards away, unaffected by the clatter of the drill. Slowly they move up a gully.

I wander over a small mound called a pingo, a hump created by subsurface ice pushing upward. On the tundra I see the deep indentations of musk ox hoofs, bunches of electric green arctic poppies, and arctic willows that creep along the turf like infantrymen under barbed wire, as if their deciduous limbs are reluctant to rise and confront the wind.

I sit on a rock fragment overlooking a river valley, scanning for tens of miles, seeing no walking or flying creature until I become aware of something maneuvering on the underside of my hat brim. I remove the hat and a mosquito wanders onto my gloved left hand, slipping because the smooth leather affords it no purchase. I remove the glove and offer the insect flesh, surely a fine meal in this sparse place. But it declines, falls to the ground, and listlessly crawls away, dulled by the cold.

Beyond the greenish floor of the lake bed I see the pale humps of breccia hills and—suddenly—along the river toward the west three black specks, the musk oxen with calf. I lean back to enjoy the scene, and my right hand encounters caribou droppings, fresh.

The ATVs fire up, coughing like a squadron of propeller-driven airplanes. I hurry back to join a small convoy heading west, led by Schutt. We transit a valley. Across the way is a large white conspicuous object, conspicuous because white is seldom seen here in the summer. I scan the object with binoculars. It's a polar bear, someone declares. I say, it's not a bear; it's not moving.

Schutt slings his shotgun and motors down a ravine to emerge about a hundred yards from the object. Suddenly it moves. I think, good grief, it's big enough to be a bear; it is a bear. The animal stands on all fours, stretches fore and aft in very unbearlike fashion, and runs off. No, bears don't stretch like that. Must be a caribou. A white caribou? Schutt returns to

Grasping history, George Dunfield wraps a sample of Haughton's lake-bed sediments—the only remnants of the Miocene known to exist in the Arctic. Refinements of drilling techniques used here may help retrieve Martian sediments, perhaps rich in fossil remains.

report that it's an arctic hare—a rabbit! I'm feeling foolish. How can this be?

Brian Glass explains that the monotonous, treeless terrain offers few cues for perspective, and things can appear larger than they are. Indeed, Arctic explorer Vilhjalmur Stefansson wrote in 1913 about stalking a grizzly only to discover, finally, that his grizzly was a marmot.

Fresh tracks along the watercourses reveal the presence of polar bears. In the sand Jim Rice measures a footprint eight inches wide. In a valley east of camp two sets of tracks ascend a steep slope straight up with never a waver. I marvel at the power of the beasts who made them. Because my tent is closest to the Haughton River, I keep a shotgun in the tent vestibule at night, consoling myself that we have found no tracks by the Haughton. Much later it occurs to me that bear tracks may not have imprinted on its rock and gravel banks.

ON JULY 13 drill cores are stowed, rocks are sorted, tents struck, and a group of scientists departs, making room for newcomers. This shift brings a biologist, a computer scientist, an expert in artificial intelligence, and a team of robotics experts from Carnegie Mellon University with a remotely controlled helicopter for mapping Haughton's terrain. But first a pestering wind blows from the northeast and gathers strength, popping pegs on Lee's tent, which makes a good imitation of a parachute until we smother it. During dinner the sides of the mess tent thump and crack. Schutt estimates the gusts "at around 60 knots."

There is nothing to do but seek shelter and hope for the best. My tent, designed to withstand such blasts, rocks but holds fast. When two smaller tents flatten, people secure them to ATVs with bungee cords. The paraphernalia tent, whose side begins to flutter, spews loose items to the wind and requires three anchoring ATVs. Bruno, who routinely sleeps out in blows and snows, begs for entry into a tent. Schutt fashions a windbreak from a gear case; dog and humans hunker down for the night.

By morning the camp is windless, sunny, and warming. Perfect weather to fly the

Haughton's face is freed from monotony by the grace of geometric curves. Huge polygons form as frozen ground thaws and refreezes in annual cycles. Mounds called pingos, one a hundred feet across, at left, form as soil heaves upward over underground ice. Similar features on Mars (right) offer the hope that water may be present and accessible to future human visitors.

NATIONAL SPACE SCIENCE DATA CENTER

14-foot-long, 160-pound helicopter used in Japan for crop-dusting. Team director Omead Amidi of the Robotics Institute at Carnegie Mellon has added 320,000 dollars' worth of sensing, positioning, laser mapping, and navigational gear. Ryan Miller monitors the mapping system. Pilot Mark DeLouis gives the machine commands from a handheld console, and for the next few days the helicopter goes about its mapping tasks while the dentist-drill whine of its engine disturbs the peace of the camp seagull. DeLouis keeps his eyes fixed on the machine as Amidi walks beside him, pointing out rocks so the pilot will not stumble.

Charles Cockell, the British biologist, heads to the tundra, seeking lemmings for a genetics study. He sets out long, baited aluminum traps, but the lemmings will have none of it. After several days the final score is Lemmings 20, Cockell 0. The biologist gives up, grumbling—"The rascals. Next time I'll bring dynamite."

His work has been recorded by a camera-equipped laptop manipulated by Rick Alena, a computer scientist. Alena drapes a black cape over himself and the machine as a shield from the sun and looks like a photographer from the Civil War. All this is rudimentary and prelude, he says. "Someday an astronaut will carry sensing and communications gear on the wrist."

Cockell is impressed that the drilling team has acquired two intact cores from the crumbly breccia. "The intense heat of the impact would have created boiling hot water," he speculates. "Perhaps heat-adapted microorganisms like

Set like gems in an austere brooch, Sapphire and Emerald Lakes lap the line between gray impact breccia and Haughton's rim. The lakes' different hues may be due to minerals, plants, or depth—among the many unknowns scientists will probe in their quest to understand Haughton and, by extension, Mars.

you see in Yellowstone Park's hot springs might have gained a foothold in this environment. If we find the fossil remains of such microorganisms here, it will help us in our search for them in craters and river valleys on Mars." A team of scientists at NASA Ames will search for these biological signatures in the cores.

Late on that final evening I make a trip with Lee to Tripod Hill, so called because at a certain spot a camera-on-tripod is erected to record any changes in a mudslide hundreds of feet long across the valley. Lee has explained that this is an important mudslide that might tell us something about Mars, where similar looking slides have been spotted. Over three weeks the dark mudslide at Haughton has lightened considerably, indicating that water from melting ground ice has dried up. Lee wonders whether the Martian slides also change in color, perhaps revealing the presence of ground ice—water! A provocative possibility indeed, and another element in the equation that could bind Haughton to its sister craters on Mars.

For the moment I've had enough science. I walk to the crest of Tripod Hill, where hordes of fractured rocks lie golden in the midnight sun. I pick up a tablet-size shard that bears several egg-shaped fossils, which a paleontologist later identifies as small creatures from an Ordovician sea nearly half a billion years ago. Somehow this particular area of the crater escaped the ravages of the impact explosion. I know that it is likely that no other human being, except for a few of the expedition members, has ever stood at this spot.

There is no wind. Sharply outlined in the crystal air, the crater's features present for inspection: great loaves of breccia creased with sinuous valleys, Rhinoceros Creek glistening through the lake-bed sediments, eminences of dolomite protruding like fists through the breccia, the Haughton River canyon proceeding to the sea. It is a scene like nowhere else on Earth. Could it once have been this way on Mars?

Close enough, says Robert Zubrin, president of the Mars Society, a group whose members range from aerospace engineers to poets, all devoted to the exploration of Mars. By summer of the year 2000, Zubrin tells me, his group will build a 1.2-million-dollar, three-tier simulated Martian habitat on Devon. In the shape of three tuna cans sitting on one another, the structure will house six astronauts and scientists with food and equipment sufficient for two months of simulated Martian traverses. Zubrin adds that his organization plans to lobby the new American President in 2001 to commit to a Mars mission, as President John F. Kennedy committed to the moon in 1961.

Looks like Pascal Lee and his band are onto something. □

By MICHAEL E. LONG
Photographs by TIM LAMAN

Bolts of blazing color

reveal a red-knobbed

hornbill perched deep

in rain forest canopy

on the Indonesian

island of Sulawesi.

Many of the world's

54 hornbill species

are at risk as humans

destroy the birds' hab-

itat and hunt them for

their bills and feathers

or simply for food.

THE SHRINKING WORLD OF HORN

BILLS

Dive-bombing for a fig, a yard-long great rhinoceros hornbill—revered as an icon of the god of war by Borneo's Iban people—startles a feeding red leaf monkey. Fruit-eating hornbills play a significant role in tropical ecology by scattering seeds on the rain forest floor.

NOT MANY PEOPLE would recognize the slit high in the trunk of the knobthorn tree as the entrance to a bird's nest. And nobody, unless he had a high-power telescope trained on the half-inch-wide opening, would see the gray-rimmed pupil peering through it. The youngster inside, an African red-billed hornbill, is hard at the keyhole of its new world, considering whether to fledge—which may not seem to be a particularly good idea in the penetrating drizzle of this dank morning in South Africa's Kruger National Park.

Mother and father hornbill are nowhere to be seen, and that is by design—it is up to the youngster to peck its way to freedom. For this, nature has provided the bird with a powerful bill. The bill is an integral part of its skull, which is fastened to upper vertebrae that are fused and therefore stiff, creating, in effect, a feathered pickax.

After observing its surroundings for many minutes, the bird begins to peck, and a hole is made. A head protrudes. The hornbill now has two eyes on the world, and it pauses for additional observation. More pecking, then head and right wing are free. Then—pop!—the magpie-size hornbill is out of the nest and flying to a branch, where it sits, once again taking the measure of its surroundings.

But how did the bird get in the nest in the first place? The answer is one of the great tales of animal behavior, for most hornbill females make unique nests in tree cavities, using their bills to wall themselves in with a plaster made of mud, droppings, chewed wood and bark, and other detritus. They leave only a slit, narrow enough to deter predators but sufficiently wide for the male to present food from the outside. After a few months, having laid and incubated their eggs, the females peck a hole in the wall and leave. The chicks wall themselves back in, to fledge at their leisure.

The hornbill universe, with initial entries appearing in the fossil record some 15 million years ago, comprises 54 species of birds. Their range includes most of sub-Saharan Africa and extends east to the forests of Southeast Asia and the Solomon Islands.

Africa is home to the largest and the loudest—the nine-pound southern ground hornbill's deep bass call booms as far as two and a half miles, about the same distance a lion's roar carries. The African dwarf red-billed, smallest of hornbills, is the size of a dove.

Hornbills possess magnificent beaks—more than 13 inches long on one great pied hornbill—which they wield like forceps to grasp and toss insect prey in the air, then with impressive coordination catch it in their gullets. Bills are also used to poke among branches for fruit or even to keep a poisonous snake at bill's length to protect vulnerable body parts. Many hornbills wear on their beaks a horny, sometimes spectacular crownlike protrusion called a casque, hollow except for the nearly solid, ivorylike casque of the helmeted hornbill.

Whence, presumably, the name. Examining a tropical bird whose casque had two peaks, the taxonomist Linnaeus in 1758 bestowed the scientific name *Buceros*, Latin for "having ox's horns." This probably accounts for the common name; at least it will do until a better explanation comes along, says my companion Alan Kemp, an ornithologist and curator of birds at the Transvaal Museum in Pretoria.

Kemp suggests we prowl for more hornbills. By park regulations we are obliged to remain in our truck, lest one of Kruger's 2,000 lions decide to take advantage. We drive past elephants, giraffes, warthogs, white rhinos slightly smaller than tanks and are delayed for a time by a roadblock of lounging lions. Farther along Kemp picks up a squirrel killed on the road and puts it on the backseat.

Later in the afternoon a group of southern ground hornbills crosses the road and heads into the bush. The dark-bodied birds walk deliberately through the long grass with their heads canted downward, in the manner of cowled monks proceeding to choir. There are seven, about the size of turkeys, wearing red skin folds around their heads and throats and

Room service: A red-knobbed hornbill arrives with breakfast, which he will regurgitate for his roughly three-month-old chick safely inside a nest hole in an *Alstonia* tree. Though its mother has left the confines of the nest, the chick remains within for another few weeks, dependent on its parents until it fledges.

maneuvering long black bills to knock back insects. The birds keep their bills open a bit to ventilate the afternoon heat.

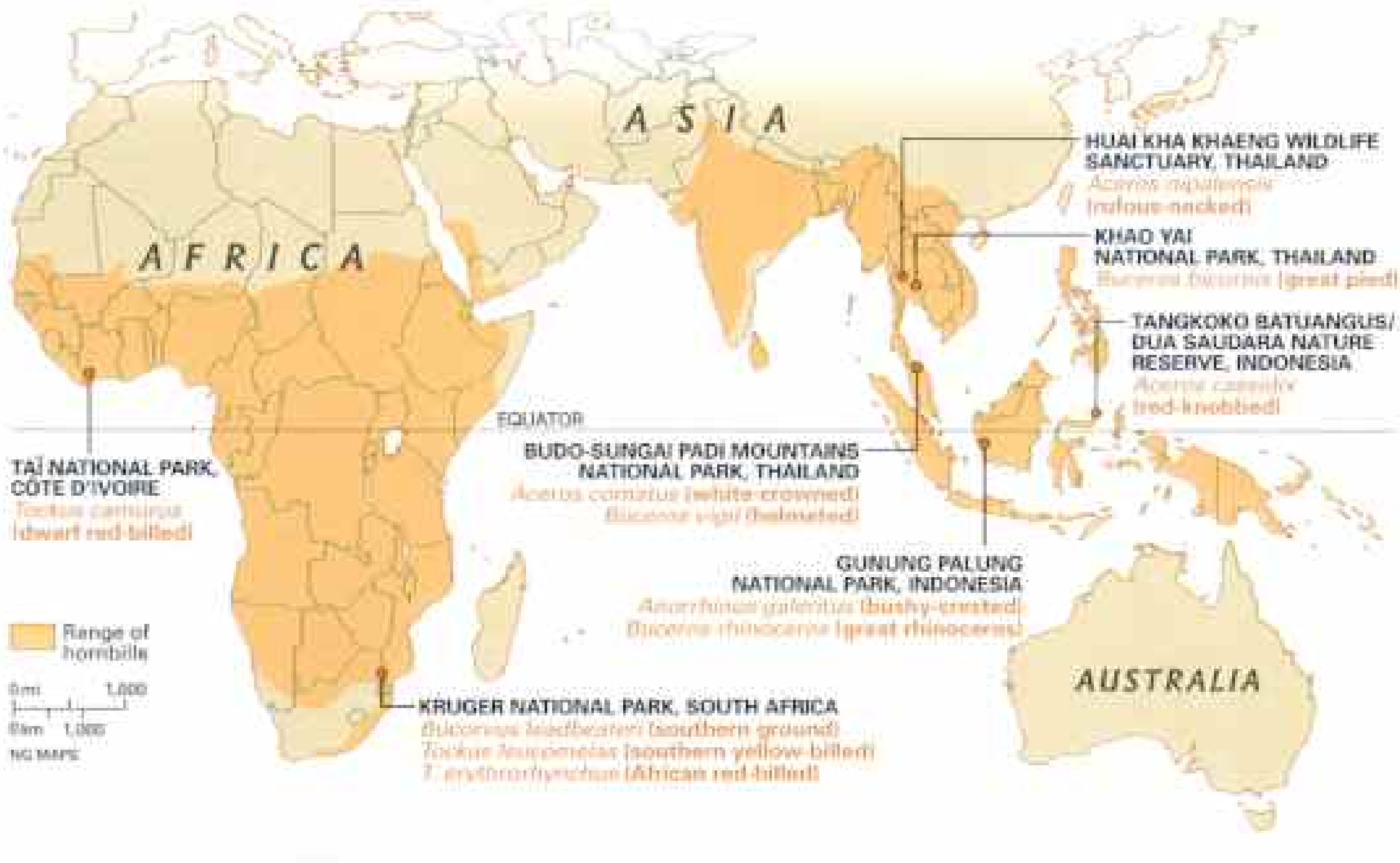
Kemp puts the truck in four-wheel drive, and we follow. He counts two mature males, a female, and four immature birds. Kemp tells me that ground hornbills, once plentiful in the savannas, have disappeared from 70 percent of their original range in South Africa. It is the old story of habitat destruction, birds falling prey to poison set out for nuisance animals, and a twist—persecution. The territorial and pugnacious hornbills wore out their welcome with farmers by a pernicious habit of attacking their own images reflected in windows. Bird shatters window. Farmer shoots bird.

"I know one farmer who had 27 windows smashed in one afternoon," recalls Kemp. The birds would add irritation to injury by "returning in two or three weeks to see if they had gotten rid of their antagonists."

Though ground hornbills can fly well enough, they prefer to walk while foraging. As if on a mission, the birds we're following traverse methodically in a skirmish line, feeding on insects and an occasional mouse. Our truck pitches and rolls over the rough terrain, splinters a log, and, when scraped by acacia thorns, responds with a screech like fingernails dragged across a blackboard. The birds spook but settle down. Content with our presence, they mount a marula tree's thick branch and extend their wings, exposing bare skin to dissipate more heat.

Refreshed, they march off and resume foraging. Kemp tosses the dead squirrel toward the troop, and the hornbills find it of interest. A male retrieves it and carries it around as if it is a trophy. When he drops it by accident, another male edges against him sideways and, as if recovering a fumbled football, grabs the squirrel and proceeds to march and shake.

Kemp explains that we are witnessing status-control behavior, in which one bird will withhold or bestow food to show



dominance. It appears that this bird is in a withholding mood.

I am puzzled that the former possessor of the squirrel seems unconcerned. Kemp, who estimates that the life span of these birds averages around 45 years, observes, "The two males may have a 20-year-old relationship. Who knows what's gone on between them? It's more like watching primates than watching birds."

Suddenly two juveniles dart in to grab the squirrel and a foofaraw erupts. "The breakdown of law and order," Kemp notes. The older bird is too strong and pulls the squirrel away. The bandits calm down. The male turns and in a determined swallow knocks back the whole squirrel, head first.

I feel privileged to be in the presence of these hornbills, which exhibit qualities I never before associated with birds. They are dignified, self-assured, confident, inquisitive if not meddling, and have a tendency to manipulate.

I love to watch birds, hear them sing. But as things go in the animal kingdom, one-on-one most birds are afraid of me. I don't have that impression with ground hornbills—these birds are gents; they have chutzpah. Think about it: Have you ever had a turkey or a pheasant walk up and look you forthrightly in the eye?

ASIAN HORNBILLS, however, are not likely to look anyone in the eye. They're too busy hiding in the forest, guarding their privacy, so wary of human intrusion they contrive to bomb you if you don't mind your manners. So explains Pilai Poonswad, one of the most dedicated of hornbill researchers, recalling her first encounter with a great pied hornbill in a Thailand forest 20 years ago. "I made the mistake of gazing at a nest in the open, not from a blind," she remembers. "The male didn't like it. He dropped tree branches on me."

Some of the Asian species are among the most colorful of birds, drawing from a palette that includes russet, pink, yellow, subtle blue,

It's easy pickings for a bushy-crested hornbill as she plucks a ripe *Aglaia* fruit from a twig (facing page). Most species—like the red-knobbed hornbill at right—carry such food in their gullets when flying to the nest to feed their young. The casque, a horny protrusion on the upper bill that gives hornbills their name, may play a role in sexual selection or amplify the birds' calls. From loud barks to thunderous booms, hornbill cries resound across a range that extends from the dry savannas of sub-Saharan Africa to the lush forests of Melanesia.

HORNBILLS

Sole provider for his confined mate and chick, a great pied hornbill in Thailand's Khao Yai National Park (left) delivers as many as 13 fruit and insect meals each day. The female has all but walled up the nest hole to guard against predators. Unfazed by the camera's careful intrusion (see Point of View in this issue), she passes a morsel to her four-week-old (right). "One day the male arrived with a green cat-eyed snake [below]," says photographer Tim Laman. "The chick swallowed it like a string of spaghetti." Hornbill pairs often return to the same tree every season.

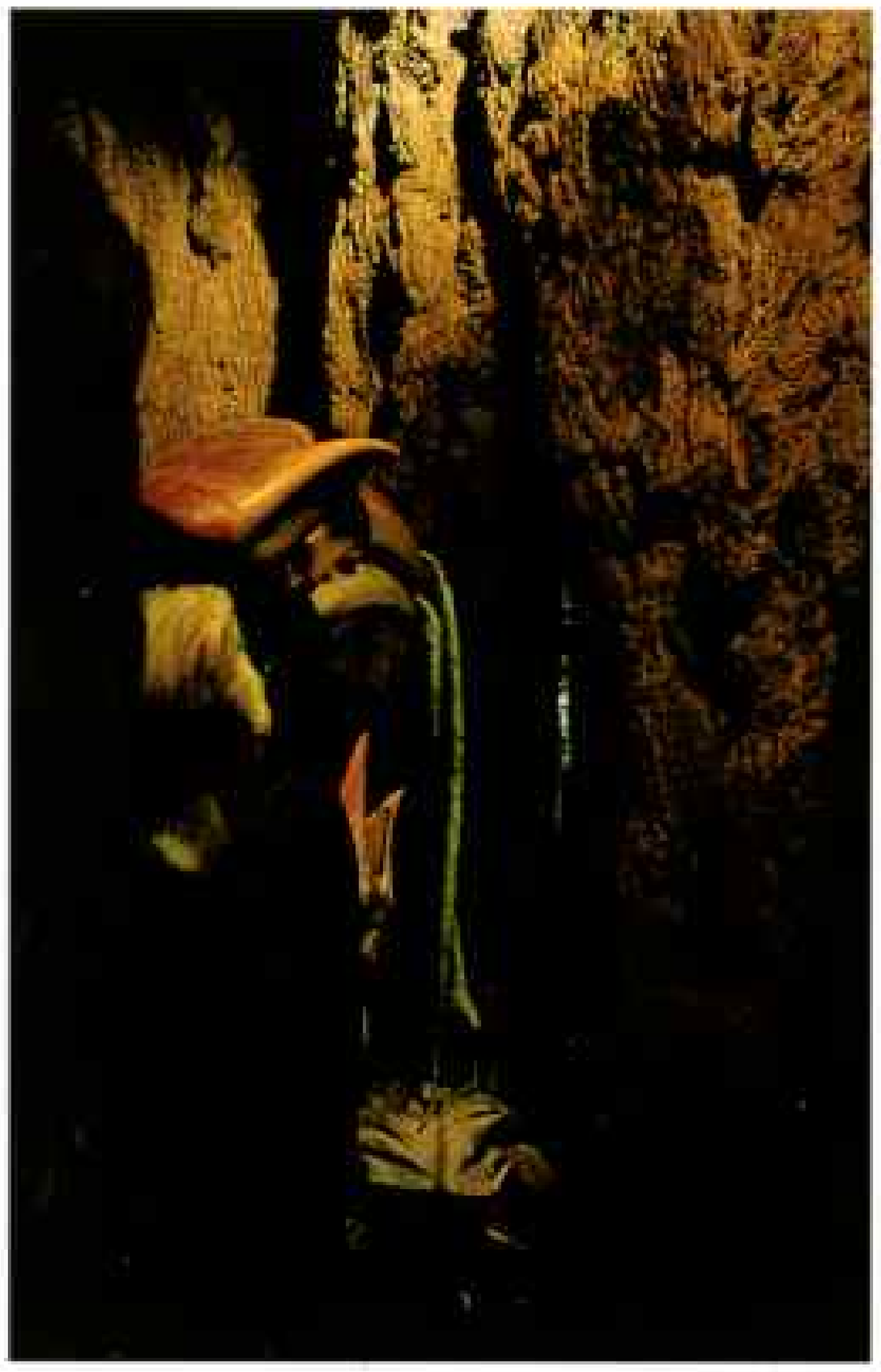
and vibrant red. The luminescent reddish orange neck feathers of a rufous-necked hornbill make it the handsomest hornbill of all, in Poonswad's opinion.

Known to all simply as Pilai, Poonswad is a parasitologist who turned to hornbill research as an avocation that grew into fierce devotion. "I fell in love with them," she says. "I will fight anybody to protect them." Then, with a demeanor the texture of iron, this diminutive woman adds, "I will fight to the death."

I have met Pilai at Khao Yai—"big mountain"—the first of Thailand's national parks, 800 square miles of rumpled terrain northeast of Bangkok. It is nothing unusual for an elephant to stroll through the parking lot of the visitors center, which is surrounded on all sides by the park's other wild creatures, including tigers, bears, cobras, and several of Thailand's 12 species of hornbills.

From the veranda of my bungalow at the edge of the forest, Pilai points out long-armed gibbons cavorting in the trees. A fidgeting rainbow of color called a jungle fowl trills *cock-a-daw-do,* betraying its role as an ancestor of the domestic chicken. It scratches busily for insects; I wish I could interest it in decimating the army of short-legged ants on my bed.

Pilai introduces me to Boonma Saengthong, a lean and serious man who once shot and killed two poachers when he worked as a park ranger. Boonma explains that he gave the poachers plenty of warning. *(Continued on page 66)*



Denver writer MIKE LONG's first NATIONAL GEOGRAPHIC article appeared in 1972; his most recent, on prairie dogs, in April 1998. Field biologist TIM LAMAN has photographed strangler figs (April 1997) and orangutans (August 1998) for the magazine.

Swooping down to forage, a male great pied hornbill belongs to the largest of the 31 Asian species. Lacking underwing coverts—feathers that allow for smooth airflow—hornbills flap loudly across the sky. Large birds' wingbeats can be heard more than half a mile away.

