

DOUBLE MAP SUPPLEMENT: ALASKA

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# NATIONAL GEOGRAPHIC

ENGLISH CHANNEL  
TUNNEL 37

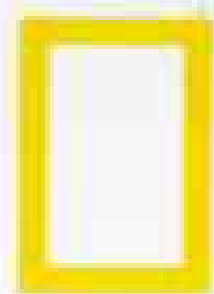
RICE, THE ESSENTIAL  
HARVEST 48

ALASKA'S SKY-HIGH  
WILDERNESS 80

MICHELANGELO'S  
"LAST JUDGMENT" 102

SIBERIAN CRANES 124

# TURKEY



# NATIONAL GEOGRAPHIC

MAY 1994

## Turkey Struggles for Balance

By Thomas B. Allen  
Photographs by Reza



*At the crossroads of Asia and Europe, this progressive Muslim nation strives to carve out a major role in a diverse region beset by post-Cold War turmoil.*

2

## English Channel Tunnel

By Cathy Newman  
Paintings by Ken Dallison

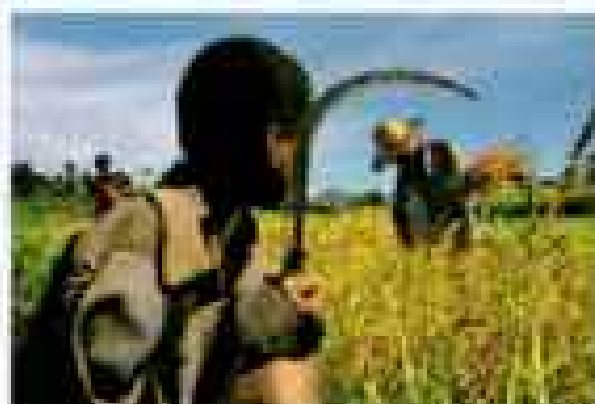


*Joining England and France in a marriage of convenience, the 31-mile-long "Chunnel" opens this month—and may shrink la différence between historic squabblers.*

37

## Rice, the Essential Harvest

By Peter T. White  
Photographs by Robb Kendrick



*Symbol of life, wealth, and fertility from ancient times, rice even today sustains half the world. Now scientists hope to reinvent the grain to wrest more food from less land.*

48

## Wrangell-St. Elias: Alaska's Sky-High Wilderness

By Noel Grove  
Photographs by George F. Mobley



*Only a handful of homesteaders, prospectors, hunters, and visitors tackle the unforgiving terrain of our largest national park. With a double map supplement of Alaska.*

80

## Michelangelo's "Last Judgment"

By Meg Nottingham Walsh  
Photographs by Victor R. Boswell, Jr.



*After years of painstaking restoration, the master's fresco above the Sistine Chapel altar is reborn in an explosion of color—an enduring testament to genius and devotion.*

102

## Siberian Cranes

By George Archibald



*Imperiled by hunting and habitat loss, these majestic birds soar miles high to wintering grounds in Iran, India, and China. Will the fight to save them succeed?*

124

*COVER: Whirling toward a mystical union with the divine, dervishes in Istanbul add their 13th-century traditions to the spiritual and secular mix that is modern Turkey. Photograph by Reza.*

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# TURKEY

*Struggles for Balance*



By THOMAS B. ALLEN

Photographs by REZA

Like a wrestler reaching for his opponent in a time-honored contest called *yağlı güreş*, Turkey—at once ancient and modern, democratic and authoritarian, Muslim and secular—is fighting to find its place in the world.



**Stormy weather** strikes the Bosphorus, the strait that separates Europe from Asia and divides Istanbul. Ever a crossroads of turbulent politics and intrigue, Turkey scrambles to reconcile its internal differences while defining its post-Cold War position amid unpredictable neighbors: the fledgling Black Sea and Turkic republics of the former U.S.S.R. and volatile Iran, Iraq, and Syria.





**Rifles mimic minarets** in the capital of Ankara at the April 1993 funeral of President Turgut Özal, architect of Turkey's modern economy. Empowered as guardian of the republic, the military in the past 34 years has seized control three times, then relinquished it to civilians. "Today the state seems to be working," asserts former president and retired general Kenan Evren. "The era of coups is finished."