Rufous-necked hornbill close-up

In the half-light of tropical dawn we heard the deep resonance of wingbeats draw closer. Then silence. The hornbill glided into our mist net, and suddenly his world turned upside down. Thai parasitologist Pilai Poonswad moved in quickly to extricate the rufous-necked hornbill thrashing and squawking in the net (below).

In the mountainous forests of western Thailand's Huai Kha Khaeng Wildlife Sanctuary, we had been crouched in blinds—and darkness—beneath the bird's nest tree, waiting for the male to deliver the day's first meal to his mate incubating their egg inside the tree 60 feet above.

Pilai and her team from the Thailand Hornbill Project were jubilant. This was the first time a rufous-necked hornbill had been captured by biologists, and it was a step toward learning more about this elusive species.

Once found from Nepal to Vietnam, the rufous-necked hornbill is now extinct in parts of its range and barely hanging on in others. Hunting by local tribes and habitat loss to logging and agriculture are taking their toll. In Thailand, its last stronghold, fewer than a thousand birds remain, largely in remote mountain regions.

The team first found this species in Huai Kha Khaeng in 1990. By 1998 the group was monitoring four active nests. At one, a male—unaware of being seen—flashed his near-neon colors from a canopy perch (facing page).

After measuring the netted hornbill and strapping a radio transmitter to his back, we returned him to the task of feeding his mate. Such captures will provide a bank of invaluable data on foraging range and habitat use, which will aid conservation efforts. Low on funding but high on enthusiasm, Pilai and her team are determined to raise awareness about the state of these majestic birds and give them a fighting chance.

—TIM LAMAN

(Continued from page 60) which they disregarded. Now he is one of a squad of Pilai's assistants in Khao Yai and other areas—financed by funds donated to her Hornbill Research Foundation—who tend nests, record calls, and collect data on the family life of hornbills.

Assisting Pilai is like assisting a tornado. She jokes that once applicants hear the job description, most disappear. Those who sign on have stories to tell. One man, sleeping on a branch of a fig tree to avoid elephants, was awakened by a cobra stalking geckos outside his mosquito net. An American volunteer full of drive for the hornbill cause turned to stone when a tiger strolled up and sniffed her blind. Boonma once encountered two of the world's most dangerous snakes in combat, a banded krait and a king cobra 14 feet long. The cobra won and devoured the krait, he says. Pilai remembers crossing a rain-swollen stream hand-over-hand clinging to a rope, while the torrent beneath nearly removed her trousers.

The next morning's sun comes up hammer and tongs, reminding us that this is the tropics and the day will burn. Entering the forest from a trailhead, I experience a delicious coolness under the green umbrella of the canopy. Immense hardwoods soar; strangler figs present an obstacle course of buttressing roots as tall as I am; liana vines dangle chaotically as if unplugged from a giant switchboard. Dry *Macaranga* leaves broad enough to accommodate a Thanksgiving turkey crunch underfoot with a noise like pistol shots, alerting, I hope, any forest creature bigger than I am.

Boonma leads, decapitating foliage and whacking vines with a bayonet-size knife. We pass piles of elephant dung, tiger scat showing evidence of a deer dinner, and several trees with bark deeply chiseled by the claws of an Asiatic black bear.

An hour later we arrive at a palm-thatch blind about 50 yards from a giant dipterocarp, a tree that can tower nearly 200 feet. Pilai points to a slit 70 feet up that reveals a great pied hornbill nest. While we wait for the male to arrive, Pilai explains that a nest cavity can begin as a tiny hole drilled by a woodpecker.

On safari in the African savanna, southern ground hornbills scan for whatever burrowing, crawling, or skittering creatures they can find. Mostly carnivorous, this largest of hornbills wields a pickax beak to hack at rodents, snakes, and even tortoises. Full lashes (right) shield eyes from sun and dust.

Enlarged by fungus, the hole attracts a colony of bees whose honey attracts a bear, which enlarges the hole further with its claws.

Then the cavity is ready for hornbill occupancy, and like newlyweds examining apartments, a pair checks out various cavities before deciding. There aren't enough to go around, and hornbills compete with each other and with lizards and squirrels for nest sites.

Pilai recalls a hornbill pair that discovered a monitor lizard in a prospective nest. "The male flew away and kept yelling," she said. "But the female silently went to the hole and fought the lizard, which tried to hit her with its tail. The female won, while the male backed off," she says with huge amusement. Copulation takes place during the last phase of nest building; then the female walls herself in.

I pose an obvious question. Pilai explains that mother hornbill simply backs up to the slit and defecates energetically and unerringly through it, ejecting a fecal stream that marks the ground beneath the nest. Trying to imitate, the chick will miss the slit at first, but mother picks up the droppings and tosses them out.

What about water? The answer surprises—hornbills seem not to drink. Indeed, only four species have been observed to take water, and that sparingly. "They get water from their food," says Pilai.

An hour or so passes. I hear the *wit-wit-wit* of a fairy bluebird and the scarlet—shamelessly scarlet—minivet's *ta-ta-ta*. Boonma's hammock is plump with Boonma. Cicadas whine. Flies buzz. Pilai nudges me, pointing to a tiny larval tick on her trouser leg, part of a

Unwilling subject, a southern ground hornbill tries to escape researcher Alan Kemp (above, in green cap) and veterinarian Douw Grobler in South Africa's Kruger National Park. After being sedated and measured and having his blood sampled, the male finds his way back to his lifelong mate (top left, with blue throat patch). In a reversal of roles she offers him food. Indulging in a favorite snack, a juvenile with a still mottled throat pouch nabs, crushes, and tosses back a scorpion (left).

dual threat that confronts trekkers: dry-season ticks, wet-season leeches.

The distinctive *kok* of a great pied hornbill interrupts our drowse. Coming closer, he thrashes the air with wings spanning five feet, making the chug-chug sound of a steam locomotive leaving a station. The bird alights on a branch near the nest, checks out the neighborhood, then flattens against the tree like a telephone lineman, holding fast with claws and propped by spread tail feathers. A dark body accentuates the glorious yellow of his bill and casque, shining in the sun. Pilai has explained that each day the bird applies a gloss of yellow oil from a preen gland at the base of his tail.

He regurgitates a fig, dipping his enormous bill perpendicular so gravity can prompt the fig to roll down the inside of his beak like a returning bowling ball. He catches the fig precisely between the tips of his bill and delivers it to his mate through the slit.

Pilai has observed a male presenting as many as 150 figs at one visit. A male also offers other fruit, insects such as beetles, and animals including snakes, lizards, giant scorpions, geckos, bats, and the young of other birds. A female likes variety in her diet. "If a mate keeps bringing the same food," Pilai tells me, "she may throw it back at him."

DEPARTURE BRINGS another trek among vines and over trees fallen on the trail at precisely the angles to impede progress. We follow Boonma, who always looks like he has just stepped out of a cool shower. I stop to observe a colony of white aphid nymphs on a leaf, tiny white bodies

Putting on a big show, southern yellow-billed hornbills—small at just 18 inches from bill to tail—defend their 40-acre territory in Kruger National Park from encroachment by others of their own kind. Their clucking calls rise in volume and tempo. At the climax the pair raise and fan out their wings and tails, bowing in unison, their world secure —for the moment.

exuding bundles of filaments that flutter in the wind. Suddenly there is a great thrashing and snapping of branches in the foliage; I see Boonma's face tighten, then relax. We have disturbed a six-foot-long monitor lizard, which has chosen to depart the area.

Over dinner that evening Pilai discusses the plight of the Thai hornbills. There is little to be done about habitat constriction, she says. It has already taken place—less than 25 percent of Thailand's original forest remains.

Pilai does what she can about poaching. One of her study areas in the south, where villagers hunted hornbill chicks for food and money, posed a challenge. "Black marketeers will pay around one thousand dollars for a white-crowned hornbill chick," she says, referring to one of the rarest of the region's birds. "That's six months' income for a villager who works on a rubber plantation." But the persuasive Pilai mounted a public relations offensive, appealing to the villagers' sense of place, heritage, and family. "If you keep taking the chicks, the birds will die out, and your children will never see them," she emphasized. "Would you want yourselves to die out?"

Thinking he might get some money from Pilai, one crafty villager said, "We will bring the chicks to you." Pilai responded, "If you bring chicks to me, I will bring the policeman to you!" The villagers have stopped the practice and now participate with enthusiasm as agents in Pilai's foundation, which has, she informs me, a hornbill adoption program.

"For $120 you can adopt a hornbill for one year," she says. "A villager will tend the nest, and we will send you pictures and report on the bird's behavior, what it is doing, what it is eating, its family life. You can even pick the species. If you visit here, we will be happy to take you to the nest."

I write a check and request a helmeted hornbill, notable for one of the loudest calls in the forest, a deep *hou-hou* that merges into a cascade of shrill *hee-hees* and a diminuendo of mocking *ha-has*. Helmeteds possess tails a yard long and are unique for their ivorylike casques. They have been observed to engage in long bouts of aerial head butting, presumably to achieve dominance, much the same as mountain sheep. I ask that my adoptee be named Melville, in fond memory of my first Editor at NATIONAL GEOGRAPHIC, Melville Bell Grosvenor, a tough yet tender visionary who was not above a little head butting himself.

Some months later I received a letter from Pilai containing photographs of a handsome helmeted perched above the nest that enclosed his mate, 80 feet up in a 130-foot dipterocarp tree on Ta Po Mountain in Thailand's southern tip. Melville's mate had walled herself in the nest, Pilai wrote. Each day Melville brought his mate an average of 48 figs plus an occasional locust, cicada, or other insect. There was also a picture of the two villagers who tended the nest and observed Melville.

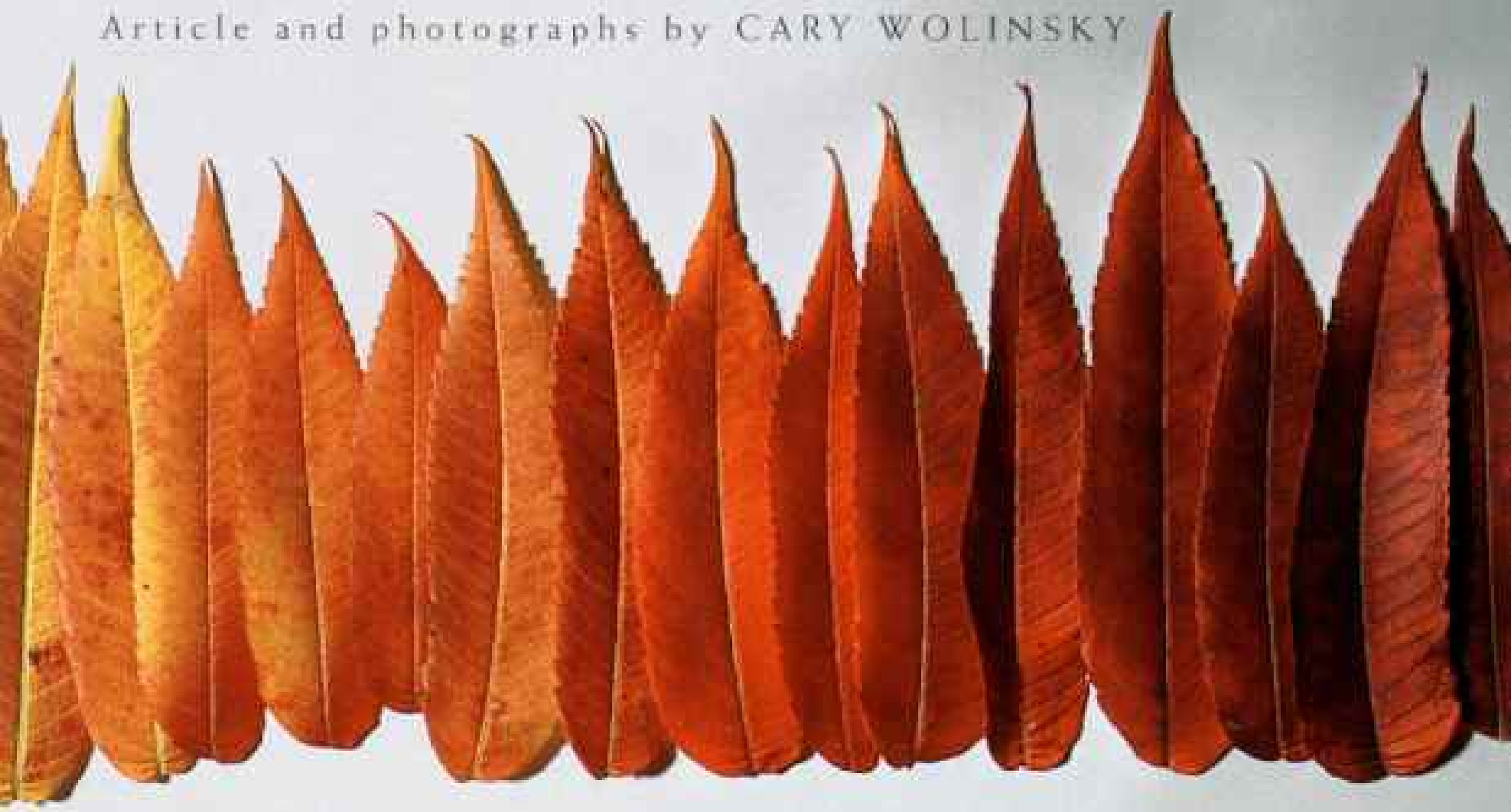
Then the bad news—because of terrorist activity in the area, Thai military groups moved in, and the villagers were unable to ascertain whether Melville and his mate had fledged a chick. I'm confident they did, even if Melville had to butt a few heads. □

THE QUEST

New England Yankees call it "the Color," as in, "the Color was better last October," or ". . . must have been that dry spell that ruined the Color." Each autumn sumacs display their leaves in a dazzling palette, competing with birches and maples. Days later, the Color is gone. Like the deep blue of an October sky or the warm orange of a winter fire, it is impossible to hold. Perhaps color's ephemeral nature motivated early humans to search out ways to possess it. They watched their fires blacken cave ceilings, daubed walls with red and yellow ocher, experimented with shells, insects, flowers, roots, and bark. They mimicked animals by painting their bodies to signal aggression, to camouflage themselves from danger, to attract a mate. Sources of color were jealously guarded. Pigments of purple, saffron, and ultramarine were, at times, worth their weight in gold. Ancient cities were built on fortunes made in part

FOR COLOR

Article and photographs by CARY WOLINSKY



from a purple dye from mollusks. In Nuremberg a man was burned at the stake in a fire made of his own imitation saffron. Ultramarine, extracted from lapis lazuli, was reverently reserved in Renaissance art for painting the robes of the Virgin Mary. In the 19th century a 19-year-old English chemistry student was the first to manufacture a synthetic dye. Suddenly the world became much more colorful. In 1907 the Lumière brothers of Paris covered a film plate with minute grains of dyed potato starch: Color photography blossomed. A crude color television, demonstrated in London in 1928, foreshadowed the glow of color in every living room. As scientists discovered the psychological influences of color, marketers manipulated consumers with the latest hues for cosmetics, fashions, and cars. Now computers have taken up the quest, imitating nature's palette in hundreds, thousands, millions of colors.

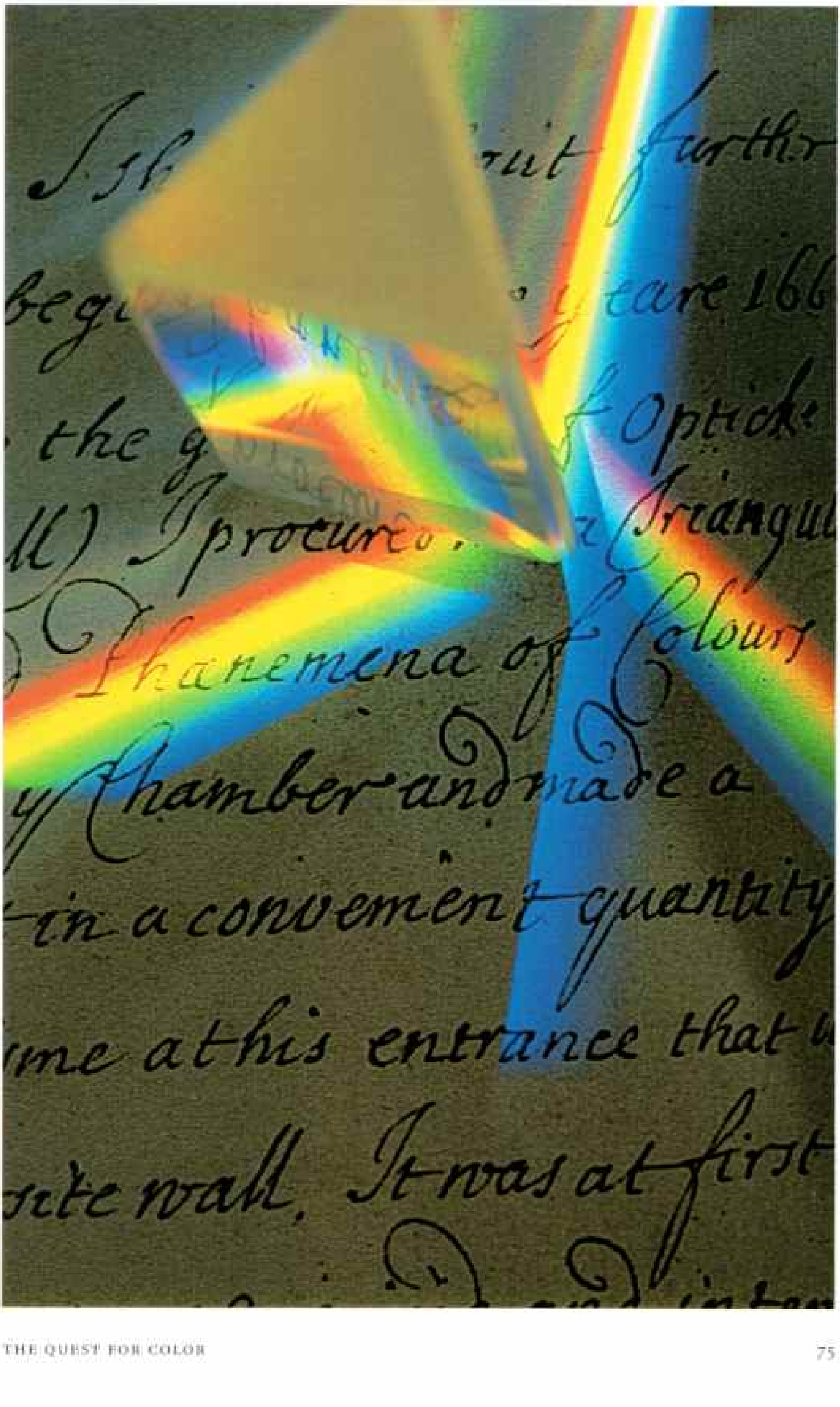
ON THE NATURE OF COLOR

Philosophers, artists, mystics, and scientists have long debated the nature of color. For more than a thousand years India's astrologers have taught that the sun's white light is composed of all colors. Personified as the deity Surya, the sun is the single source of life and ruler of eight other celestial bodies. The bodies each transmit one pure color to Earth, affecting the destiny of every living creature.

The colors are associated with gemstones: cat's-eye, hessonite, coral, sapphire, pearl, emerald, yellow sapphire, diamond, and ruby. Examples are set out above at Jantar Mantar, the 18th-century astronomical observatory at Jaipur.

In the Western tradition Aristotle's belief that all colors are created by mixing black and white prevailed well into the 17th century. Even Leonardo da Vinci could not decide the question, declaring at different times that there were six primary colors, or eight. In 1613 Jesuit teacher François d'Aguilon declared that there were three primary colors: red, yellow, and blue, which together with white and black could be combined to make all colors.

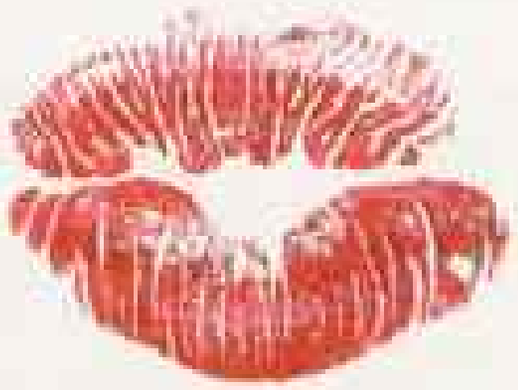
"In the begining of the yeare 1666 . . . I procured me a Triangular glasse Prisme, to try therewith the Celebrated Phænemena of Colours," wrote Sir Isaac Newton in 1672, when making public his "New Theory about Light and Colours" (right). By intercepting a beam of sunlight with a prism, Newton proved that white light was composed of all visible colors of the spectrum and could be recombined back into white light. His ideas helped launch the era of modern optics.



EARTH TONES

Early humans created permanent colors with natural pigments. Paleolithic cave painters used numerous minerals, including blackish manganese dioxide as well as red and yellow ocher (above). Azurite and costly lapis lazuli were later ground to make rare blue pigments. Even now, chunks of blue chrysocolla, a copper compound unearthed at a mine in Arizona (below), are sent to Germany, where they are pulverized for use as artists' pigment. Chemically produced colors that reflect specific wavelengths of light meet commercial demands for automotive paint, textile dyes, and plastics. Expensive synthetic red dye even serves tradition when diluted with cornstarch on a roof in New Delhi, India (right), for use in a festival.

◀ To create brilliant Fiesta Red dinnerware in 1936, the Homer Laughlin China Company used uranium oxide. The color was temporarily discontinued in 1943 when the U.S. government took control of uranium for the war effort and was finally dropped in 1972.



◀ In many animal species, including humans, red quickens the heart rate and causes the release of adrenaline. Men in the U.S. respond most strongly to reds with yellow mixed in; women prefer blue-based reds.

▶ "Red tape," which has come to mean bureaucratic complications, is used to bind correspondence between solicitors and barristers in England. The tape was originally dyed with safflower.

▶ The dye magenta, invented in 1859, was named in honor of Napoleon III's victory over Austria at the Lombard town of Magenta, Italy. The shade is one of the four principal inks used in color printing.

◀ Soot swept from the chimneys of peat-burning stoves is still used to dye wool on Harris in Scotland's Outer Hebrides. Peat soot produces colors ranging from light yellow-beige to deep brown.

BRITISH MUSEUM, LONDON

◀ Ancient Greeks mixed pigment with hot wax to color their warships. The process was later used during the Roman period for portraits placed on Egyptian mummies in the Fayum region. Their colors remain brilliant today.

▶ Makers of traditional cheeses like Swiss, cheddar, and Gouda color their products to maintain a consistent and marketable look. But consumer preferences vary: In the U.S., Midwesterners like their cheddar orange; East Coast buyers often prefer light yellow.

▶ Crayola. It is crave, the French word for chalk, and ola, from oleaginous (oily). Paraffin and pigment are the principal components of the more than two billion crayons Crayola makes each year.

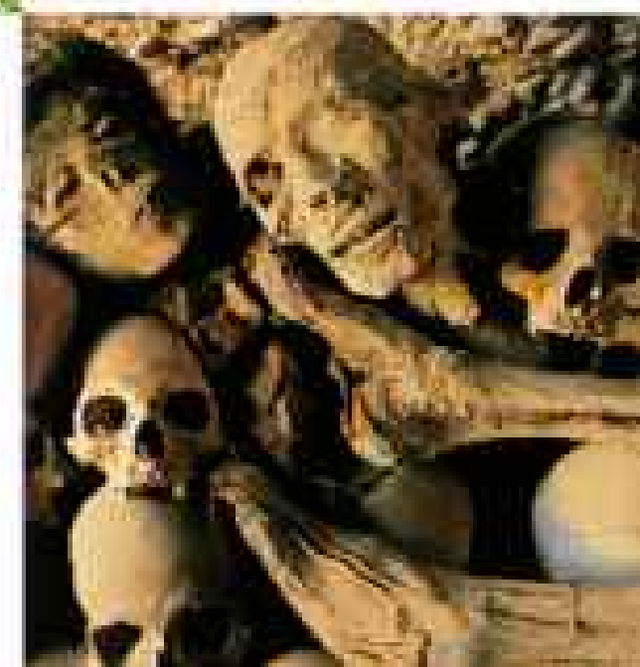
◀ Fleas in Louis XVI's palace gave the ladies of the court fits, but when one of Marie Antoinette's favorite shades was christened puce (French for flea), the name stuck. Dyers soon offered hues called belly of flea, thigh of flea, and blushing flea.

◀ Want to keep the color? Artificial turf is exposed to intense sunlight and heat in the Arizona desert by Atlas Weathering Services Group, a firm that tests how quickly numerous products fade.

PAINTING BY JOHN DAWSON

▶ Campbell Soup adopted the color red in 1898 after an executive was inspired by the red-and-white uniforms of Cornell University's football team. Many companies now score points using red, which creates the illusion of advancing toward consumers.

▶ Popular with European painters for three centuries, mummy was a rich brown pigment made by grinding the remains of Egyptian mummies.



◀ "White does not exist in nature," painter Pierre-Auguste Renoir is reported to have said. Fresh snow reflects nearly all incident light. In wind-sculpted drifts, pockets reflect the blue sky, while ridges reflect the orange of sunset.

◀ Some folks are fussy about their yolks. To satisfy German preference, egg producers feed chickens marigold petals and paprika to darken the yolks. Green eggs and ham are a different story altogether.

▶ Production of Indian yellow, an artist's pigment made in India from soil soaked with the urine of cows fed on mango leaves, was outlawed because the leaves made the sacred animals ill.

▶ When chickens see blood, they peck. Red contact lenses prevent the birds from seeing that color—and thus from killing each other. The contacts are currently being tested on 100,000 chickens in the U.S.

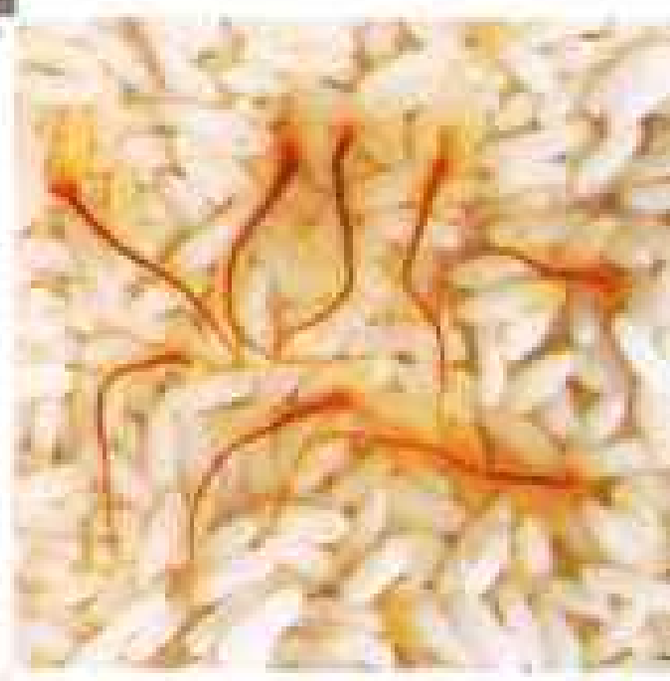
◀ Own a color? In 1985 the courts allowed Owens Corning to trademark pink for fiberglas insulation. However, NutraSweet was denied the right to trademark pastel blue for its Equal sweetener packets.

COMPUTER IMAGE BY BRIAN E. STAUFFER, NGS STAFF

◀ Inmates are reported to be calmer when held in cells painted a specific shade of pink. That same pink suppresses appetite, while orange stimulates it. Yellow surroundings may improve the performance of schoolchildren.

▶ We see a marsh marigold as solid yellow. With their ultraviolet vision bees see an entirely different pattern in the same flower.

THOMAS EISNER



▶ Saffron, the dried stigmata of the flower *Crocus sativus*—and the world's most expensive spice—colors risotto Milanese a golden yellow. Some 14,000 stigmas produce just one ounce of saffron.

◀ Orange, the color, suffered an identity crisis, having no name in European languages until orange, the fruit, arrived from Asia. "Orange" comes from the Sanskrit *naranga*, meaning orange tree.

◀ In 1857 William Perkin, a 19-year-old Englishman, became the first person to commercially produce an artificial dye. He had inadvertently discovered the dye the previous year while trying to synthesize quinine from coal tar (left) as a treatment for malaria.

▶ Candy manufacturers often use microencapsulated colors to avoid staining the tongue. In developing countries some people prefer having a candy-stained mouth; it boasts of disposable income.

▶ Most animals and plants get their color from pigment. However, the blue in *Morpho rhetenor* butterfly wings comes from light reflected by microscopic texture variations on colorless wing scales.

SHADES OF ROYALTY

Legend attributes the discovery of purple to the Phoenician god Melkarth, whose dog bit into a seashell that turned his mouth a rich purple. Extracted from the shellfish *Murex brandaris*, *M. trunculus*, and *Purpura haemastoma*, one ounce of dye destined for royal garments required tens of thousands of mollusks. Although Tyrian purple is no longer made, dyeing with shellfish is still done in Oaxaca, Mexico (right). Each winter *Purpura* mollusks are plucked from rocks. Collectors dye yarn on the spot with a secretion from the mollusks. Cloth dyed this way was once paid as tribute to Aztec rulers.

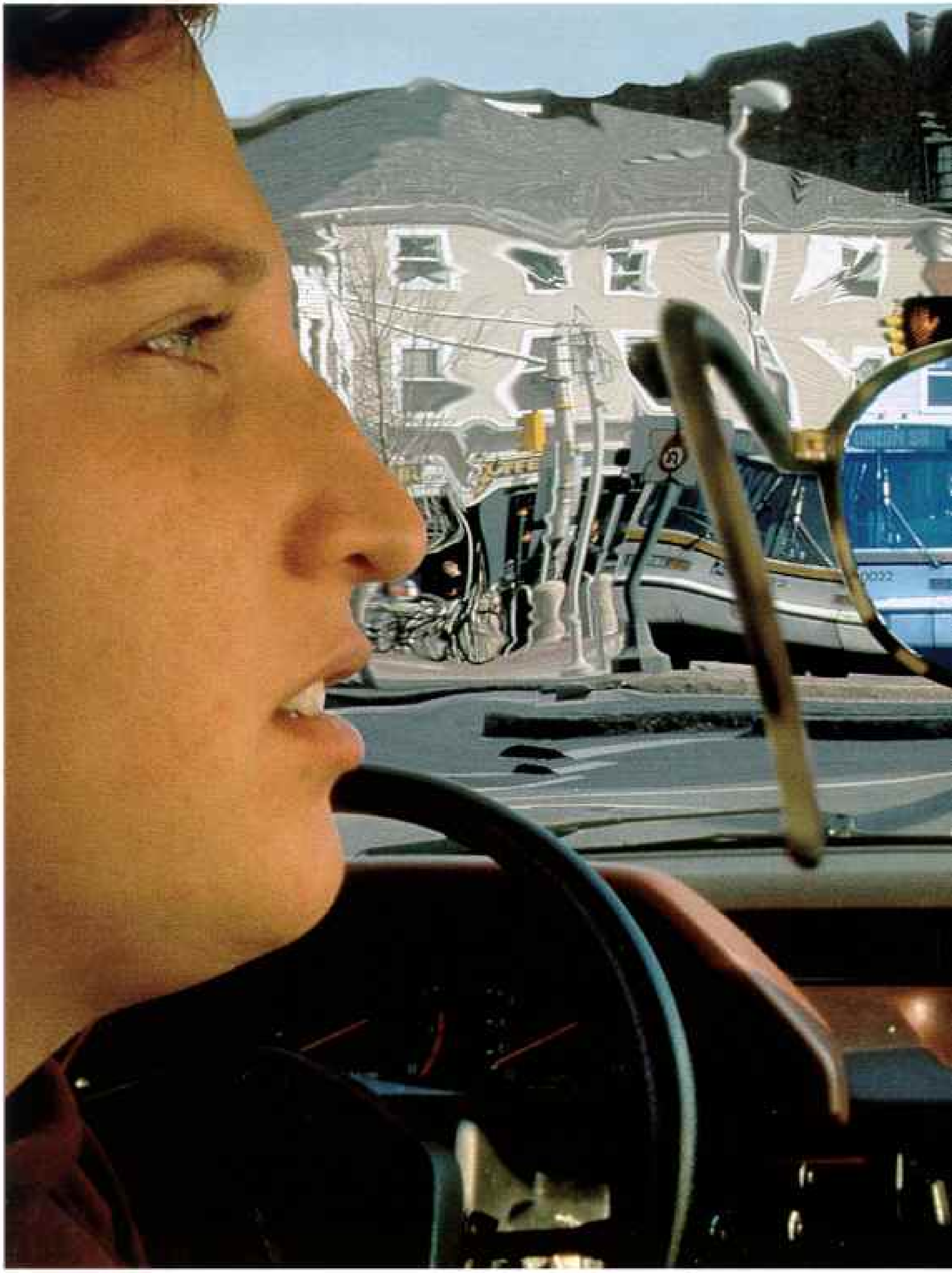
Production of the natural colorant carmine continues in the Canary Islands, where host cactuses, *Opuntia*, are "seeded" with cochineal insects (facing page). The insects encase themselves in webbing and feed on the cactuses. Harvested before they lay eggs (above), the insects are dried and crushed to extract the colorant. So in demand was cochineal that vast fortunes were made by Spanish conquerors, who held a monopoly until the late 18th century, when the French and the English penetrated secrets of the process and produced cochineal for themselves.

COLOR FOOLS

Artfully applied touches of color turn blobs of PVC into a display sample of a Japanese *bento* meal (right). Plants "see" far-red, a color beyond human vision, as a signal to increase shoot growth. Using plastic mulch that reflects far-red (above), researcher Michael Kasperbauer tricks tomato plants into sensing competitors nearby. The tomatoes

grow bigger and ripen earlier. Other colored mulches affect flavor and nutrient content.

To understand what his color-blind patients see, optician David Harris has them computer-color a black-and-white photograph (far left) in an attempt to match an original. Harris has developed lenses with special colored filters that allow the brain to reinterpret color, thus enhancing patients' color vision.



LOST IN THE NO-FUN HOUSE

CATHY WOLINSKY WITH COMPUTER ENHANCEMENT BY BRIAN E. STRAUSS

Visual distortions often plague Alex Michaels. "The road seems to buckle, buildings fold, cars come straight at me." Using computer imaging, Michaels re-creates her symptoms of scotopic sensitivity/Irlen syndrome. Blue lenses, developed by researcher Helen Irlen, help control episodes. Colored lenses also aid some dyslexic and autistic individuals.

TONY STONE IMAGES (BACKGROUND)

HIDE AND SEEK

Cryptic coloration, or camouflage, and the ability to see in color are products of natural selection that help animals search for food, attract mates, and elude predators. Consider the pale gray peppered moth, *Biston betularia* (above, at left), here superimposed on a 1930s photograph of Sheffield, England. In pastoral times the moth was well concealed when it alighted on lichen-covered trees. With the advent of smokestack industry, soot settled on the land, and as *B. betularia*'s pale camouflage became ineffective, its numbers declined sharply. A darker form of the same species blended with the sooty background and thrived. By the 1970s English air was cleaner, and the lighter moth again prevailed.

Stalkers often use color to conceal themselves from prey. Tigers blend well with shadows and tall grass. Borneo crab spiders mimic the color of bird droppings on which their favorite insect prey feed. Arctic foxes turn white when the landscape softens with snow. Man too is skilled in the use of camouflage. On the almost treeless 78 square miles of North Harris Estate in Scotland, Jonathan Bulmer (right, at bottom) employs five ghillies, or stalkers, to assist guests who want to hunt Scottish red deer. All wear Harris tweed for a traditional purpose—camouflage, not fashion. From a distance their tweeds blend with mottled patterns created by lichen-covered stone, heather, grasses, and standing water, making it difficult for deer to see them. Each estate has its own tweed dyed to blend with local vegetation, which itself is sometimes used to dye the tweed's wool.

INKY BLACK

The making of *sumi*, ink sticks used by Japanese calligraphers, can be traced back at least two millennia in China, where they were made by burning pine. The Kobaien Company, a 15th-generation family business in Nara, makes one-quarter of Japan's sumi. Every two hours Yoshiro Sakaguchi enters a chamber choked with oily black

fog to brush soot from the caps of rapeseed oil lamps (above). The soot is mixed with cowhide glue and perfume. Toshitsugu Okabe kneads the mixture with his feet (opposite), rolls the material into small, soft cylinders, then presses them into decorative molds. The sticks (left) are dried slowly in damp ash and hung for as long as three months. Sumi is made only in winter, as the glue tends to spoil in hot weather.

WHITEST WHITE

In ninth-century Japan dolls made of paper and grass were set adrift in rivers to carry off misfortune. Over time, craftsmen developed more elaborate and costly dolls for display. Oyster shells are aged for at least 20 years at Kyoto's Nakagawa Gofun Enogu factory (below), then sorted and crushed into *gofun*, a highly stable white pigment. Artists in the workshop of Chozan Kawase mix the fine white powder with animal glue and apply it in thin layers to forms (above) made of sawdust and glue. Hair is painted with sumi (preceding pages), and red is applied to lips using 50-year-old cochineal (right). Fifteen silk-adorned *hina* dolls in ancient court dress are displayed each year on Hina Matsuri, Girl's Day Festival, and may cost as much as $25,000.

DRENCHED IN DEVOTION

Dyes mixed in water rain on young Indian women at the Dauji Temple in Uttar Pradesh, at a festival celebrating the passion of the Hindu god Krishna for his lover Radha. In the legend, *gopis* (cowgirls) showered the couple with colorful flower petals. To Hindus each color is symbolic of a force in life.

CELEBRATING

CANYON COUNTRY

GRAND STAIRCASE–ESCALANTE NATIONAL MONUMENT

By T. H. WATKINS

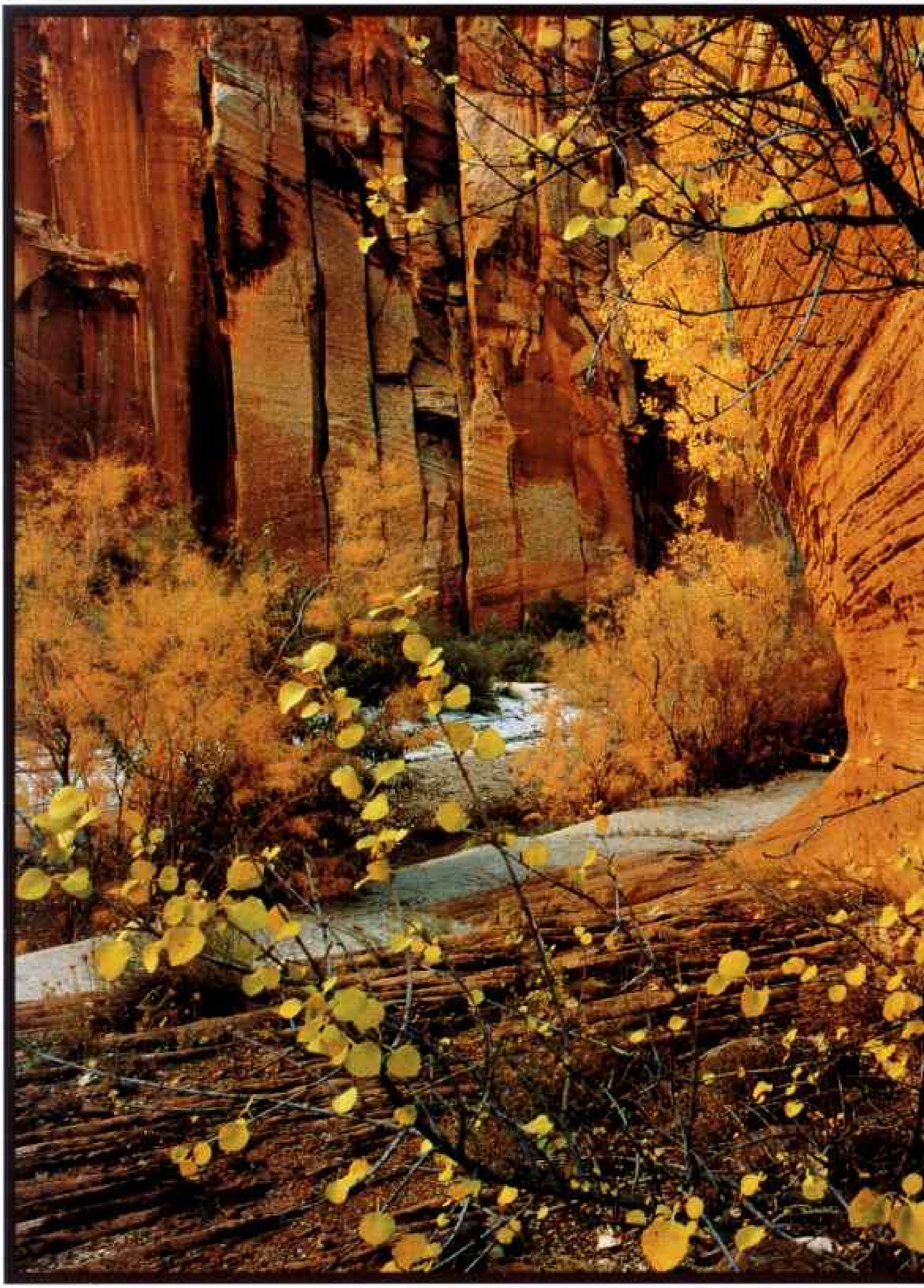
Photographs by DIANE COOK and LEN JENSHEL

THE GHOST OF Everett Ruess, some say, still haunts the canyons of southern Utah, for it was here that he vanished in 1934. The 20-year-old writer and artist had set off from the town of Escalante with a couple of pack burros to spend some time painting and writing in red rock country. "I am going south towards the river now," he wrote his parents, "through some rather wild country. I am not sure yet whether I will go across Smokey Mountain to Lee's Ferry." Ruess was never seen again.

The young man's ghost may have been watching last November when the U.S. Bureau of Land Management (BLM) issued the first draft of a proposed management plan for the nation's newest national monument—Grand Staircase–Escalante, 1.9 million acres that Ruess probably knew as well as anyone of his time. These are acres to be managed, the BLM's plan emphasized, in such a way as to "maintain the unspoiled nature" of their much celebrated beauty.

Ruess no doubt would have approved that part of the plan. Me, I was ready to do at least a modified jig.

Storm clouds swell above the deep repose of red rock desert in Utah's Grand Staircase–Escalante, a vast addition to America's protected lands.



An ancient wind-creased dune, transformed to stone, forms a wall along the Escalante River, a waterway

unknown to explorers until 1872 and one of the last rivers mapped in the continental United States.

A HIGH-DESERT REALM OF TWISTING

The largest national monument outside Alaska, Grand Staircase–Escalante, established in 1996, covers 1.9 million acres, almost all of it backcountry with no facilities. Given only one maintained trail in an area the size of Delaware, a trekker (opposite) leaves the shadows of ponderosa pines and cuts his own path up slickrock.

I had been tracking the fate of Grand Staircase–Escalante ever since President Bill Clinton announced its designation in 1996. I didn't know the monument country anywhere near as well as Everett Ruess, but I had spent a lot of time over the previous ten years getting gloriously lost in its canyons, particularly in the northern portion, where the Escalante River tumbles down from the mountains and gathers a collection of winding tributaries on its way to Lake Powell.

For me this was red rock country at its finest, and its images remained fixed in my personal landscape: Escalante Arch, atop a 500-foot wall of slickrock; Calf Creek, its two waterfalls glimmering like braids of lace; Sand Creek Canyon, crowded with shad scale and four-wing saltbush. I welcomed the notion that the primitive condition of all the country I had experienced—and a good deal more—apparently was going to be respected by the BLM, an agency not ordinarily dedicated to the wilderness ideal. Nor was I alone in feeling that way. Remarkably, the BLM's plan was received with relative equanimity by most of the parties concerned. Somehow it had emerged, lotus-like, from a bog of conflicting visions that had once bubbled furiously with anger.

IF SOME OF US—including a lot of Utahns—had been ready to toast the President for making these lands a national monument, many were just as ready to fry him. The designation was simply an enormous landgrab, some felt, one more demonstration of the federal government's insensitivity to local needs in a state where 64 percent of the land is federally owned. The bitterness was considerable throughout Kane and Garfield Counties, the two counties in which the monument lies. After the announcement both the President and Interior Secretary Bruce Babbitt were hung in effigy. Some citizens gathered to send up black balloons in mourning. Others drove graders into a few areas of the monument and gouged out primitive roads as a demonstration of their anger.

It wasn't just the size of the monument that rankled many Utahns, it was the perceived loss of opportunity. In Kane County, for example, some citizens in Kanab felt particularly sandbagged. They had just lost a fiercely held dream (or myth, some said) of acquiring as many as 900 local jobs in a proposed coal mine. The designation of the region as part of the monument all but killed the mine proposal.

Almost immediately after Clinton's declaration, Norman Carroll, chairman of the Kane County Commission, put his official signature to "A Resolution Resulting from the Creation of the Grand Staircase–Escalante National

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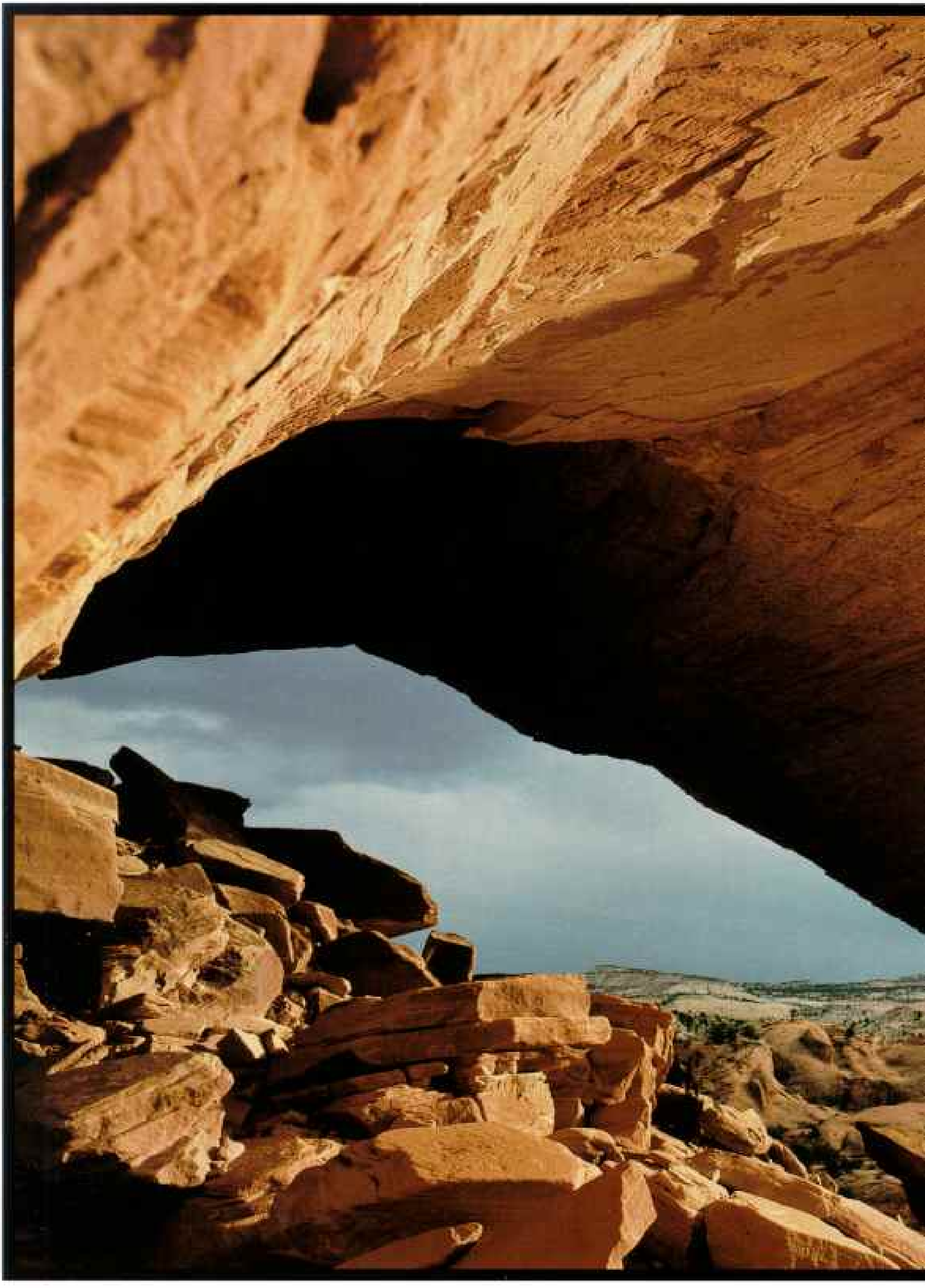
T. H. WATKINS is the Stegner Professor at Montana State University and the author of a forthcoming book, *The Hungry Years: 1929-1939*. DIANE COOK and LEN JENSHEL's most recent book, *Hot Spots*, features volcanoes. This is their first assignment for the magazine.

CANYONS AND SUN-BEATEN MESAS

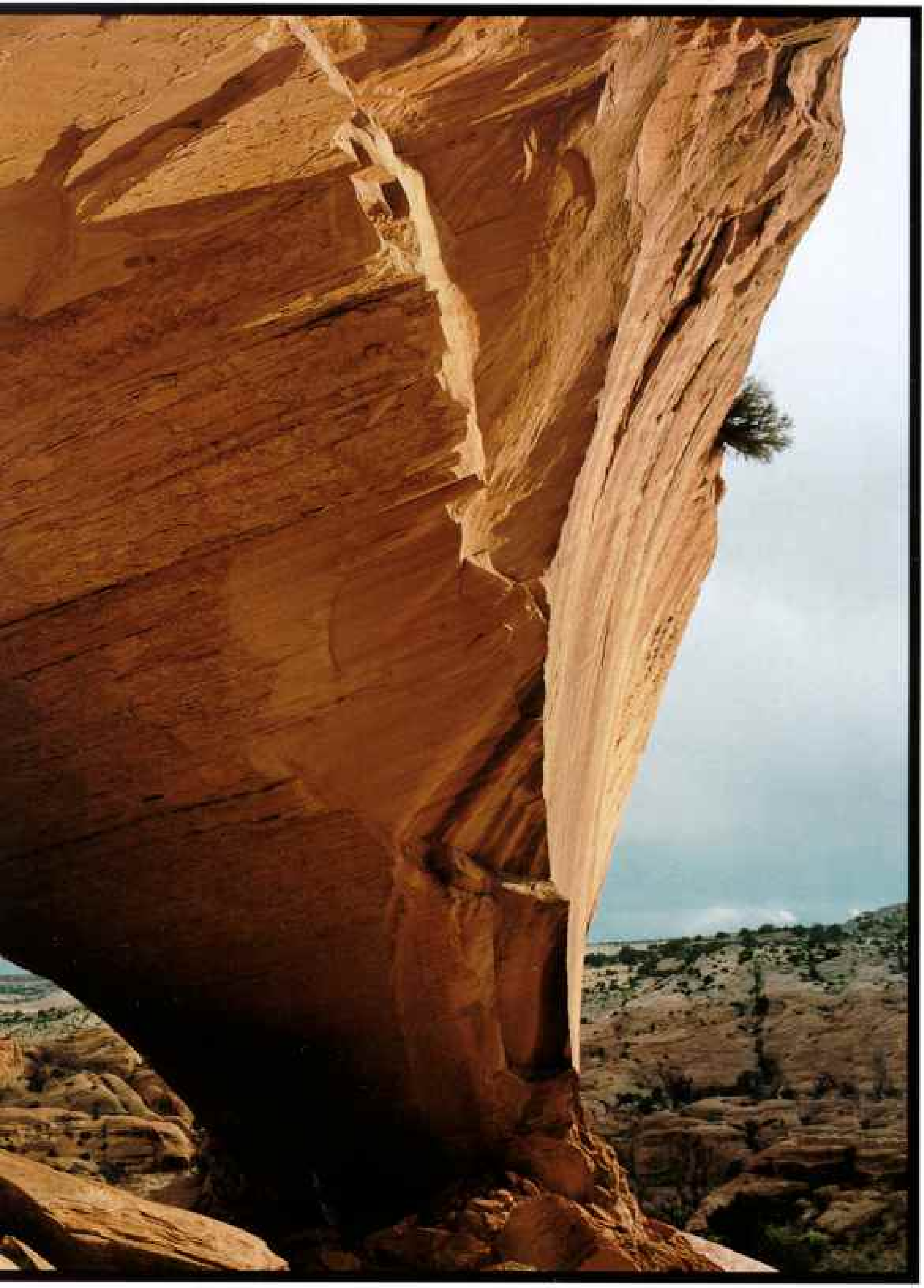
Monument and Its Adverse Effects on the People, Lands, Resources, Economic Stability, Culture and Way of Life in Kane County." The resolution went on to direct the Kane County attorney to seek a legal strategy to overturn the presidential order. "This is beautiful country, all right, and we love it," Carroll explained to me during a break in a commission meeting in the slickrock pink county courthouse in Kanab a few months later. "But the monument is way too big."

The conflict was hardly new. Similar eruptions had followed other presidential uses of the Antiquities Act, which authorizes the President, by executive order, to establish national monuments in order to preserve "objects of historic or scientific interest that are situated upon the lands owned or controlled by the Government of the United States." Howls of anger went up among miners and commercial tourist-camp developers when Theodore Roosevelt established Grand Canyon National Monument in 1908; ranchers objected violently when Franklin D. Roosevelt created Jackson Hole National Monument in 1943; and, more recently, Jimmy Carter's designation of 15 national monuments in Alaska in 1978 inspired complaints that glowed in the dark with fury.

GRAND STAIRCASE–ESCALANTE is nowhere near the size of some of those Alaska monuments (one alone was originally 11 million acres), but there's no getting around it—this is one big place, big enough to validate the levels



An ever widening lookout, Phipps Arch perches above country defiant of roads, bridges, and towns.



Washington Phipps, a pioneer in the 1870s, ran horses in the area until he was shot dead by his partner.

"WE HEARD LOUD AND CLEAR . . . KEEP IT

of agitation that surrounded it. California's Death Valley, stretching across 3.3 million acres, was raised from monument status to the level of a national park with passage of the California Desert Protection Act in 1994, so Grand Staircase–Escalante is now the largest national monument outside Alaska. It embraces an enormous, amoeba-like triangle bounded on the northeast by Capitol Reef National Park, east-southeast by Glen Canyon National Recreation Area, northwest by Dixie National Forest, and west by a jagged boundary of right-angle lines that wanders north from U.S. 89 to the southern edge of Bryce Canyon National Park.

Easy enough to describe, not so easy to comprehend—though it helps if you take to the air to see it, as I did one blustery late winter day. With a weather front moving in and snow-burdened clouds already kissing the brow of the Aquarius Plateau, our small plane jumped off the tarmac of the one-strip airport outside Escalante and set off with an intrepid whine on a heading straight for the Circle Cliffs on the edge of Capitol Reef National Park, 30 miles away. Below us stretched a tapestry of mesas and benches forested by stands of piñon and juniper (P-J forests, most southern Utahns call them) and blanketed here and there by big patches of snow. Almost everywhere, the benchlands lay sliced with canyons—deep wounds that millions of years of flowing water have carved into a quarter billion years' worth of multicolored sandstone deposits.

The wind that was bringing in the storm clouds from the southwest had cleaned the air of desert haze. The winter sun, hanging low, cast shadows that defined the contours of the land with knife-edge clarity. Weeks of intermittent rain and snow had left everything damp, which intensified the colors of the land as if God had slathered it all with coats of fresh paint, giving the landscape a luminous character that continued as we swung southeast along the border of Capitol Reef, beyond whose lumps and curling canyons rose the snowy peaks of the Henry Mountains.

Then we turned southwest, along a route

A pretty poison, woolly locoweed, flowering during autumn, can make cattle that eat its toxic leaves go berserk and die. Hikers face their own dangers, from rockfalls to heat exhaustion. "This is not cheap scenery," wrote a visitor. "It must be bought with time and sweat."

that approximated the border between the monument and Glen Canyon Recreation Area, over Pioneer Mesa, Little Death Hollow, Big Bown Bench, Harris Wash. Just ahead were the Straight Cliffs, an abrupt, 1,500-foot wall that runs almost uninterrupted 50 miles from Escalante Rim to just above Lake Powell. Vaguely parallel to the cliffs was the Hole-in-the-Rock Road, a rough 60-mile road established in 1880 by Mormon pioneers on their way to set up shop in the cottonwood groves of Bluff on the San Juan River. They had to cut their way down the cliffs to cross the Colorado River to do it though, and I admired the stubborn toughness of the people who had settled this unlikely country, determined to outlast their predecessors, the Anasazi. I wouldn't bet against them either.

Over the Straight Cliffs now and on to the Kaiparowits Plateau, a wide and confusingly intricate jumble of benches at an average elevation of 6,000 feet, covered in P-J forests

ROUGH, KEEP IT DIFFICULT TO ACCESS."

—KATE CANNON, BLM

and shaped everywhere by canyons, gulches, and washes. The Kaiparowits has the reputation of being the most isolated place in the lower forty-eight, and it was easy to see why as I looked out over a thousand square miles on which we modern humans had made hardly a mark.

There was a mark on Smoky Mountain though, a dirt road that twisted its serpentine way 800 feet up the side of the mountain and across the southern benches of the Kaiparowits. We could see the road from the air, and I knew it could stop your heart, because I had just been on it with Ken Rait, who was then with the Southern Utah Wilderness Alliance (SUWA). This part of the monument was new country to me, so Rait had spent two days showing me some of its high points along mud-slick tracks that threatened to send our four-wheeler sliding into sundry declivities.

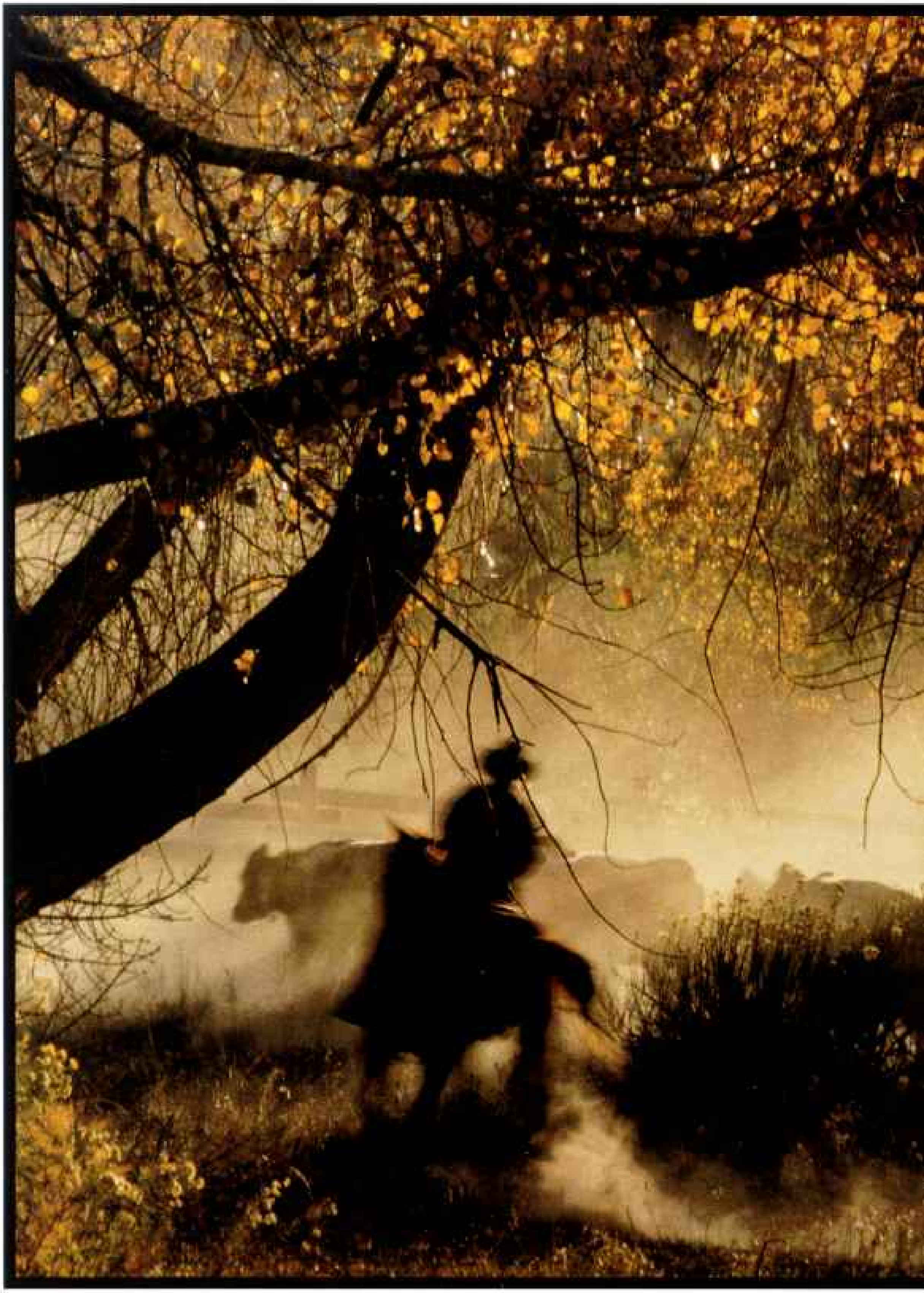
After one particularly long, slithery ride and a short hike, Rait had stood me at what he called a "power spot" overlooking Paria and Hackberry Canyons, an area that fell away beneath our feet in a spectacular complex of eroded pink, red, maroon, ivory, and white sandstones, their elegant convolutions rivaling those of Bryce Canyon National Park or Cedar Breaks National Monument. In the middle distance the tall white volcano-like cone of Mollies Nipple rose from the top of a bench, and on the far horizon I could see the huge snow-shouldered hump of Navajo Mountain. "If you tell anyone how to get here," Rait said, "I will have to kill you." I was touched by his notion that I could ever find my way back here again, much less tell anyone else how to do it. Later, we tried to get up Cottonwood Wash Road, a dirt track that begins near Big Water on U.S. 89 and runs north to Cannonville on Utah Highway 12. "One of the most beautiful areas in Utah," Rait said. But as we turned off U.S. 89, we found a sign planted in the middle of the road warning us it was impassable. Someone had spray-painted an addendum: "Deep Ruts, Complete Washouts, No Californians." It didn't sound promising. We retreated.

Now, in the air beyond the Kaiparowits, the pilot headed us toward the edge of the Grand Staircase. The name is a little misleading. It certainly confused some tourists shortly after designation of the monument. Just how high were the steps of the staircase, they asked a ranger in Canyonlands National Park, and how long would it take to walk them?

Quite a while. The "staircase" in fact is a series of random cliffs that pile up in fits and starts north of the Kaibab Plateau above Grand Canyon, the result of millions of years of fracturing, faulting, lifting, and shoving as the Rubik's Cube of the Colorado Plateau assembled itself. It would be a 40-mile "walk" up more than 5,000 feet of elevation from U.S. 89—up the "steps" of the Vermilion Cliffs, the White Cliffs, the Gray Cliffs, and the Pink Cliffs until you reached the top of the Paunsaugunt Plateau, where Bryce Canyon National Park resides—even higher and farther if you shifted a little east toward Powell Point or beyond that to the Aquarius Plateau.

We did not walk, we flew, the pilot and I, watching the disorganized, overlapping, colorful mix of cliffs and plateaus unroll beneath us as we raced the storm clouds back to the Escalante airstrip. America's new monument, I reflected, was indisputably big—big and wonderfully various. But was it big and various enough to satisfy all the visions people had for it?

THE BLM had just started its mandated three-year planning process for the monument that March of 1997, and there were plenty of people who intended to take full advantage of the government's call for public participation. Many of those I talked with, like Allen "Viv" Adams, then mayor of Kanab, told me that most of the monument's now primitive roads should be paved so that tourists could get to its wonders with a minimum of effort and that there should be visitor facilities, including campgrounds, RV hookups, and toilets. Others, like Garfield County Commissioner Louise Liston, were less enthusiastic about paved roads and facilities but said that mining, including coal mining, oil



When the dust lifts, Dell LeFevre will have ended his last cattle drive to the Escalante River, now off-limits

to cattlemen. A fifth-generation rancher, LeFevre clings to grazing rights elsewhere in the monument.

and gas development, and livestock grazing should be allowed where appropriate. Dirt bikers and all-terrain-vehicle riders should be given places to play. "We wouldn't want just a hiker's monument," Liston emphasized.

Wait a minute, said environmentalists. Too many such uses would damage the very land the monument designation is meant to protect. "Grand Staircase–Escalante is one of the largest chunks of basically untouched wild landscape in the lower forty-eight states," argued a SUWA activist I talked with in Salt Lake City. "It was designated to protect wilderness values and should be managed largely as wilderness."

Jerry Meredith, the BLM's monument manager, was the man saddled with reconciling these conflicting visions in his plans. When I talked with him, he had just started, and he said he was determined that every interest get a chance to participate in the planning process on an equal basis. And he was convinced that the process itself ultimately would leach the bitterness out of people. After all the comments and complaints I had been hearing, I was not so sure.

Unkind cuts mark the attempt of thieves to steal a petroglyph of bighorn sheep. The carving dates from about A.D. 900, when peoples of the Fremont and Anasazi cultures shared the area. The monument holds as many as 100,000 archaeological sites, most unsurveyed.

BUT I MAY HAVE BEEN WRONG. About a year and a half after the planning process began, I returned again to Escalante country. The difference in attitudes was little short of astonishing. In the small towns that pock the edges of the monument, there was less talk about lawsuits and confrontation and more about how folks might accept the monument and make the most of it—particularly when town fathers and mothers considered the increase in tourism since the monument was announced. Between 1996 and 1998, annual visitation had risen from 520,000 to 850,000.

"The most common phrase I've heard," Ron Hitchcock, Escalante High School's principal, told me, "is 'We'll make lemonade out of the lemon that's been handed to us.'" Escalante, as it happens, has been making a lot of lemonade since the spring of 1997. There is, for example, the Escalante Center, a complex of educational facilities planned for 28 acres of land next to the high school. The BLM is planning to build a visitor center here, and the Escalante Center itself will feature research and educational efforts based on the monument. Ron is chairman of the center's board. "If our high school is, in many ways, the cultural center of Escalante, as so many small-town high schools are," he said, "then having a true Escalante Center next door can only enhance that role. The entire community, county, and area can take pride in it."

His wife, Sandie, agreed that the monument may eventually become a force for unity. When she was mayor of the city in 1998, she worked hard to overcome the locals' resentment of the monument and their distrust of the federal government and the environmental community. She was particularly proud, she said, of her work in getting local officials and environmentalists from SUWA, Great Old Broads for Wilderness, the Grand Canyon Trust, and other organizations

HUNTED HERE FOR CENTURIES.

to sit down together, talk over their differences, and begin, however slowly, a process of mutual understanding.

"I have to give a lot of credit to members of the city council who were willing to sit down and open up their minds to the 'enemy,'" Sandie Hitchcock said. "And SUWA, for example, has demonstrated that it's willing to work with our community to resolve problems." Not long ago, such communication would have been nearly unthinkable.

While not everyone, whether hard-line environmentalist or wilderness-resistant local, has unqualified praise for the Escalante Center, most seem to be willing to give the effort a chance. And most will give Kate Cannon, the monument's associate manager, the benefit of the doubt too. Cannon gave me a quick tour of the BLM planning office in Cedar City. I asked her if the planning team had encountered major pressure to pave roads and otherwise develop the monument. "No," she said. "That's been one of the interesting surprises. One of the things we heard loud and clear from all constituencies was 'Leave it alone. Keep it remote, keep it rough, keep it difficult to access.' And that's what we intend to do."

So how did she think people were going to react when they saw the plan's first draft? She flashed a wry grin. "They're going to *love* it."

AMAZINGLY ENOUGH, while they didn't necessarily love it, many at least liked much of it. The draft plan was released last November 16, and, just as Cannon had promised, its "preferred alternative" was long on wildness and short on development.

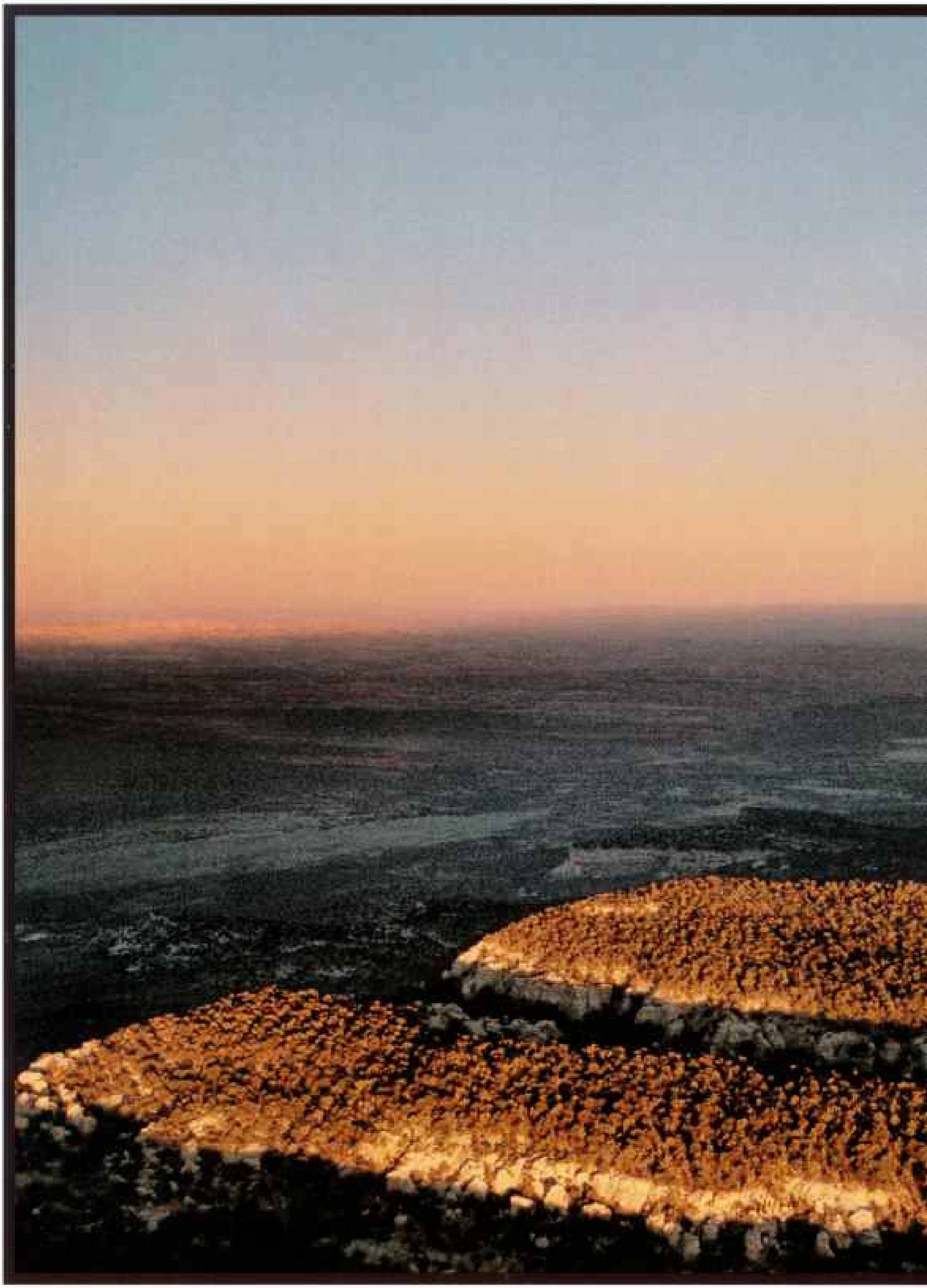
The emphasis throughout was on the natural and scientific values of the monument. More than a million acres would be managed as "primitive" zones, with access and use restricted to preserve their wilderness characteristics. Another half million acres would be managed as "outback," with their own, less rigid restrictions. There would be no new paved roads in the monument, no RV hookups, no big parking lots, no concessions. Seventeen streams would be recommended for designation as wild and scenic rivers. All tourist and administrative facilities would be built in surrounding communities, giving each town an economic stake in the monument's preservation—and going a long way toward diluting old angers.

The plan did meet with mixed feelings from some quarters. "I'm concerned," Louise Liston told me, "that it's clearly slanted toward preservation, and I worry that some historic uses of the land will be restricted." At the same time, she said, she favored the emphasis on the educational and scientific importance of the monument and very much liked the Escalante Center idea.

So did Mike Matz, executive director of SUWA, even though his organization and other wilderness advocates would still have liked to see most of the outback zones managed as wilderness, as the primitive zones would be, until such time as they might be folded into the National Wilderness Preservation System. He was not happy with the 591 miles of routes the BLM had set aside for the use of all-terrain vehicles or with a number of other points with which SUWA will be taking issue. Nevertheless, he found the draft plan "a whole lot better than we might have expected."

The final plan will be issued in the fall. There will doubtless be changes, good and bad, and the final result is not likely to satisfy everyone. Such plans never do. Still, I smell a species of hope here.

I remember the kind of development that has brought so many paved roads, parking lots, crowds, commercialism, and urban excess to Yosemite, Grand Canyon, Zion, and many other national parks that their managers must now spend much of their time trying to turn back history. By embracing and protecting most of the wildness that defines and sustains this newest American monument, the BLM—often ridiculed as the "Bureau of Livestock and Mining"—might just get it nearly right from the beginning. Are you watching, Everett Ruess?



No-man's land: That's what locals call this gaunt, mineral-rich slice of the Kaiparowits Plateau.

Monument status will likely stymie plans for coal mining. For this outback, wilderness is wealth enough. □

Resting in the depths, a cow shelters her calf in Pacific waters, where humpbacks were hunted heavily into the 1960s. Protected since 1966, these singing whales are making a comeback, giving scientists another chance to study individuals like this inquisitive male (facing page) and to fathom the behavior of a still mysterious species.

FLIP NICKLIN, MINDEN PICTURES

By DOUGLAS H. CHADWICK Photographs by FLIP NICKLIN

LISTENING TO HUMPBACKS

WHEN A BIG WHALE DIVES, currents set in motion by the passage of so many tons of flesh come eddying back up in a column that smooths the restless surface of the sea. Naturalists call this lingering spool of glassy water the whale's footprint. Out between the Hawaiian islands of Maui and Lanai, Jim Darling nosed his small boat into a fresh swirl. The whale that had left it was visible 40 feet below, suspended head down in pure blueness with its 15-foot-long arms, or flippers, flared out to either side like wings.

"That's the posture humpbacks most often assume when they sing," Darling said.

A hydrophone dangling under the boat picked up the animal's voice and fed it into a tape recorder. We could listen in with headphones but hardly needed them. The music was reverberating through the hull and rising from the waves. Bass rumbles that could have issued from the lowest octave of a cathedral pipe organ gave way to plaintive moans and then to glissandos like air squealing out of a balloon when you stretch the neck taut.

With the notes building into phrases and the phrases into repeated themes, the song may be the longest—up to 30 minutes—and the most complex in the animal kingdom. All the humpbacks in a given region sing the same song, which is constantly evolving. Experts have analyzed the frequencies, rhythms, and harmonics and the way themes change

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DOUGLAS H. CHADWICK and FLIP NICKLIN, both frequent contributors to NATIONAL GEOGRAPHIC, also teamed up for our August 1998 article on bottlenose whales.

Emerging from a blue obscurity, humpbacks cruise near Maui, part of a gathering of some 30 animals that is among the largest ever seen. Ranging through the world's oceans, humpbacks are hard to follow—and even harder to count. Estimates range upward from 30,000 worldwide.

from year to year and vary from one population to the next. Yet no one really understands what these intricate arias are about.

We do know that humpbacks are found in every ocean. Together with blue, fin, sei, Bryde's, and minke whales, they belong to the rorqual family of baleen whales. Fully grown females, which are bulkier than the males, can weigh 40 tons and reach lengths of 50 feet. Humpbacks tend to favor shallow areas, often quite close to shore, and they are among the most sociable of the great whales and the most active at the surface, all of which makes them among the easiest to observe. As a result, we know more about them than about any other large whale. But we still don't know a lot.

One thing that experts are certain of is that this species, depleted by whaling and not protected throughout its range until 1966, is showing signs of a comeback. Early population estimates are unreliable, and recent ones are hard to get, but numbers in the North Atlantic seem to have rebounded from a few thousand to between 10,000 and 12,000. The North Pacific population was thought to have tumbled from 15,000 to fewer than 2,000. That group stands at 5,000 to 8,000 today.

Knowing I was eager to absorb what biologists have been discovering about humpbacks and their ongoing recovery, Darling, director of the West Coast Whale Research Foundation in Vancouver, British Columbia, brought me along to Hawaii.

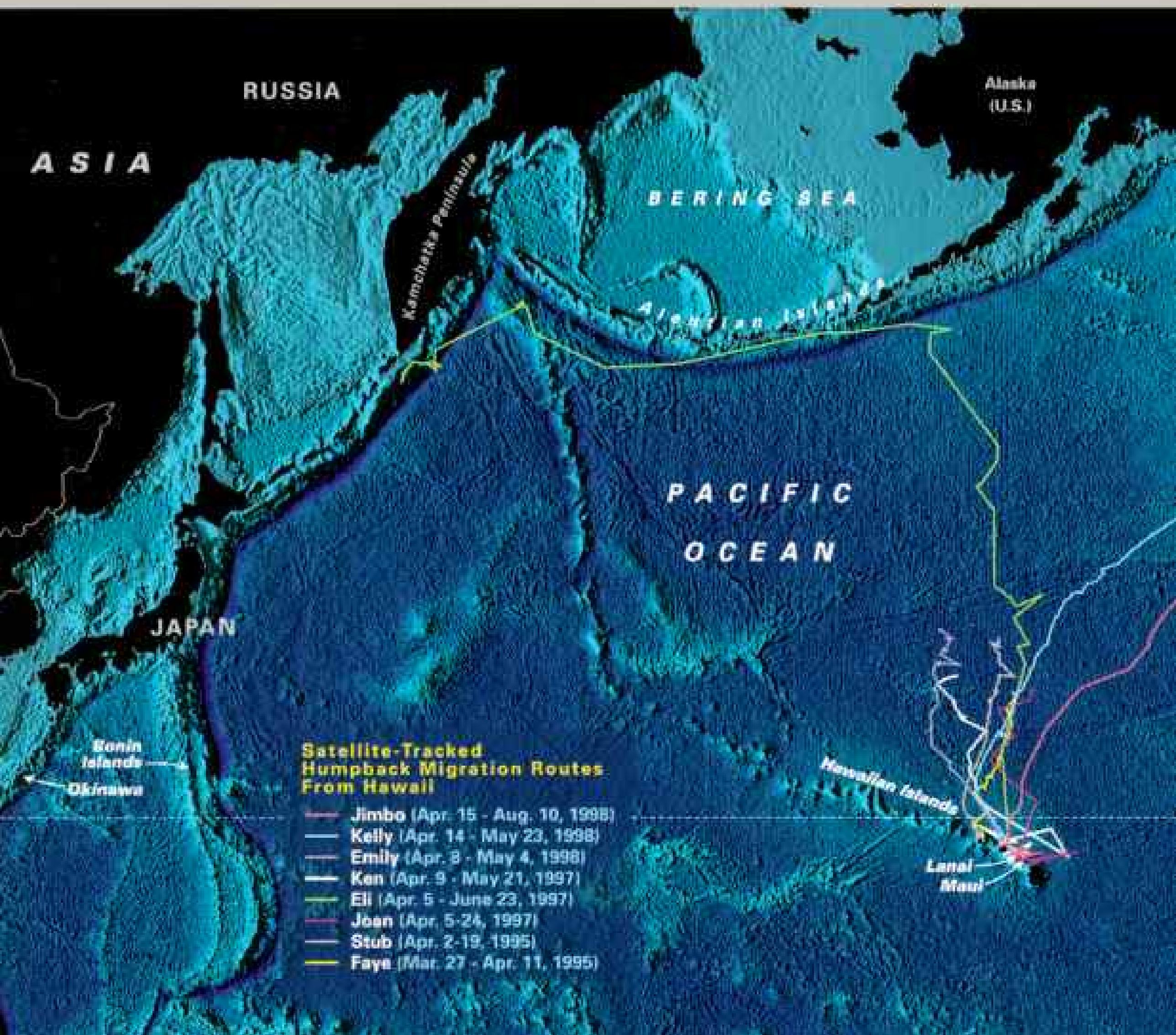
Since the singer beneath the boat didn't seem bothered by our company, Darling asked his longtime research partner, photographer Flip Nicklin, who often serves as Darling's eyes underwater, to slip overboard. I followed.

Bubbling scuba gear sometimes agitates humpbacks, so Flip and I took only masks, fins, and deep breaths. Suddenly, I no longer heard the whale's voice in my ears. I felt it inside my head and bones. The farther down I dived, the deeper the song seemed to penetrate and the more singers I became aware of in the distance, as the sounds carry for miles at depth. At 30 feet I was totally immersed—dunked, drenched—in humpback music. The sea quivered with it and with javelins of light that seemed to converge upon the singer's dark immensity. Surfacing to breathe, I noticed the leviathan roll slightly to peer up at me. Next I was treading water in helpless wonder while it came swimming my way.

I dived again, and 40 feet of solid whale passed so close that I could have reached out and touched its eye. Then the creature turned. And then it came directly at me. At the last instant it braked with its flippers. We were left hovering nose to nose. The moment probably called for profound thoughts, but I couldn't have told you my name. Slowly the animal tilted upward, bringing its head above water. I did the same and found myself staring up at a wall of quivering white throat with clusters of barnacles on the chin. The whale spiraled down toward the hydrophone and looked that over as if considering crooning into it, circled to take in the boat propeller, sank tail first to rest vertically just under the craft, which appeared dinky by comparison, and finally continued down, spread its arms, and resumed singing.

Showing his ID as he floats head down in the singing position, Frank (facing page) displays the unique pattern of tail markings that marine biologist Jim Darling photographed in 1979 (inset) and now uses to recognize him. Sketches (left) keyed to his collection of photographs have helped Darling track individual humpbacks since the late 1970s. Earlier research was based on animals killed by whalers or onetime sightings of live whales.

From winter breeding grounds in Hawaii, where a whale breaches (left), humpbacks disperse each spring to feeding areas across the North Pacific. They normally swim at a steady 3.5 miles an hour, says Bruce Mate of Oregon State University, who tagged whales with radio transmitters and charted them via satellite (map, below). Previously scientists knew only that some humpback whales journeyed to the northwestern Pacific to feed. Mate's research shows humpbacks to be intrepid travelers, cruising as far as 5,000 miles from Hawaii to Kamchatka.



DARLING WAS THERE trying to puzzle out the role of the song, heard primarily during the breeding period. Whales belonging to the dozen or so populations of humpbacks follow different migratory routes between high latitude summer feeding ranges and warmer wintering sites, where the giants essentially stop eating and concentrate on mating, birth, and the rearing of young. Hawaii is a breeding area for North Pacific humpbacks, which start arriving in November and leave by April. Darling had already established that the singers are males. Most people assumed that the animals, like male songbirds, sing to attract mates. He wasn't so sure and wanted a more thorough look.

Minutes after my face-to-face meeting with the whale beneath our boat, another humpback loomed into view, presumably drawn by the song. The singer went silent as the newcomer, known as a "joiner," approached, and they began swimming rapidly around each other. When they surfaced, Darling fired a small dart into each to collect tissue for genetic analysis, which is the surest way to tell the look-alike sexes of humpbacks apart and can also reveal whether animals are related. The two whales headed northwest together. Flip and I heaved back aboard, and we set off in pursuit. When the whales raised their tail flukes, Flip took pictures of the undersides, whose distinctive patterns of black-and-white pigments serve to identify individual humpbacks.

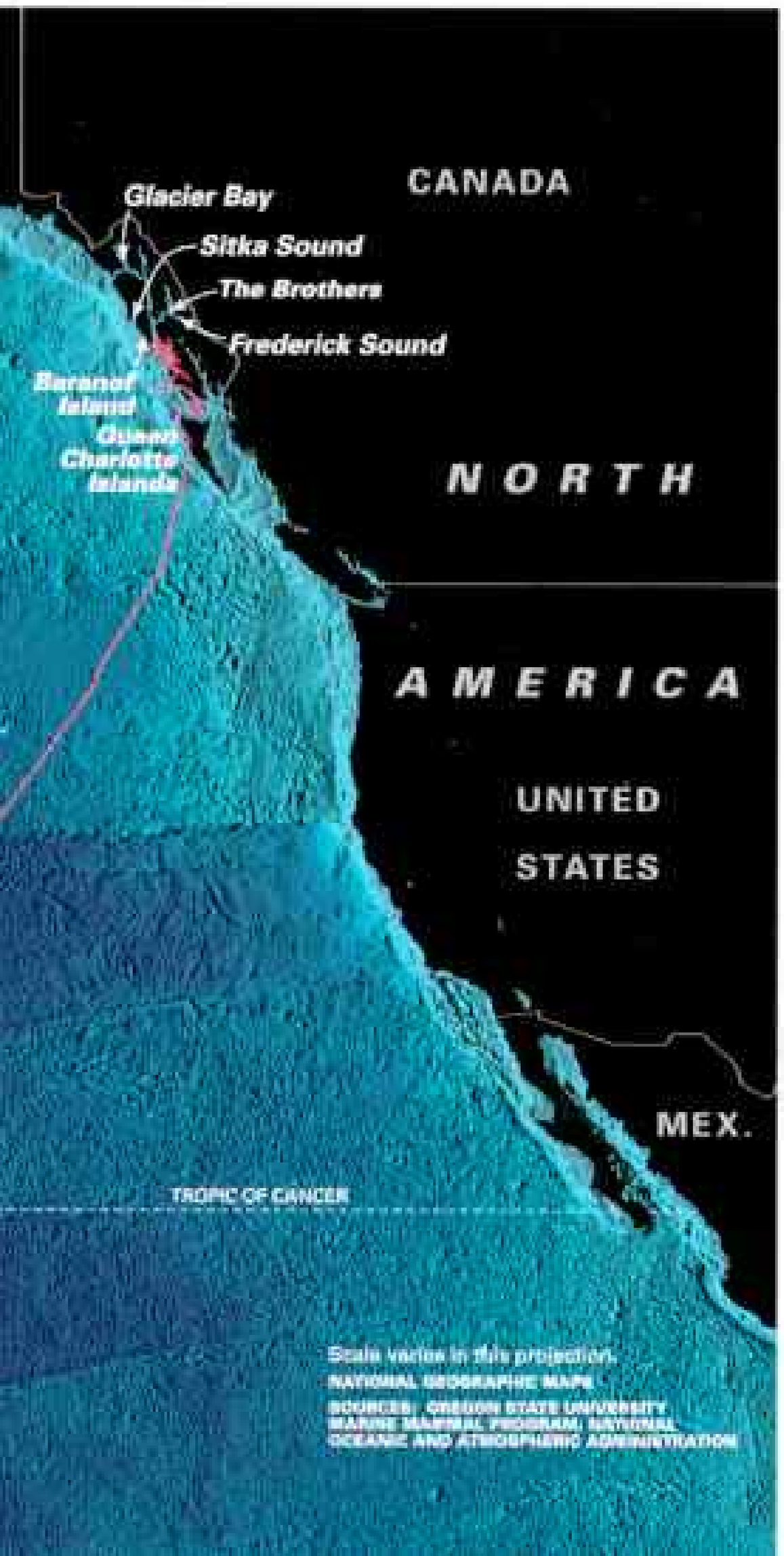
The team was elated. Between rough weather, missed shots, equipment breakdowns, uncooperative animals, and the difficulty of tracking even a tolerant whale long enough to interpret its activities, Darling is lucky to document two dozen encounters between singers and joiners during an entire winter field season. This was the first time a get-together had been witnessed and photographed underwater.

The tissue sample later revealed that the joiner was a male. Samples from earlier encounters showed that most of the joiners were males, not females. What's going on?

An available female, or cow, will generally be accompanied by a male thought to be courting her. Known as the principal escort, he attends her closely and fends off secondary escorts that approach too near. Perhaps the average male sings to recruit other males because his chances of getting close to a female improve when the principal escort is distracted by a number of rivals. A simpler possibility is that the serenade is intended for females but ends up luring challengers. Or, for all its ethereal qualities, the song could just be a version of the old masculine challenge: I'm big and tough and ready to rumble. Darling even wonders if singing could be the acoustic version of carrying around impressive horns or antlers—or wearing expensive wristwatches—as a way for males to advertise their fitness to prospective mates.

"The image of whales as gentle giants or some sort of special, enlightened beings seems to have become quite popular," Darling told me. "But whales are descended from early hoofed animals, and we might understand some of their breeding behavior better by viewing it in the context of a typically competitive mammal society."

In the days to come he would show me



Warning off competitors with a trail of bubbles, the male closest to a female (not visible) claims her as his own, while scientists observe. Because mature males outnumber females in heat, competition can be fierce. Rivals batter each other, often drawing blood.

how males jockeying for position near a cow sometimes lunged along the surface with their heads uplifted and gulped water to swell their massive throats in an apparent attempt to make themselves appear larger, like land mammals do by raising hackles and manes. They blasted rivals with disorienting clouds of bubbles, fended them off by extending pectoral fins, and lashed at one another with tail flukes.

Underwater near a large group of humpbacks I witnessed escorts colliding with one another. I could hear the whams and whumps resound. Many of the animals had bloodied dorsal fins and noses, as the barnacles that humpbacks host can turn a low-level shove into a serious scrape.

EVEN THE HUMPBACK'S more ordinary qualities have a touch of the fantastic about them. The species' common name comes from the hump on the forward part of the dorsal fin and from the way the back flexes upward sharply before a dive. Sometimes a group of humpbacks swimming in single file all arch to go under around the same time. At a distance you would swear you were looking at the rippling coils of a gigantic sea serpent.

"I'm guessing that a few old-time tales got started that way," said Steve Zeff, a naturalist guide on the *Maui Nui Explorer*, a tourist boat out of Maui's port of Lahaina with a morning load of whale-watchers. Humpbacks were high-jumping everywhere, trailing waterfalls and twisting in midair to land on their backs in geysers of spray. Their often white flippers, the longest of any whale, earned the species the genus name *Megaptera*, or "great-winged." When one shoots from the sea with bright arms flung wide, it really does seem for a moment that whales can fly.

Rachel Cartwright, who studies humpback females and their offspring in Hawaii, told me she saw a juvenile leap from the water a hundred times in a row. Herman Melville, the author of *Moby Dick*, described humpbacks as "the most gamesome and light-hearted of all the whales." In addition to breaching, these marine athletes will repeatedly slap the surface with their heads, flippers, or flukes. Pounding the water may be a form of communication, like singing. Then again, it could simply be the revved-up result of social hopes and frustrations hidden below the waves.

While we cruised by, visitors all around the islands were whale-pointing from tour boats, beaches, and balcony windows, and cars pulled abruptly off to the sides of highways. Humpback-watching is also big business in Alaska, New England, and parts of Canada, Australia, and the Caribbean. Whale-watching generates perhaps a billion dollars a year worldwide.

The change in human attitudes from the last century could hardly be more dramatic. Then, the growth industry was whaling, dominated by the Yankee fleet. Sperm oil, a prized lubricant, made sperm whales a favorite target, as were slow-moving, easily harpooned bowhead and right whales, hunted for their baleen. As they played out, whalers turned to humpbacks, which yielded a less valuable oil. In 1966 the International Whaling Commission at last

Crooning to a distant audience, a humpback (right) sings into a hydrophone. Scientists are unsure why males perform such songs during breeding season. Some believe they are meant to attract females, but Darling notes that a singer (left, in back) invariably draws male "joiners," such as the scarred veteran charging into the foreground. "It may be an acoustic display," he says, "serving the same purpose as horns or antlers."

Forty tons of bulk and power, a humpback is an awesome sight—with 15-foot flippers and an eye that peers at humans in seeming curiosity. Despite their size, Darling is at ease around the whales. "There's a grace, a control, an awareness," he says.

Hunting for knowledge, Darling takes aim at a humpback trolling for fish off southeastern Alaska (left). The dart he fires bounces off the whale's back barely noticed (right) and is retrieved, carrying a tiny core of fat and skin on its tip (far right). Genetic tests on such samples can reveal the sex and bloodlines of individual whales. Using this method, Darling is trying to establish the ratio of males to females at these feeding grounds.

banned commercial killing. By then the worldwide population of humpbacks, estimated to have once stood at 125,000 or more, may have been reduced by as much as 95 percent.

Southern humpbacks took the hardest hit. With distinctively white undersides flashing through the depths, they feed in rich Antarctic waters through the austral summer, migrate to breeding grounds as far north as the Equator, and until recently were not known to mix with northern humpbacks. Which is why marine biologists were increasingly worried as the years went by and the southern group showed few signs of recovery. No one understood the cause until 1994, when data from Soviet factory ships revealed that Antarctic humpbacks by the tens of thousands had been killed between 1949 and 1972. Lately, sightings in some southern areas have been rising close to 10 percent annually.

At least 3,000 to 3,500 humpbacks—perhaps half of the North Pacific population—breed in Hawaiian waters and are thought to forage through the warm months off British Columbia and Alaska. Another subpopulation feeds off Washington, Oregon, and California and winters by Mexican shores. A third North Pacific group, once common along Asia's continental shelf, was taken out by whaling. Or so authorities thought before survivors were documented by Jim Darling and his colleagues during the 1980s. More than 500 now migrate from northern regions to Japan's Bonin Islands and Okinawa, where humpback-watching tours are a growing enterprise.

IN HAWAII hope was rising before my eyes in the form of new, light gray babies. "The first time I went in the water with a humpback mother and calf, I knew what I wanted to do with my life," said Debbie Glockner-Ferrari. Twenty-four whale breeding seasons later, she and her husband, Mark Ferrari, were still conducting research on humpback mothers and young out of Maui.

We watched several pairs at rest 40 to 60 feet down. Clouds of small fish hovered over the females' broad backs as if they were warm-blooded reefs, scavenging bits of shed skin. The little humpie—relatively speaking, since infants average around 12 feet at birth—would usually be tucked under mom's chin or one of her flippers.

Whereas the mother might stay down as long as 45 minutes, babies can't store as much oxygen and frequently surface for fresh air. And if you're anywhere near, many calves can't help coming over for a curious glance or two. Certain mothers are relaxed about it; others quickly rise to herd the youngster away. Sometimes it's the calf that acts shy while the mother is the inquisitive one.

"They are highly individualistic animals," Debbie said. "One of our favorites was Daisy, a wonderful, friendly female and a very important whale scientifically." Daisy showed up with a new baby four years in a row when the textbooks all stated that humpbacks could only produce a healthy calf once every two to three years. In all, the females that Debbie and Mark

were able to recognize had calves a year apart 16 percent of the time. This discovery suggests that the whales' potential for a strong recovery from their low numbers could be higher than anyone dared wish.

A mother humpback's rearing chores begin immediately upon birth. Because the infant's lungs are not inflated, the baby will tend to sink until its mother nudges it up to the surface for its first, sweet gasp of air. For most of the next year, mothers provide milk, guidance, and protection from enemies. At least a quarter of the females carry rake marks from teeth. Many are caused by killer whales, which attack a variety of baleen whales and focus on vulnerable targets such as the young.

Moby made it through his first year or two in fine fettle. That's the name the researchers gave a stout, pale gray youngster. They introduced me one morning during my second season in Hawaii. Moby spun and frolicked around us for a couple of hours and once nearly landed atop us with a breach. Every so often our 30-ton playmate would break off to rush toward a nearby vessel and nose around the stern, sometimes bumping the hull or slapping it with a fluke as he turned. Whale-watchers call such extra-close encounters muggings.

"One day we saw a female mugging boats," Mark recalled, "and there was an odd pattern to it. She would curve her tail in front of the bow to hold the ship in place and bring her head around so that her eye was close to the propeller. Then we noticed that her calf had a series of deep, healing gashes along its back. You could tell it had been badly cut up by prop blades. Now, maybe it only looked like this mother was inspecting propellers, searching for the guilty boat. But I kept thinking: Man, I don't want to be around when she finds it."

Another time, people watching a courting group realized that one member was no longer surfacing. It was a male, and it had just died. After the other whales left, one male stayed on with the corpse, using its flippers to stroke the body, occasionally trying to lift it up for air. The companion stayed through the afternoon, driving Mark away when he approached in the water. It was still there when darkness fell.

WITH WHALES, even interpreting something as ordinary as feeding can be tricky. Lacking teeth, baleen whales gather food by gulping the seawater that contains it. Then they use their tongues to force the liquid out through a sieve of fibrous plates—the baleen—hanging from the roof of the mouth. Since the process is often described as straining seawater, many people have the impression that the great whales swim around through the oceans with their mouths open, filtering plankton. In reality these mammals travel tremendous distances between sites where the right conditions concentrate food—small fish and krill, in the case of humpbacks.

Suppose one locates a milling ball of herring. The whale may lunge at the prey near the

surface, plow down into their midst, or dive deeper and circle below the fish, blowing a ring of fizzing bubbles to act as a net, then rise up through the center. Sometimes the animal blows different size bubbles depending upon the size of its prey. The lower jaw swings out from the upper jaw to open at a 90-degree angle, or even wider; one to three dozen grooves, or pleats, on the throat expand; and what was a sleek whale becomes a living vat swollen by as many as 15,000 gallons of water churning with fish.

Where the dining is especially rich, humpbacks do all this in coordinated groups of as many as two dozen. As they converge to scoop up the food, they are likely to be screaming—filling the water with prolonged, piercing shrieks that seem designed to further disorient the panicky, trapped targets.

In the North Atlantic humpbacks may thrash their tails as well as lay out huge clouds of bubbles to concentrate fish schools, while around Antarctica the whales' cultural tradition is to slap their flippers to round up prey. Gentle grazers of plankton pastures? Try predators par excellence, carnivores that, depending upon how you interpret bubble netting, may qualify as makers and users of tools.

I joined Darling and Nicklin as they cruised through Alaska's Frederick Sound trying to sort out some of the social relationships within feeding groups. Against a backdrop of rain forests and glaciers, the whiskery heads of sea lions popped up along the tidal rip where several humpbacks had just sounded. Darling lowered his binoculars and said, "When the humpbacks are feeding in a group, they may dive and come up time after time in exactly the same formation. They definitely seem to be synchronizing their movements. The hard part is defining where self-interest ends and true cooperation begins." So far researchers have no evidence that these animals foraging alongside one another are closely related. In fact, the only stable family structure known among humpbacks is the year-long bond between mother and calf. That doesn't mean these whales don't have buddies, colleagues, or whatever you want to call seasonal companions.

We anchored by a group of islands called The Brothers one evening and met up with Fred Sharpe of the Alaska Whale Foundation and his associate Lisa Walker. As we shared a driftwood beach fire, Sharpe said, "We're seeing some of the same individuals together in groups year after year, and researchers up in the Glacier Bay area have found feeding associations lasting two decades. Whales that know each other probably work together more efficiently than strangers can." Cupping an ear, he asked if I had heard a sound out in the darkness. I had. It was a great cry from a humpback.

"Trumpeting like that is associated with a high level of excitement," Walker explained. "We hear it when killer whales are around and the humpbacks are alarmed. But we also hear it when the feeding is especially good, which makes us wonder if they are sending a message for companions to come join them. Underwater they can blast out at 170 decibels—louder than a jet's roar. They also make all kinds of lower intensity social sounds. I wish I knew what they were talking about. What I like

An eruption of whales churns the surface as five humpbacks (below) snap up herring. Whale-watchers flock to such spectacles (right) during the spring-to-fall feeding season off Alaska, while scientists debate whether groups of whales hunt cooperatively. Among those who believe they do is Fred Sharpe of the Alaska Whale Foundation, who has observed "running buddies" working together to trap fish. Surrounding a school of herring with a net of bubbles, the whales charge open-mouthed to the surface with loud cries, driving the fish before them.

about humpback research is the way it lets your imagination roam free."

FARTHER WEST I steered Jan Straley's skiff among plumes of spray in Sitka Sound as she shouted, "Turn right! A little more. Steady right there," raising her camera to snap off photographs of whales' flukes for identification. "The lead animal is number 336, a male," she continued, "and the one behind him with the dark flukes is a female, number 206. They've been around here for three weeks, always together. I've known one of them for 15 years, the other for 17." Roving the channels and coves of southeastern Alaska since 1979, Straley, a biologist at the University of Alaska Southeast, has identified around a thousand humpbacks. "I'm starting to see offspring of the offspring of whales that I first knew as calves," she said.

As her records built up, they showed the animals moving up and down the coast of Alaska's Panhandle to visit the same productive haunts year after year. Straley was struck by how late in the season some stayed on: into November, beginning to sing the breeding season song usually heard in the tropics; December, showing aggression typical of courting groups; and January, with snow piling up on the beaches. One old female and one yearling may have stayed through an entire winter.

It is usually said that the humpbacks' foodless tropical sojourn takes up almost half the year, counting travel time. But Straley began to wonder if some Alaska whales, particularly females, might not just shoot over to Hawaii, breed, and shoot back toward the dinner table. This would fit an idea proposed by Darling: Males arrive in Hawaii early and establish a hierarchy, possibly with the help of their songs, that results in the dominant ones breeding a succession of females as they pass through.

Bruce Mate of Oregon State University, a whale expert who leads the way in tracking humpbacks with satellite-monitored radios, found one humpback that covered the 2,600 miles between Hawaii and Alaska in just 30 days. In Maui he invited me to go along with him as he tried to tag more animals with transmitters contained in cigar-size darts. After two weeks of pounding over the waves, he had stiff legs, an aching back, and a fancy crossbow unsprung by salt spray. But he also had several humpbacks in touch with orbiting spacecraft—while having minimized disturbance.

Months later, he said, "One swam directly to the Queen Charlotte Islands off British Columbia, then headed north up the buffet line, hitting feeding sites along the outer coast, until it reached Baranof Island. Then it raced to the Queen Charlottes and back, 400 miles in four days, including stops at all the feeding sites. Almost every time we radio-tag a whale, we find it traveling far more than people imagined."

A humpback that Mate put on the air in 1997 swam due north from Hawaii to the Aleutian Islands, then, instead of heading for the panhandle as expected, it cut west and ended up off Russia's Kamchatka Peninsula before the beacon quit. Looking through collections of fluke photographs, researchers have found the occasional humpback traveling to Hawaii from Japan, Mexico, and southern British Columbia. Straley now and then records whales in Alaska formerly seen summering farther south. The various humpback subpopulations may not be as separate as once thought.

Even as the glad tidings about humpback recovery add up, managers face new concerns that range from underwater sound pollution to competition with the fishing industry. The burgeoning flotillas of whale-watchers can themselves disturb humpbacks, though the rewards in terms of public awareness and education seem to far outweigh any harm from this new version of setting out to sea after whales. Hawaii's officials worry about increasing runoff of silt and chemicals from agriculture and development.

Much of the animals' range around the 50th state lies within the Hawaiian Islands Humpback Whale National Marine Sanctuary, established in 1992 and recently expanded to 1,800 square miles. The Marine Mammal Protection Act fines boaters who go too fast in whale waters or push closer than a hundred yards—unless, as often happens, the humpbacks come to them. Sanctuary rules stiffen those fines and will maintain that level of protection if humpbacks are removed from the endangered species list. Such a move looks increasingly possible. It means we have been doing enough things right to recharge the seas with these sentient giants and the grandeur they impart. I can't remember ever hearing better news above water or below. □

Under her wing, a calf stays close to its mother off Hawaii while a male trails the pair, perhaps hoping to mate if the female comes into heat. Once perilously scarce, humpbacks have more than doubled in the North Pacific, raising hopes for a worldwide recovery.

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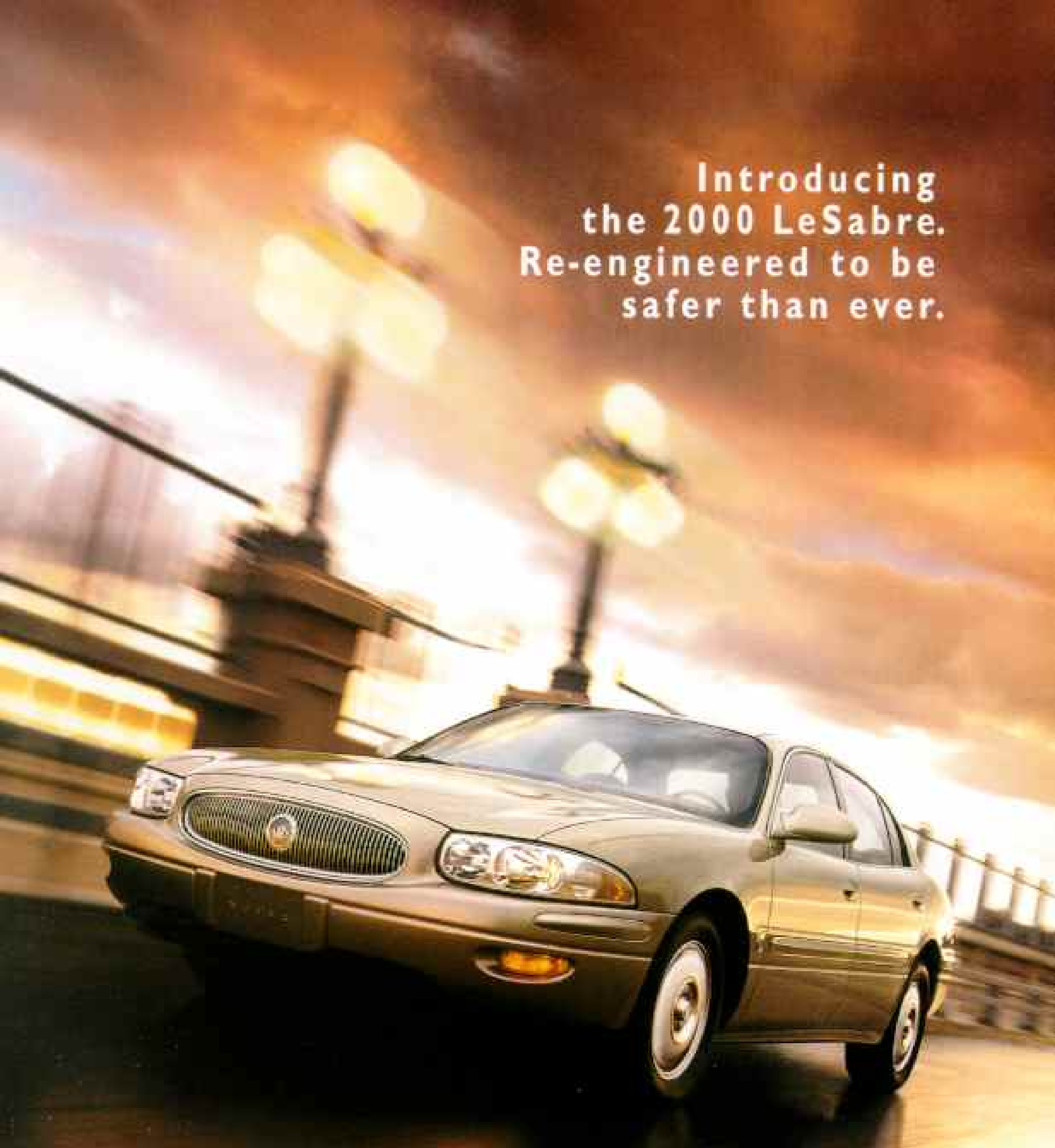

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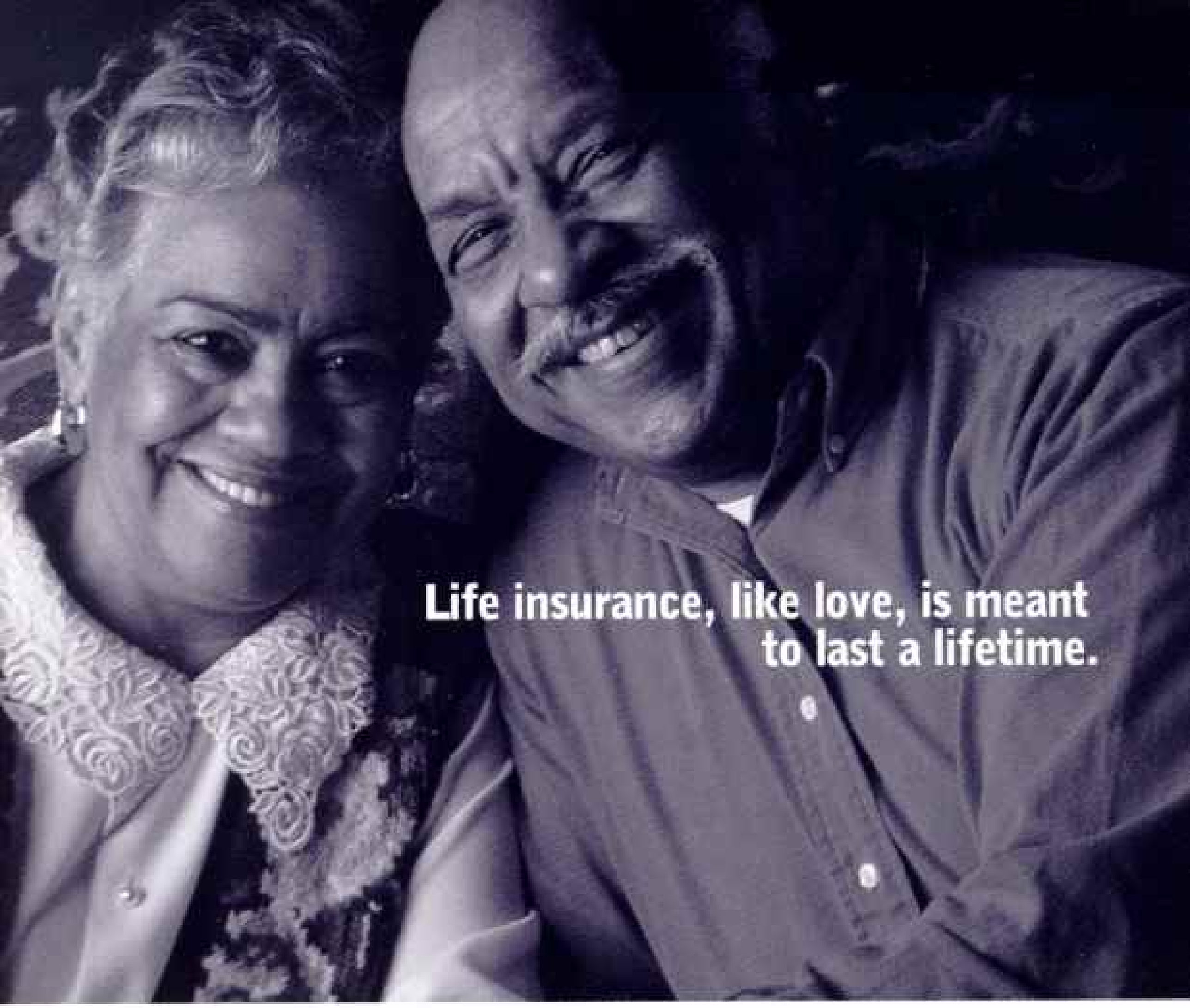

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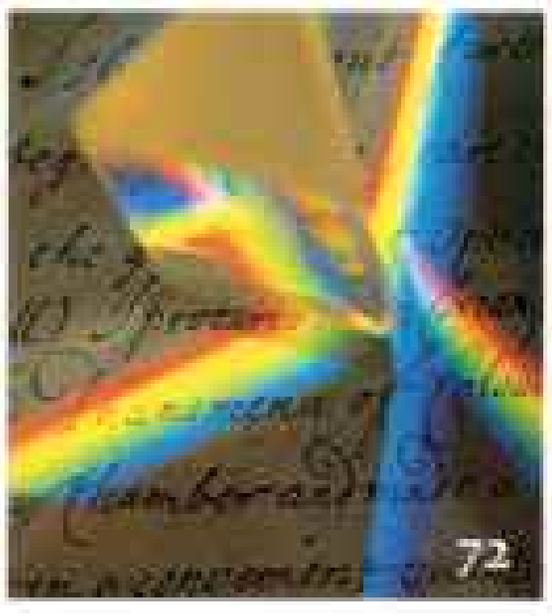

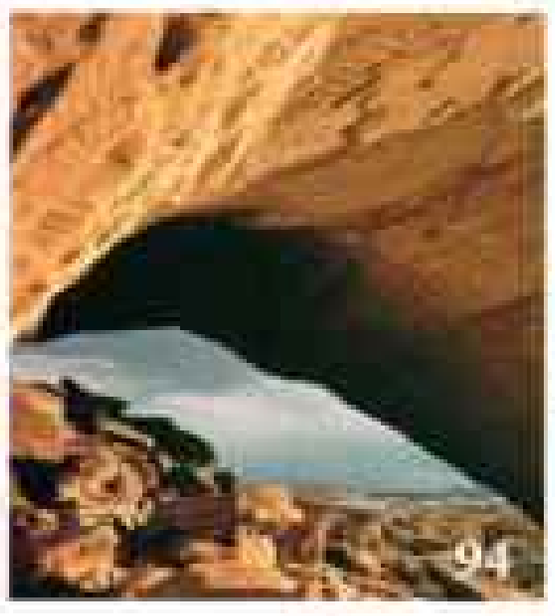

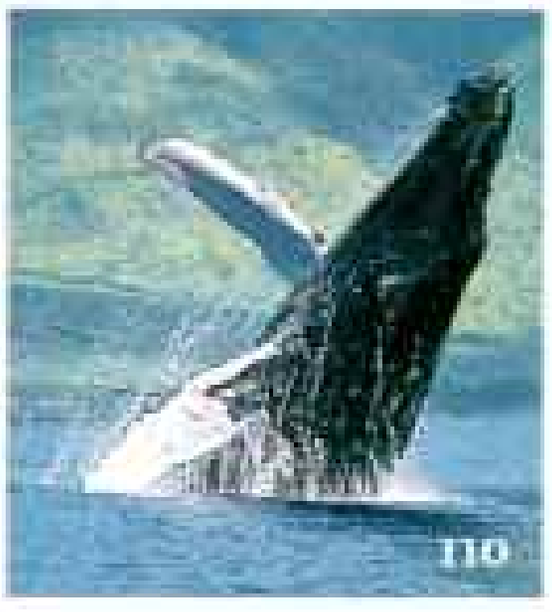

The Cover

Costumed in traditional Baluchi garb, an Iranian actress tosses a cloth symbolizing the creative spirit of women in a film directed by her husband on Kish Island, Iran. Photograph by Alexandra Avakian

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NATIONAL GEOGRAPHIC
On Assignment

BURTEIN FARAH

■ IRAN

Looking Back and Moving Forward

"No story is ever easy," says photographer Alexandra Avakian. "But working in Iran was not as difficult as you might think." Being a woman worked to her advantage, she says, allowing her intimate access to women's daily lives. "Cultural barriers make it very difficult for a man to do that." Alexandra felt obliged to wear a chador, the figure-concealing Islamic dress, only a few times during her four and a half months in the country. "Depending on where you are, there are different levels of *hejab*, or covering up," she says. In the town of Haftvan, where Alexandra's ancestors once lived, a modest dress and head scarf sufficed. Visiting the Armenian cemetery there with the town's mayor (above), she placed flowers on the grave of her great-great-grandmother. "My great-grandfather was also a mayor of Haftvan," says Alexandra.

Writer Fen Montaigne had a few tense moments while in Iran, "but most people were warm and gracious," he says. "During a two-week stretch in the countryside I spent all but one night as a guest in people's homes." His meeting with Ayatollah Majdeddin Mahallati (left) was typical of the hospitality he received. "He welcomed Alexandra and me so warmly," Fen says. "The ayatollah is a good example of the complexities of Iran today. Four of his children live in America, and he said he hopes that the mutual vilification that has marked U.S.-Iranian relations is coming to an end."

ALEXANDRA AVAKIAN

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O Say, You Can Still See the Flag

After a British attack on Baltimore's Fort McHenry in 1814, bombs had stopped bursting in air and the rockets' red glare had faded—and the star-spangled banner had survived. Francis Scott Key immortalized the flag in a poem that became the national anthem. The earliest known photograph of the banner (above) was made at the Boston Navy Yard in 1873. In 1907 the flag came to the Smithsonian Institution in Washington, D.C., where conservators have now launched a new battle—to slow the deterioration of this national treasure. They will clean it, remove linen backing added in an earlier conservation effort, and redisplay the banner under controlled lighting and temperature. Last December, using a moving platform to avoid direct contact with the cloth, they vacuumed the 150-pound, 30-by-34-foot wool and linen behemoth (left). Analysis, including infrared imaging, will reveal spots where heat, light, dirt, and oil have weakened the fibers.

At the National Museum of American History visitors can watch conservators at work on the flag in a climate-controlled area—a new, living museum exhibit.

SMITHSONIAN INSTITUTION (TOP); JEFF TINSLEY, SMITHSONIAN INSTITUTION

Linda begged Steve to log off the Internet for a day.

"How about we see the world in person this afternoon?" she challenged.

And before you could say "download," their Ford Expedition

took them to places so unreal and so far out there, Steve thought,

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Celebrating Life, a Medical Marvel

"You will soon witness a miracle," read the message in a fortune cookie opened by Lawney Falloon. It was early December 1988, a few days after his first child, Krysta, was born with an underdeveloped heart. The prophecy soon came true: Krysta received a transplanted heart 20 days into her life in an operation chronicled in a March 1990 GEOGRAPHIC article, "The Enigma of Time."

BRUCE DALE

Last December Krysta and her family had a party at their home in Solvang, California, to mark the tenth anniversary of that miracle. "We had a whole bunch of people," she reports, "and I got a lot of presents, which I liked."

A decade after the six-hour surgery, Krysta (left) is an active ten-year-old who plays basketball and soccer and skis yearly at Lake Tahoe. "She has to be carefully monitored; she has an EKG every four months and a yearly biopsy, and she takes an immune suppressant every day and will for the rest of her life," says her mother, Christina. "But physically she is in no way held back. She's living a quality life with no limitations."

Krysta becomes more aware of how special her story is as she gets older. "The party brought it to the forefront," says Christina, who has actively promoted organ donation efforts. And the rest of her family's awareness? "We never forget the miracle it truly is."

New Mammal in Miniature

If good things come in small packages, *Batodonoides vanhouteni* was as good as they come. After dissolving a hunk of 54-million-year-old Wyoming limestone in acid, University of Michigan graduate student Jonathan Bloch spotted through his microscope the fossilized jaws and 13 teeth of a shrewlike insect-eater. Less than an inch long, the animal—the smaller of the two in the artist's reconstruction at right—is by weight the littlest nonflying mammal ever found, smaller in fact than many scientists thought possible. It is dwarfed by the previous record holder, today's Etruscan shrew (right, at right). The tiny creature's lower jaw measured less than a third of an inch long, the largest tooth a mere three-hundredths of an inch.

JENNIFER C. CHRISTIANSEN, NCSU

JOHN MADERE, INTERNATIONAL FLAVORS & FRAGRANCES

A Fragrance Blooms in Space

A rose is a rose is a rose, but it is both more and less of a rose in the microgravity of space. Scientists sent a rosebud of the miniature variety "Overnight Scentsation" (left) into space with John Glenn and his fellow astronauts last year (GEOGRAPHIC, June 1999). They chemically sampled the rose as it opened. Analysis at International Flavors & Fragrances, a scent-development firm (GEOGRAPHIC, October 1998), showed that its overall aroma was only half as strong as that of an earthbound flower. But the highflier's "floral rosy scent increased dramatically in space," says Braja Mookherjee, a researcher at IFF. The firm hopes that that rosy note will make a new fragrance sing.

TEXT BY BORIS WEINTRAUB

Mother Nature's Treadmill

Mother Nature's Energy Bar

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Forum

Regarding our March issue, Joseph Lawrence of Chebanse, Illinois, remarked: "After being parched and dried out and windblown by the [Sahara] articles, I was quenched by the next on north Florida springs. Both stories showed how a diverse world adapts."

Heart of the Sahara

My first encounter with the Sahara was 24 years ago, from the window seat of an Egypt Air flight from Cairo to Kano, Nigeria. My latest one, in the living room of my Florida home through the pages of the GEOGRAPHIC, was as awe inspiring as the first. Having lived on the brink of the Sahara for 16 years, I feel the article represents both the beauty and perils of life in Saharan Africa. Donovan Webster and George Steinmetz have done an outstanding job portraying the grandeur of the Sahara and the tenacity of its peoples. And I say to them, "*Sannu de aayaki*—well done."

VALSA GEORGE
Port Charlotte, Florida

Hostile dagger-waving travelers, snake-infested ruins, dead German honeymooners, buried land mines. The Sahara is nevertheless spectacularly beautiful, but I bet the author, who lives in my neck of the woods, was kissing the Jeffersonian ground upon his return. I'll take the eastern woodlands of America, even with our occasional winter blizzard or summer deluge, any day over those searing sands!

TOM TRIGO
Charlottesville, Virginia

North Florida Springs

Having spent many hot Sunday afternoons of my 1960s childhood floating in a refreshing north Florida spring, I was delighted by your article and reminded of my mother's dramatic exclamation on every one of those outings: "I feel like I'm in the middle of a NATIONAL GEOGRAPHIC!" Thirty years later those fascinating and beautiful springs have made it into your journal. It seems my mother recognized GEOGRAPHIC-worthy material.

CHRISTINE SOBER
Franklin, North Carolina

Ken Ringle's excellent writing and Wes Skiles' hauntingly mysterious photographs captured the majestic beauty that cave divers have long tried to keep secret for themselves. While studying marine biology at Florida State University in the late seventies, I was able to spelunk many of the caves and caverns mentioned in the article. At that time cave diving was in its infancy, and many divers unwittingly took unnecessary risks to explore the aquifer. I recall pulling a fellow diver out of Morrison Spring during a night dive, thereby saving his life. I did not dive again in those caves for two years. I hope ongoing research will help make these beautiful places safer for divers and protect them for the profoundly important ecosystems they are.

DIRK E. PETERSON
South Chelmsford, Massachusetts

I was thrilled to open my March issue and find a picture of Little River Springs—the place where I, as a teenager, spent my weekends and summers. However, I am concerned about the area's future. A cement-manufacturing plant, predicted to emit more than a hundred pounds of mercury into the air each year, has been proposed within ten miles of the Suwannee, Ichetucknee, and Santa Fe Rivers. Unfortunately, not all in this area care about the natural state of these rivers and springs. The issue has divided the community, and the rivers appear to be losing. My only hope is that a reporter will not have to do a follow-up article 20 years from now to survey the damage caused by industry.

BONNIE HAUSER
O'Brien, Florida

Steller's Sea-Eagles

The magnificent eagles depicted in your March issue are currently undergoing severe problems due to lead poisoning in their wintering grounds in Hokkaido, Japan. Over the past five years the principal prey of the eagles, walleye pollack, has been greatly reduced by fishing. Because of a concurrent increase in the number of sika deer being hunted on the island, large numbers of eagles are switching to this food source. Sportsmen traditionally remove the desirable meat and leave the remains of the deer carcass in the field; eagles die after consuming lead in the carcass. This problem could be easily remedied if the environment agency of Japan mandated that hunters use copper rifle bullets or shotgun slugs, preserving an uncontaminated food source for wintering eagles.

DAVID K. GARCELON
Institute for Wildlife Studies
Arcata, California

El Niño/La Niña

The opening paragraph attempts to emphasize the importance of the 1997-98 El Niño by quoting losses attributable to the event. These numbers came from a continuing study by our office. Unfortunately a typo misquoted fatalities as 2,100 rather than 21,000. It should also be noted that the effect of climate variability cannot be described simply through deaths and dollars lost and is not always a negative. The El Niño Southern Oscillation can cause both severe misfortune and great abundance.

KELLY SPONBERG
NOAA Office of Global Programs
Silver Spring, Maryland

Curt Suplee recognized the variability of our weather and identified some human activities that worsened the effects of El Niño. Yet I wonder how many readers recognize that the image of stumps glowing and smoldering in what was left of a slashed and burned portion of Brazilian rain forest (page 77) shows the work of humankind? Or how many readers know that undisturbed rain forest has no understory fuels capable of sustaining a fire unless the forest is first razed by the hand of man? If we wish to sustain ourselves via our Earth's bounty and maintain the biodiversity so eloquently described in your February issue, it's time to recognize the processes that drive ecosystems and start placing blame for many disasters where it belongs—on our folly.

ROBERT DYE
Nokomis, Florida

The El Niño article made several references to the forces of nature causing drought and famine. I always thought that nature caused drought but man caused famine.

STEVE OSTERFELD
Cincinnati, Ohio

In the Wake of the Spill

While working for the Alaska Department of Fish and Game during the *Exxon Valdez* oil spill, I saw the devastation to wildlife. One lesson stood out the most: To significantly reduce the risk of future spills, Americans and other heavy-consumer nations would need to reduce both the number of people demanding petroleum products and the amount of these products that each person consumes. Ten years later new American houses are commonly larger than necessary, and more people are driving gas-guzzling sport-utility vehicles. Captain Hazelwood shouldn't be the only one required to do community service.

BRUCE H. BAKER
Auke Bay, Alaska

Isn't it true that all Alaskans share some complicity in Exxon's negligence? Don't they each receive a sizable yearly stipend from the oil royalties? Alaskans have made a deal with the devil in an area that should never have seen an oil pipe or tanker, and they're going to have to live with it.

BOB KLAPUT
Ford City, Pennsylvania

I was interested to see the picture of the harbor seal with the glued-on satellite tag (page 111). The glued area, which mats down the seal's fur, appears quite large in relation to the size of the seal. Does this have an adverse effect on the seal with regard to heat loss?

RICHARD AUSTIN
Mondefield, England

The tag, about the size of a cigarette pack, is glued to a lightweight, flexible mesh backing, which is then glued to the animal's fur. Since harbor seals molt once a year, the tag stays on for a maximum of 11 months. The biologist assures us that the tag causes no adverse effects to the seal.

Unmasking the Snapping Turtle

As boys, my three brothers and I were in perpetual summer contact with snappers, our most direct competitor in bringing a brood of ducklings to butchering age. We all learned that a snapper is never really dead. Once while skinning a snapper out of its shell, an hour after guillotining its head, I barked at my brother to stop pinching my ear. When I swatted at the pain and saw my hand covered in blood, I realized the snapper's head was fixed to my ear. My brother spent 15 minutes with a knife and pliers prying the thing off. A snapping turtle is what a rock would be if it were alive.

RICHARD MERTENS
Medford, Wisconsin

The jaws are not the only part of a snapping turtle that continues to function after the death of the animal. Its heart may continue to beat erratically for as long as a day. When I was growing up in New Jersey, children sometimes caught snapping turtles to sell to a local processing plant. The plant did not use the internal organs and would return them to the seller upon request. For kids with understanding teachers, a still beating turtle heart made a terrific show-and-tell.

GUIDO RILEY
Everett, Washington

I have a common snapping turtle as a pet. He has never bitten or even hissed at anyone in four years. He loves the cat and even chases him about the house. He pounds his head on the aquarium until you pay attention to him, and he loves to have his back scratched. Just maybe his temperament is the true nature of the beast.

JANICE M. PETRO
Hammond, Indiana

Earth Almanac

The sale of the Baca Ranch to the U.S. Forest Service has fallen through. The owners withdrew from negotiations with federal officials after failing to receive assurance that the appraised value of the land would be kept confidential until the sale was firm.

SARAH MEYER
Los Alamos, New Mexico

Letters for Forum should be sent to National Geographic Magazine, PO Box 98198, Washington, DC 20090-8198, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and space.

We need your help.

On January 25, 1999, Colombia's western coffee region was devastated by one of the deadliest earthquakes to hit the country in over a century. Affecting over 30 municipalities in six states, this natural disaster has left 55% of the population homeless. Towns have been reduced to rubble. Local businesses destroyed. And more than 250,000 people are currently destitute.

In order to provide humanitarian and social assistance in this time of need, the *National Federation of Coffee Growers of Colombia* has created the "Colombian Relief Fund." All contributions to this fund will be used to provide immediate shelter, food and medical care, and to aid in the reconstruction of this region's homes, infrastructure and livelihood.

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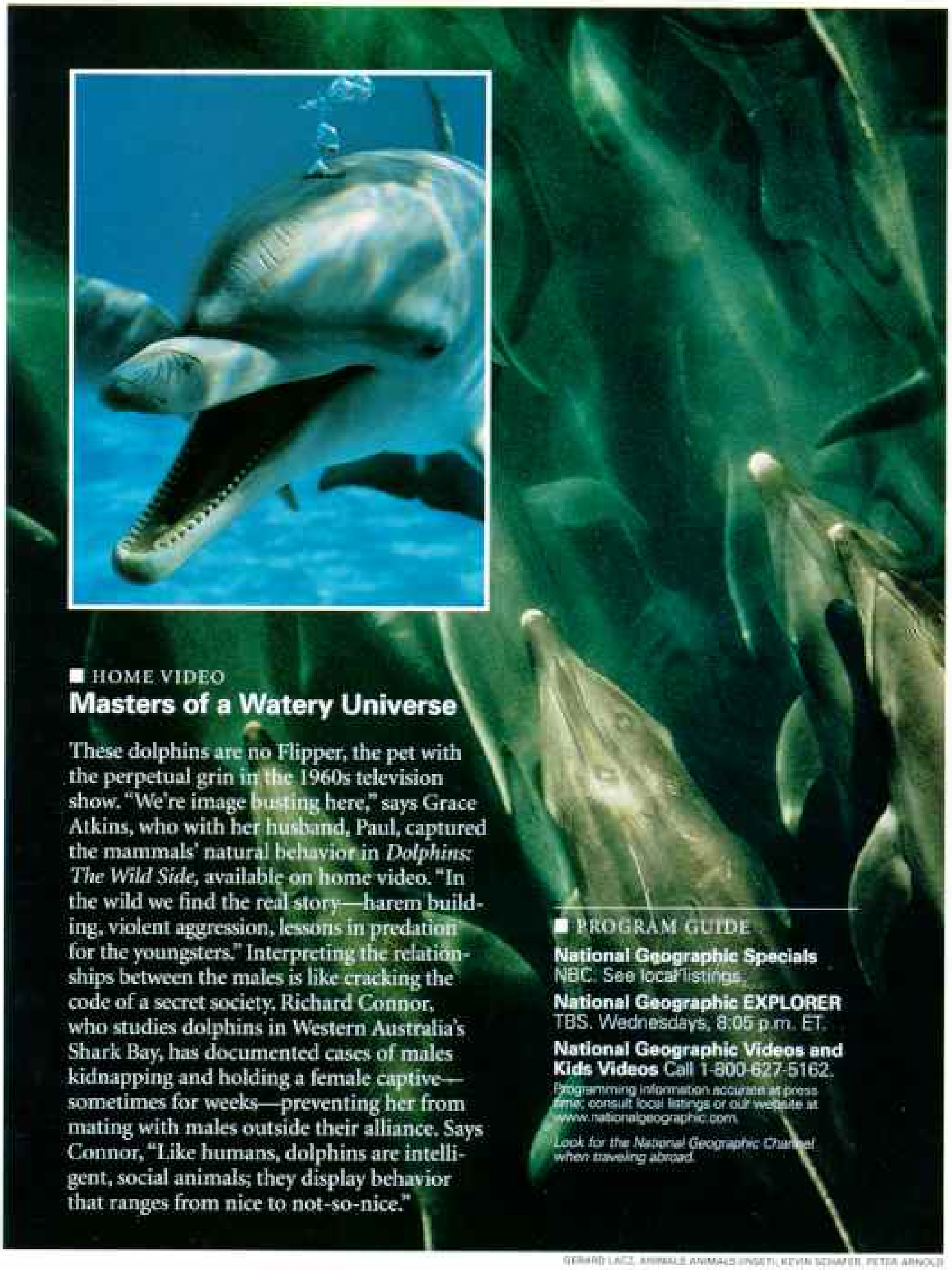
Western Lowland Gorilla (*Gorilla gorilla gorilla*) **Size:** Height, 150-170 cm **Weight:** 90-180 kg **Habitat:** Tropical lowland forests in central west Africa **Surviving number:** Estimated at fewer than 100,000
Photographed by Richard G. Ruggiero

WILDLIFE AS CANON SEES IT

Foraging along a forest river, a silverback western lowland gorilla selects the nutritious stems of streamside sedges. The lowland gorilla's diet consists primarily of terrestrial herbaceous vegetation. But because they prefer ripe forest fruits such as figs, family groups range widely to find them when seasonally available. This western subspecies had long remained isolated due to its remote habitat. Increasingly, however, forest destruction, new roads, and the illicit commercial bushmeat trade threaten the long-term survival of the western lowland gorilla. As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.



■ HOME VIDEO

Masters of a Watery Universe

These dolphins are no Flipper, the pet with the perpetual grin in the 1960s television show. "We're image busting here," says Grace Atkins, who with her husband, Paul, captured the mammals' natural behavior in *Dolphins: The Wild Side*, available on home video. "In the wild we find the real story—harem building, violent aggression, lessons in predation for the youngsters." Interpreting the relationships between the males is like cracking the code of a secret society. Richard Connor, who studies dolphins in Western Australia's Shark Bay, has documented cases of males kidnapping and holding a female captive—sometimes for weeks—preventing her from mating with males outside their alliance. Says Connor, "Like humans, dolphins are intelligent, social animals; they display behavior that ranges from nice to not-so-nice."

■ PROGRAM GUIDE

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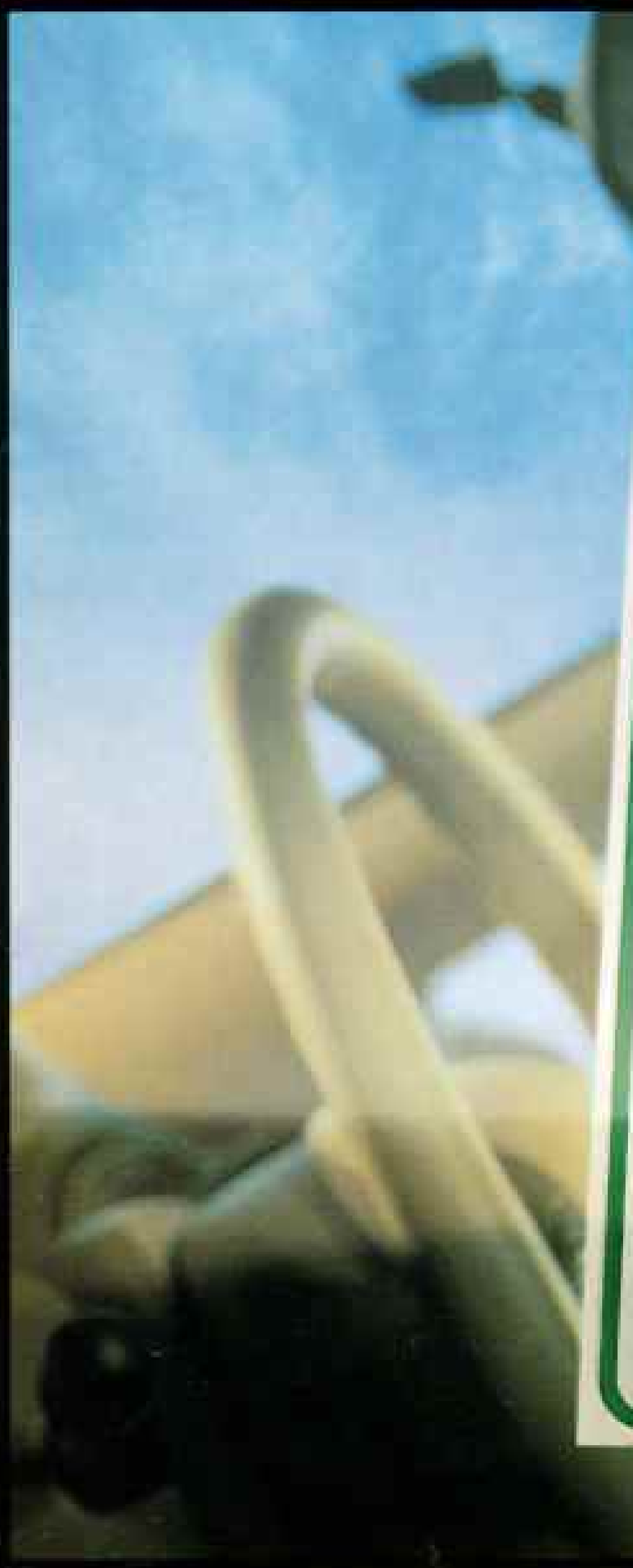

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1996 Car and Driver "10Best"†
1996 J.D. Power and Associates "Most Appealing Minivan"*
1995 MotorWeek "Best Minivan"†
1995 "North American Car Of The Year"*
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1995 Automobile Journalists Assoc. of Canada "Car of the Year"*
1995 AutoWeek "Most Significant"†
1995 Kiplinger's "Best Minivan"†
1994 Kiplinger's "Best Minivan"†
1994 MotorWeek "Best Minivan"†
1993 MotorWeek "Best Minivan"†
1991 MotorWeek "Best Minivan"†
1991 Automobile Magazine "All-Star"†
1991 Kiplinger's "Most Improved"†
1990 Automobile Magazine "All-Star"†
1989 Automobile Magazine "All-Star"†
1988 Automobile Magazine "All-Star"†
1982 MotorWeek "Best Minivan"†

SAFETY AWARDS:

1997 Kiplinger's "First to
1996 Prevention Magazin
1995 Kiplinger's "First Fo
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1993 Prevention Magazin
1992 Prevention Magazin
1992 Kiplinger's "Safety
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VALUE AWARDS:

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1998 SmartMoney "A Sec
1997 Kiplinger's "Best Re
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QUALITY AND SAFETY AWARDS	17
Design and Engineering Awards	30

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NATIONAL GEOGRAPHIC

Earth Almanac

DAVID P. MAITLAND

Caribbean Crabs With a Newly Discovered Diet—Snakes

Many crabs are but humble scavengers. However, manicou crabs on the island of Tobago have a taste for live prey, such as this cloudy slug-eating snake, nearly two feet long. "They're sit-and-wait predators," says zoologist David Maitland of Scotland's Napier University, who is the first to describe the crabs' behavior. "They're extremely aggressive. They pick a spot in a stream, and if a snake comes near, they grab it with powerful claws. Their main diet is other manicou crabs—they're cannibals."

Mexican Wolves: Still Struggling

It's been a hard road back for the Mexican wolf, exterminated from the wild in the U.S. by 1970. In March 1998, 11 captive-bred wolves were released in southeastern Arizona. Though they adapted well, ominous problems arose. Five wolves were fatally shot, and two more are missing and presumed dead. Four of the victims belonged to the six-member Hawk's Nest pack, as did this male—among those shot. This year 13 more wolves are scheduled for release. A reward is offered for information about the killings.

MICHAEL J. TERRIO

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Deepwater Refuge for Deep Divers

Some 25 feet long and weighing about five tons, northern bottlenose whales have a favorite hangout off Nova Scotia, east of Sable Island. Sailors named it the Gully (right), a yawning submarine canyon

TOM NICKLIN

a mile deep in spots (GEOGRAPHIC, August 1998). It's the main habitat for 100 to 200 bottlenoses. They regularly dive to 2,500 feet and may stay down for more than an hour in search of squid.

The Gully may be rich in marine mammals, but a nearby undersea shelf also promises hydrocarbons. A natural-gas pipeline is being built from Sable Island to Nova Scotia, and it will eventually stretch to Boston. "Noise and contaminants from oil and gas operations could harm what we believe is a special ecological community at the bottom of the Gully," says marine biologist Hal Whitehead of Dalhousie University in Halifax.

Last year Canada's Division of Fisheries and Oceans declared 550 square miles of the Gully's depths a pilot Marine Protected Area. The government is working with conservation groups and industry—oil, gas, shipping, and fishing—while studies of the Gully's little-known marine life continue.

Choosy Squirrels Shape Oak Forests

Not all acorns are the same to squirrels, say biologists Michael Steele and Peter Smallwood. White oak acorns sprout in the fall, making them unsuitable for storing. The furry hoarders tend to eat them on the spot; those overlooked sprout near their parent tree. Red oak acorns don't germinate until spring. Squirrels bury them some distance away for winter food—but sometimes fail to recover them—thus helping red oaks disperse.

E.R. DEGGINGER, ANIMALS ANIMALS

United They Conquer

Argentine ants are spreading around the world. In South America colonies typically attack one another. But when the ants invade new territory, their behavior changes. In California they assault and displace local species like this harvester ant, yet their own colonies rarely clash, say David Holway and colleagues at the University of California, San Diego. Because they aren't fighting, they grow in numbers and form cooperative supercolonies.

TEXT BY JOHN L. ELIOT

MARC DANTZKER

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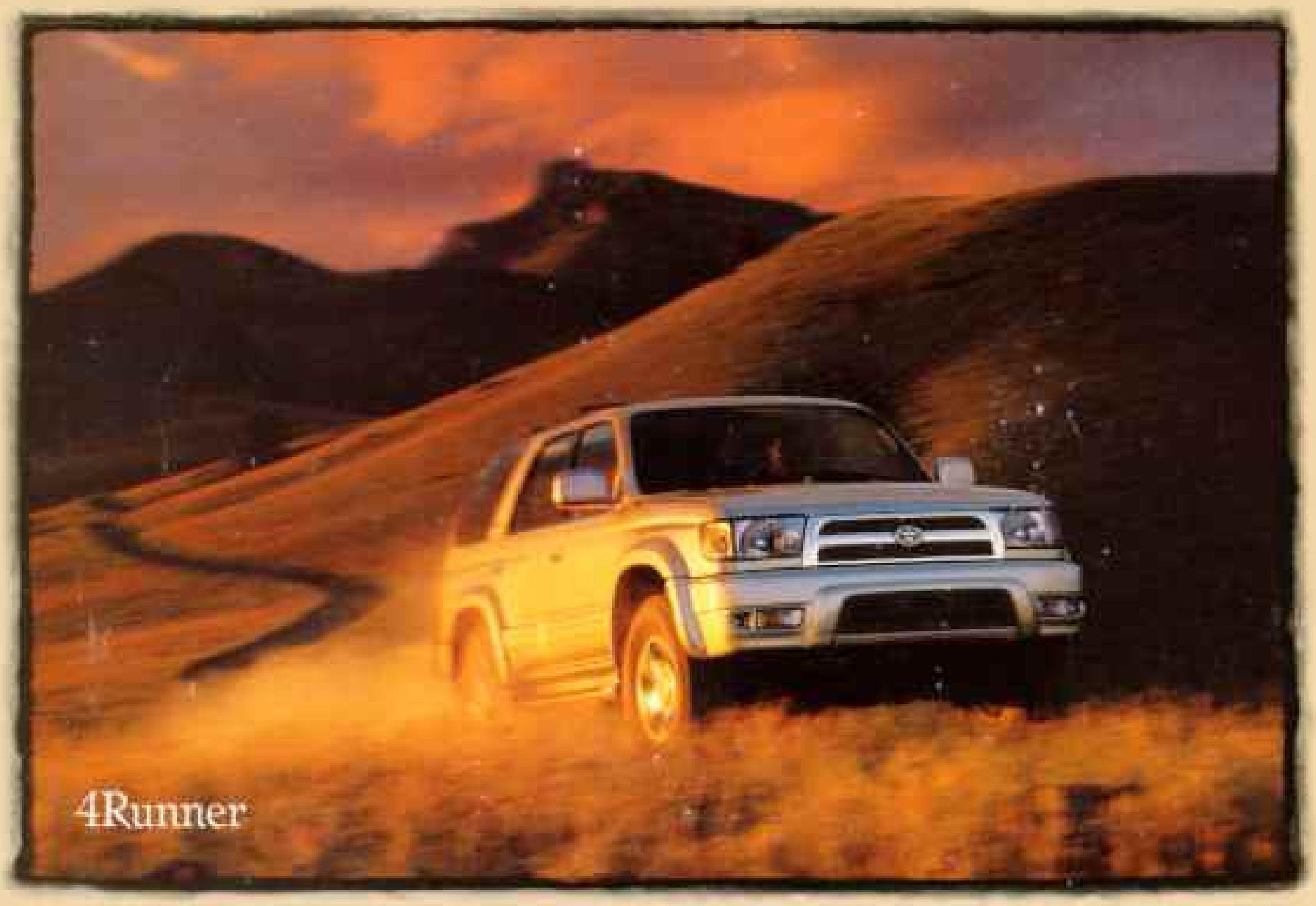

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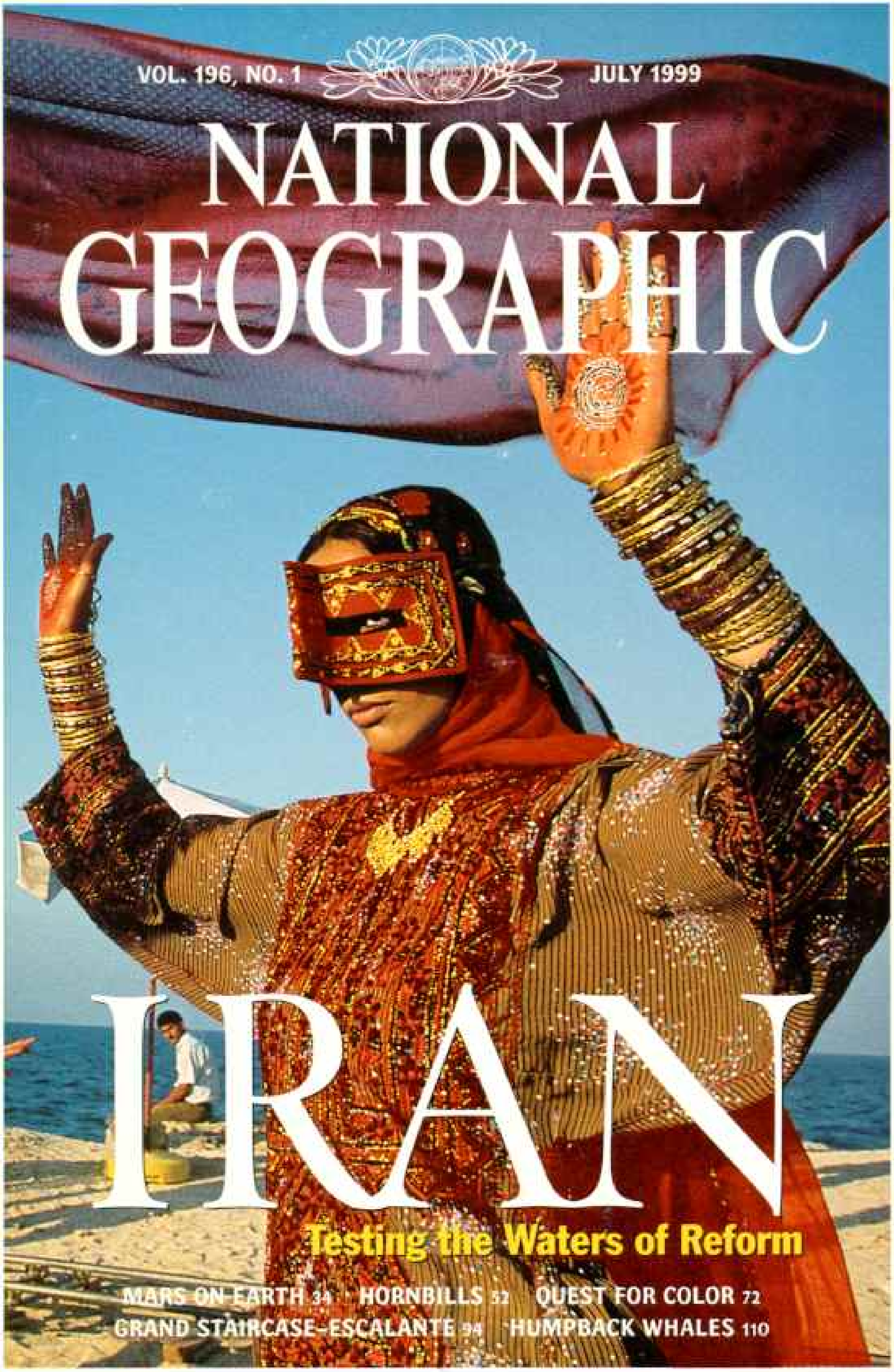
VOL. 196, NO. 1 JULY 1999

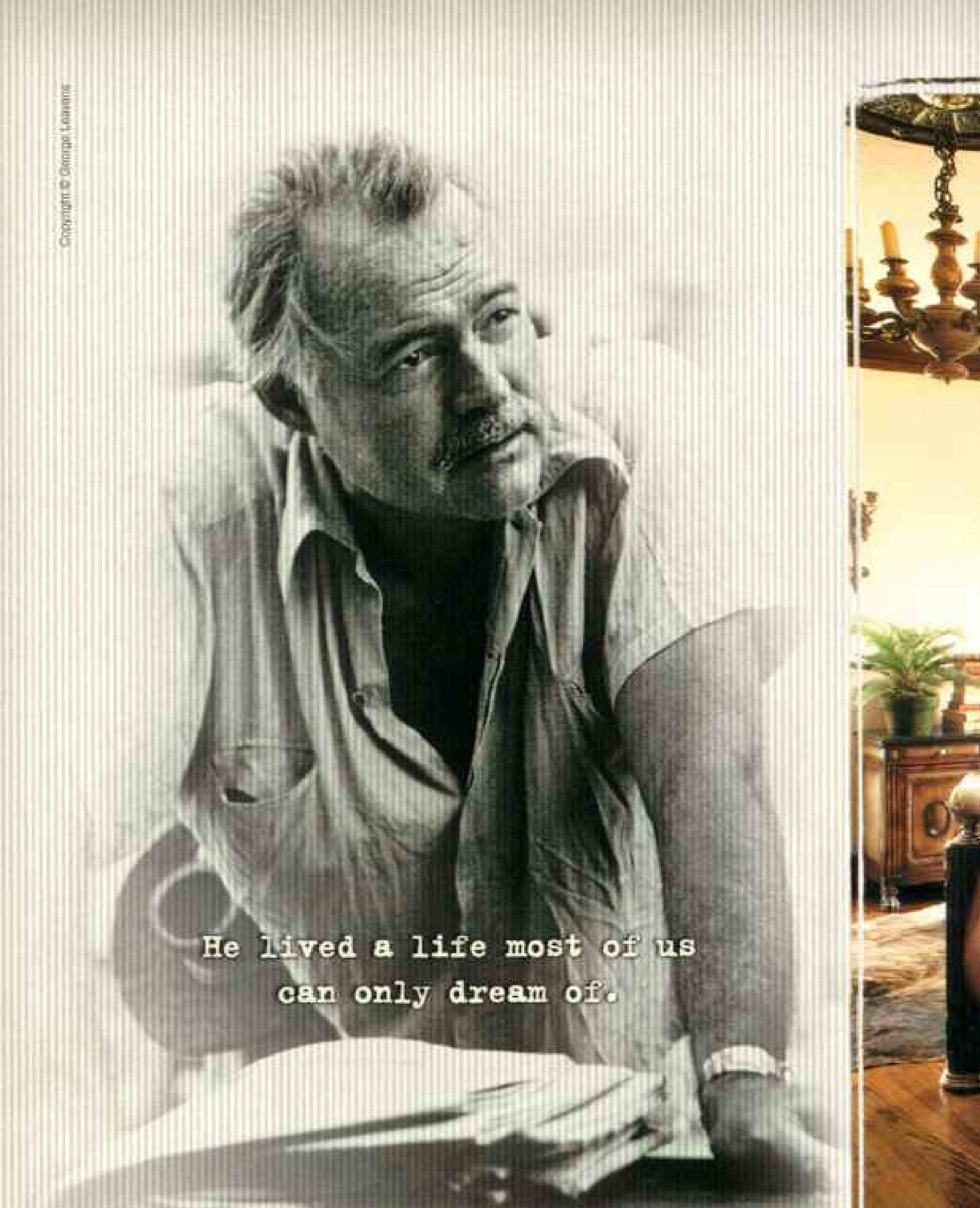
NATIONAL GEOGRAPHIC



IRAN

Testing the Waters of Reform

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.



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There are no holidays set aside to honor the highly efficient. No marble statues standing in tribute of the very reliable. Not even a single collector's plate commemorating the pragmatic.

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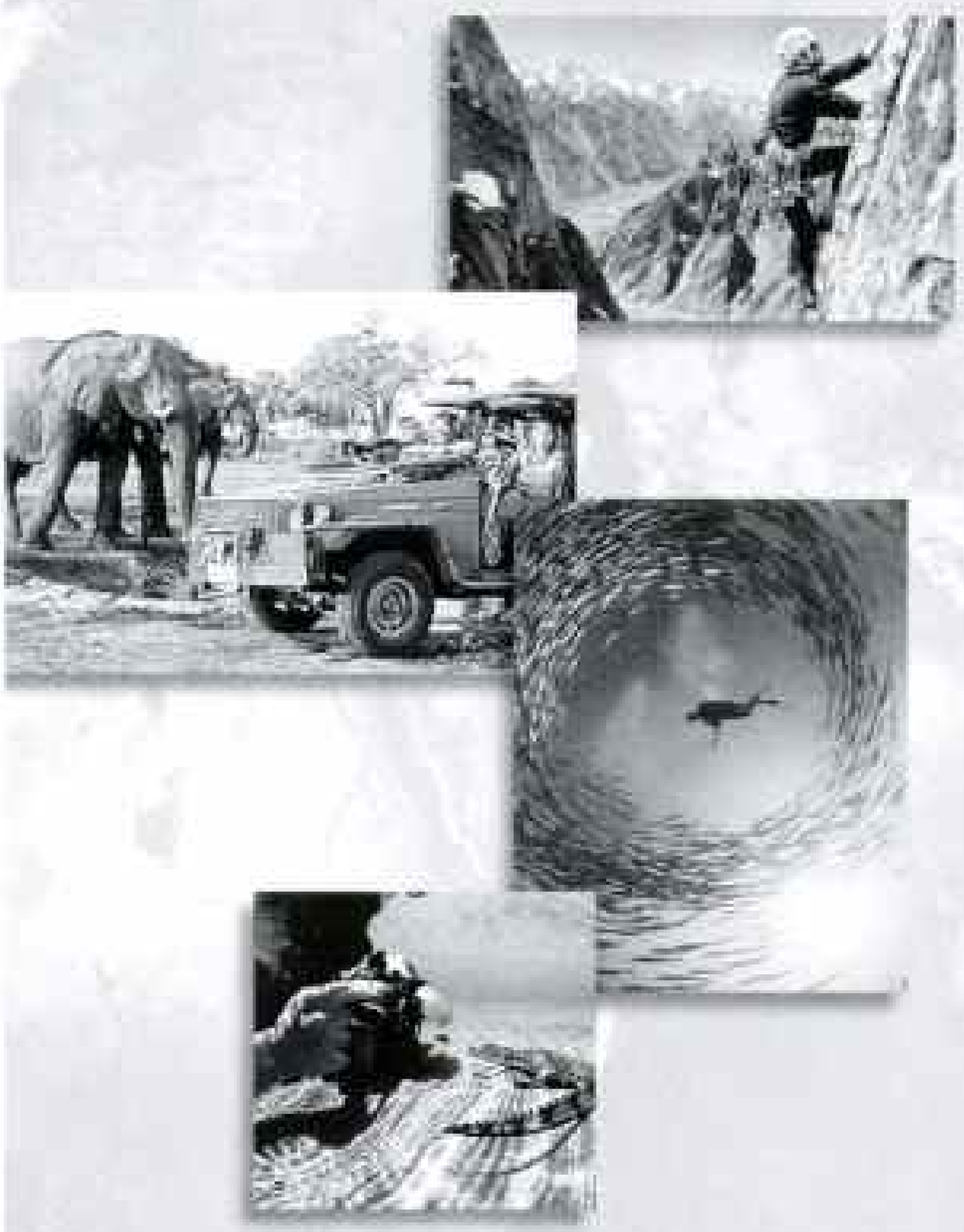

NATIONAL GEOGRAPHIC

The Great Adventurers

National Geographic's lecture series, *The Great Adventurers*, brings you face-to-face with some of the remarkable people who have been face-to-face with the world's wonders. Their stories will inspire you. Their photographs, astonish you. Join the adventure!

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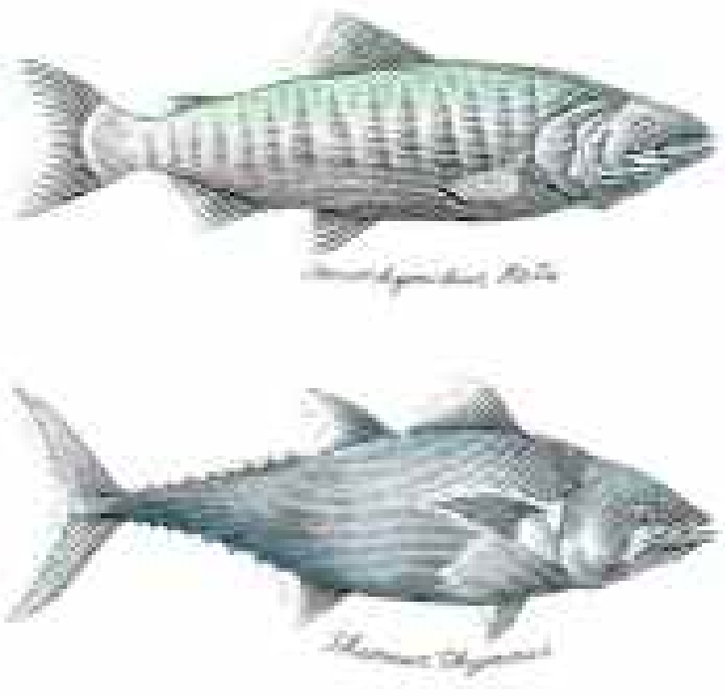

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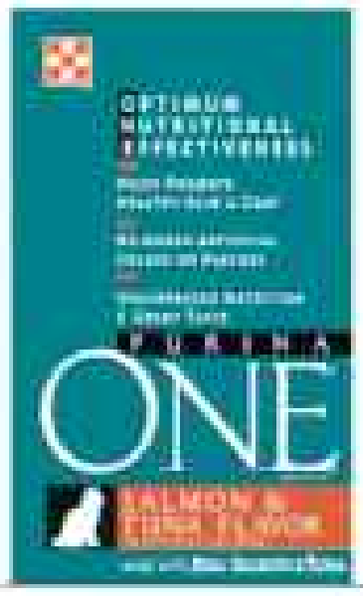

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NIGEL MARSHALL

■ FROM THE GEOGRAPHIC ARCHIVES

Bird's-eye View

A hunter uses his head—and that of an Abyssinian ground hornbill, *Bucorvis abyssinicus*—to stalk big game in northern Nigeria. He even moves like a browsing hornbill. "Only the headdress, which he has made of wood, leather, and beads, will be visible as he creeps through the bush to his unsuspecting quarry," according to the original legend for this photograph, which we published in May 1944 in an article by Helen Trybulowski Gilles. This turkey-size African hornbill rarely flies, and its call, said Gilles, "is a deep booming drum."

Gilles praised Nigeria's bird life as "varied, beautiful, and curious," but she was less impressed with the hornbill. "Rather offensive in appearance are the burutu birds, or ground hornbills," she wrote, dismissing the animal's eyelashes as "degenerate feathers."

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OR DID WE?

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POINT OF VIEW

BOTH BY TIM LAMAN

Window on a Hornbill Nest

I have long been intrigued by the work of Joan and Alan Root, who were the first to film hornbill females and chicks inside their unique walled-in nesting chambers (GEOGRAPHIC, December 1969). I wanted to adapt and refine their techniques in order to photograph great pied hornbills in Thailand. Before the nesting season I built a platform 80 feet up on the trunk of a tree, near a nest hole often used by hornbills. Through the rear wall of the nest cavity I cut an opening for the camera, built a wooden frame around it, and added a sliding cover. After making a canvas blind, I left and waited three months before returning. By then a female was inside with a four-week-old chick. To make photographs, I replaced the sliding cover with a pane of glass. Instead of shining light directly through the camera hole, as the Roots had done, I used a strobe placed in a hole three feet above, drilled three months earlier by Thai biologist Phitaya Chuailua (above, at right, beside me). One result was a portrait (left) of the female behind her huge six-week-old chick, neither aware of my presence.

—TIM LAMAN

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By Webmaster Raymond Steinbacher, and the research staff at Green Tree Press, Inc.

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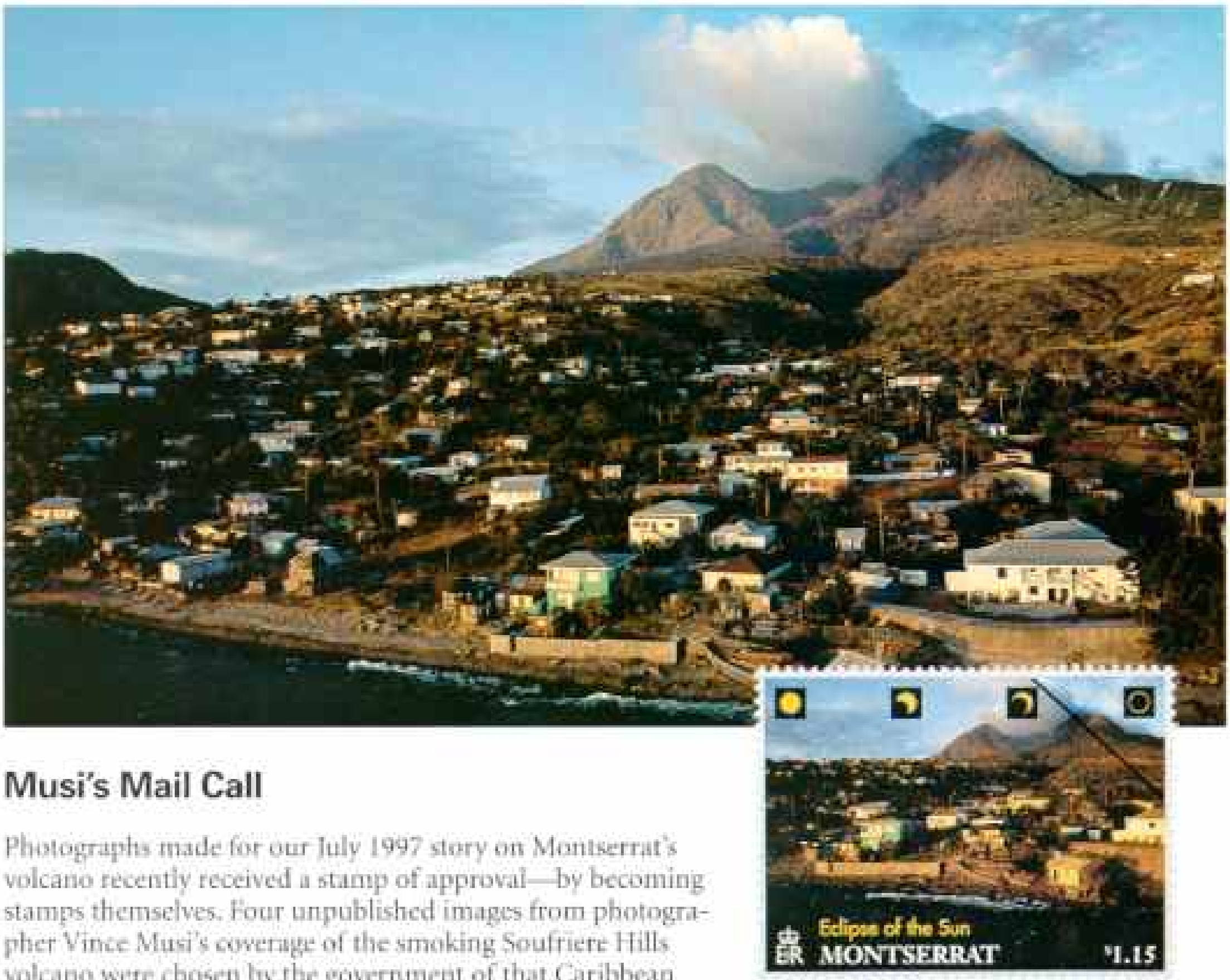

VINCENT J. MUSI (TOP)

Musi's Mail Call

Photographs made for our July 1997 story on Montserrat's volcano recently received a stamp of approval—by becoming stamps themselves. Four unpublished images from photographer Vince Musi's coverage of the smoking Soufriere Hills volcano were chosen by the government of that Caribbean island nation for commemorative postage stamps.

"It's a real compliment," says Vince, who collected stamps as a kid and whose photographer's credit on the stamp sheet's margin is a rare honor. It was also a surprise: His landscapes help commemorate an event he missed out on—the total eclipse of the sun witnessed by the island in February 1998. "I wasn't even on the island for that," he says, "although I was there for a lunar eclipse."

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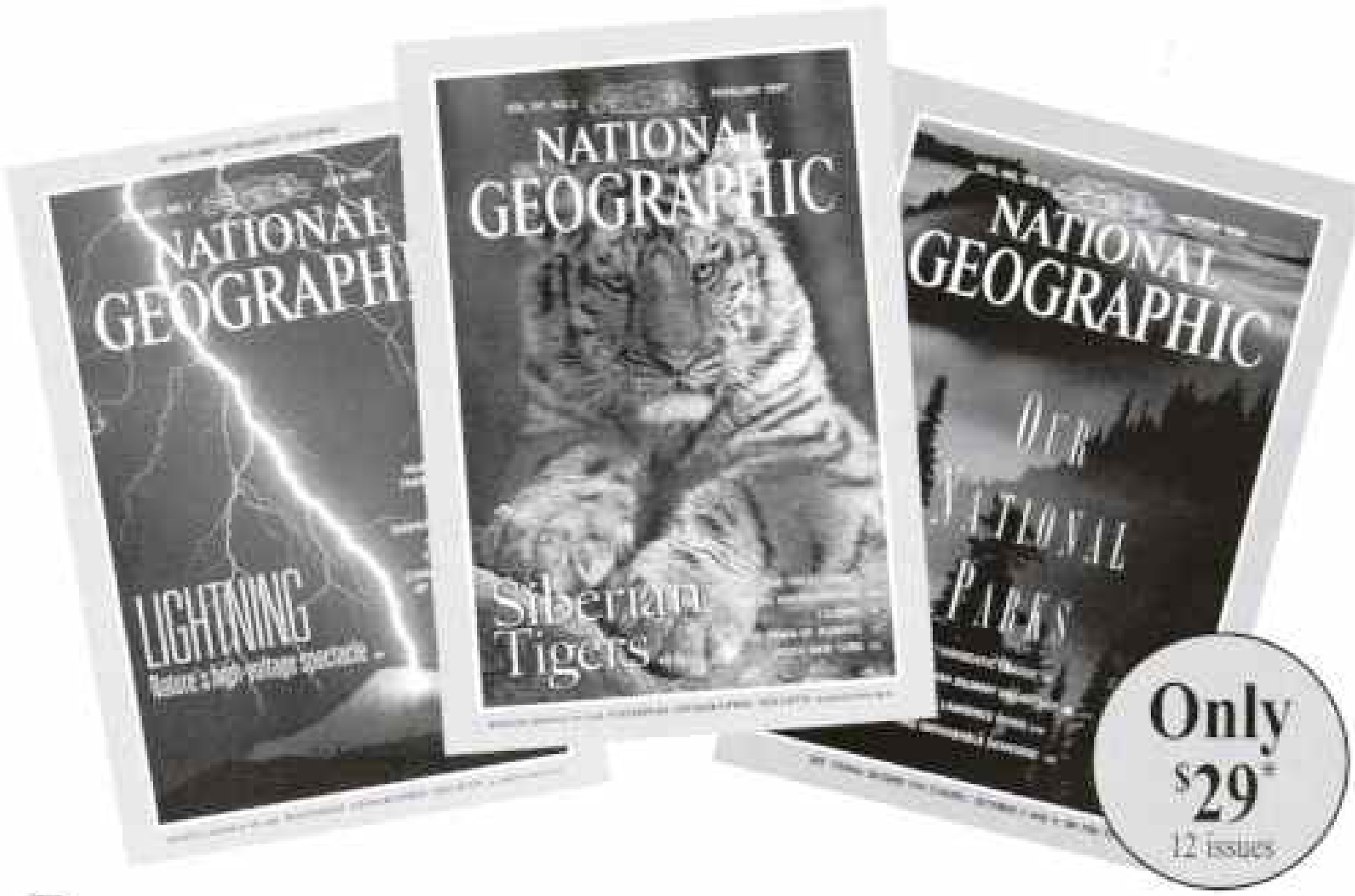

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NGAGV09

RICHARD THOMPSON

A World of Trouble

Even on their best behavior, our staff members sometimes run afoul of the law. While covering Ndoki in the Republic of the Congo, photographer Michael "Nick" Nichols was thrown into a dirt-floored, rat-ridden cell because he didn't have his passport with him when local police demanded it. He had sent it to the capital for a work-visa extension. Before help arrived 36 hours later, the police had distributed Nick's possessions among themselves. He got them back but "was never so glad to get out of anywhere in my life," he remembers.

Staff writer Ann Williams, traveling recently in Honduras, had trouble with traffic-control measures in Tegucigalpa after Hurricane Mitch. Her car, driven by a Honduran assistant, Paco, displayed odd-numbered license plates on an officially designated even-numbered day—allowable for journalists. On their way to the airport, Paco ran a police roadblock, then waved off an angry officer by pointing to his press badge. Ann spent a few nervous moments negotiating their release: "I never thought I'd be facing jail time over license plates."

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MEDFORD TAYLOR

Water Music for Jacques Cousteau

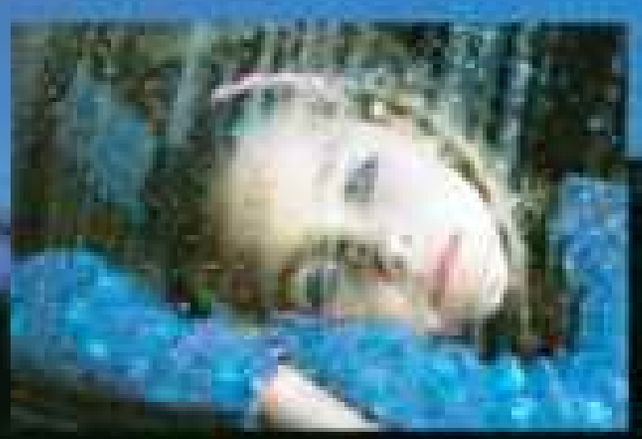
Composer Steve Heitzeg grew up on a Minnesota farm in the 1960s, far from any seashore. But National Geographic's TV Specials brought the ocean to him. "My idol was Jacques Cousteau," says Steve, whose symphony *Aqua (Hommage à Jacques-Yves Cousteau)* was performed in January by the Norfolk-based Virginia Symphony. The tribute features conventional instruments as well as a percussionist's turn on seashells (above), driftwood, and plastic six-pack rings.

JIM RICHARDSON

Colombian Call for Help

"The biggest need is for housing," says Colombian journalist Nora Correa, whose concern for victims of her country's January 25 earthquake prompted her to contact us. Nora saw a shot of flood-relief housing in North Dakota (above) in our July 1998 Latin American edition and felt the trailers would be perfect for the 150,000 Colombians left homeless. But where to find such housing? We put her in touch with the U.S. Federal Emergency Management Agency. "Now we wait and hope," says Nora.

TEXT BY MAGGIE ZACKOWITZ



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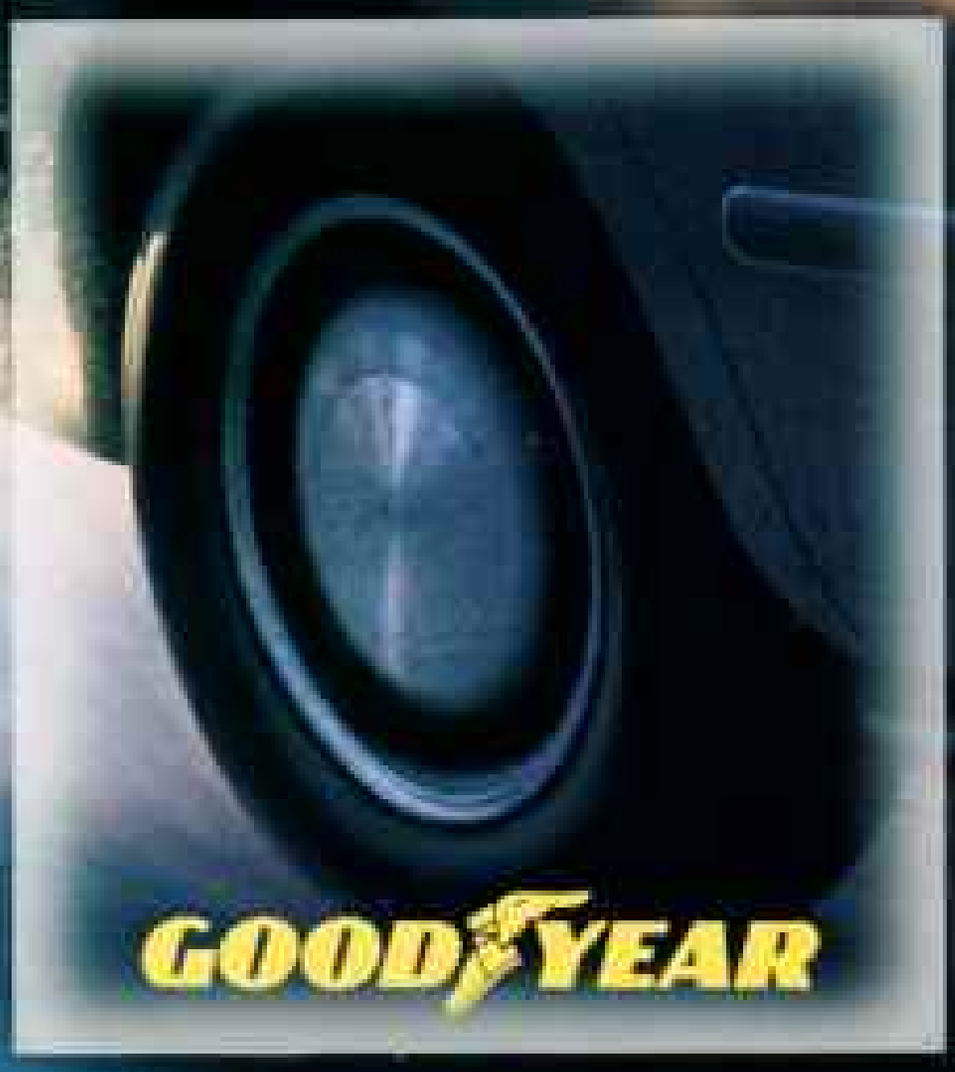

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Screens Worth Saving

The Society's website is celebrating its third birthday, and *you* get the gift: a screen saver with 15 National Geographic images. Refresh your monitor with glimpses of a Luvale ritual in Zambia (right), a charging elephant in central Africa (lower right), a baseball game in Texas (below), and more. Each screen includes information on the scene and the photographer. Get yours free at *www.nationalgeographic.com/download.*

■ What sort of people became pirates? Meet a sampling at . . . */whydah.*

■ A new generation is changing Iran. Read the article in this issue and offer your opinions at . . . */ngm/9907.*

CHRIS JOHNS, NGS (TOP RIGHT); MICHAEL NICHOLS (CENTER RIGHT); WILLIAM ALBERT ALLARD (ABOVE); MARTY SNIDERMAN

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■ TRIVIA TREK

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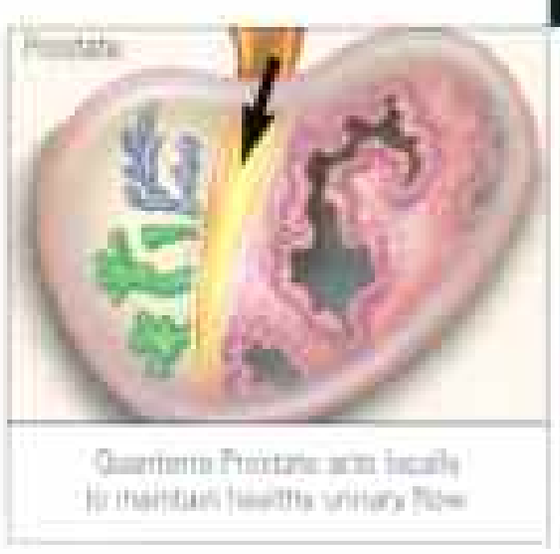

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