## Along the coastal highway

Turkey's Black Sea towns are awakening to a sunny fall day. The roadside blurs by: mustachioed men and kerchiefed women, car wrecks and donkeys, chickens and cows, mosques and concrete mixers, laundry drying on a line, tobacco drying on a fence, bus shelters full of kids going to school and adults going to work. Then the traffic knots up, and we sit in the fumes and honkings of cars, trucks, minivans, tractors, buses, and motorcycles. Now Ümit Niron, my interpreter of Turkish words and sights and smells, can turn his eyes from the road and tell me what I see.

The schoolkids wear uniforms, blue smocks for the little girls and boys; shirts and ties, blue blazers, and slacks for the older boys. Most of the older girls wear white blouses and plaid skirts. Others are buttoned into long, dark blue coats, and they hide their brows under pale blue kerchiefs. "Religious school," Ümit says. "That is what the girls must wear."

Stuck in the traffic with us is a grimy, battered bus, its windows smeared with yellow paint. The Turkish buses I have seen all sparkled, inside and out. This

**Lighter than air**, a balloon lifts the spirits of children outside a mosque in the Eyüp section of Istanbul. Both the boy and girl wear the garments of Islamic fundamentalism, which resists the idea that a country can be Western as well as Muslim. To curb the influence of Islam after he founded the republic in 1923, Mustafa Kemal, or Atatürk, replaced Islamic law with a Swiss-based civil code. "The Republic of Turkey cannot be the land of sheikhs, dervishes, disciples, and lay brothers," he said.

one, Ümit explains, is not Turkish. It is a Russian bus, the rolling home of traders from former Soviet republics.

Men and women are climbing into tractor-hauled wagons. They are harvesters, heading to the mountains for tea, to the orchards for hazelnuts, to the fields for corn and sugar beets.

"We must go to a wedding," Ümit says. "The end of harvest is the time for weddings."

**J**OURNEYING THROUGH the rich weave of history and geography that is Turkey, I did go to weddings, and to mosques, and to Russian bazaars. In villages, cities, and factories and on farms and waterfronts, I found a nation on the move, led by Tansu Çiller, the first woman to become prime minister of this Muslim nation. She intends to build on the economic boom of the eighties, and, looking toward the future, she promises her people: "We will not walk, we will run."

As ever, Turkey is a bridge between Europe and Asia, between West and East (map, page 13). Today the bridge strains against waves of change. Jobless villagers pour into cities already packed with people and problems. New nations emerge where the mighty Soviet Union once loomed. Militant Muslims, within and beyond Turkey's borders, challenge Turkey's long-held determination to be a secular nation. And in the bloodstained southeast corner of the country the government hopes to win a guerrilla war against Kurdish separatists, using the energy and opportunities created by hydroelectric dams and irrigation

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THOMAS B. ALLEN has written numerous articles for the *GEOGRAPHIC* as well as nine books; this is his third article published this year in the magazine. Arduous assignments appeal to Paris-based freelance photographer REZA. His most recent story for the magazine was on Cairo (April 1993).

**Eavesdropping** on the world, a satellite dish serves up television shows in Istanbul (right), a cosmopolitan center of culture for centuries. Transformed at the birth of the republic, Ankara wears Western-style clothes and political posters. Driven by the

free-market economic reforms of the past decade, both cities have hustled into the passing lane. New highways take consumers to malls and Pizza Huts, while skyscrapers climb near subway construction sites and burgeoning suburbs.

canals. Here the outlawed Kurdistan Workers Party has been fighting since 1984 to form a Kurdish state.

"When I meet someone, I wonder in the back of my mind, is he a Kurd?" a government official in Ankara told me. "This is a sad by-product of the struggle."

Another is criticism of Turkey's human rights record in the southeast. A 1993 U. S. congressional report accused Turkey of acting under a "broad and ambiguous definition of terrorism" that authorized torture, permitted "use of excessive force against noncombatants," and restricted "freedom of expression and association."

Officials try to play down the troubles, preferring to talk about Turkey's role in the post-Cold War world. Home of ancient Greeks and Romans, heart of the Byzantine







**First woman** prime minister of Turkey, Tansu Çiller commands respect from top brass at an Ankara ceremony that marks the founding of the republic.

Civil rights reforms in the early years of the republic opened politics and other

professions to women. Yet until 1992 a husband had a legal right to forbid his wife to work, and women still handle most of the menial chores in the countryside. Discrimination, says sociologist Şirin Tekeli, is "embedded in the culture, the religion."

and Ottoman Empires, Turkey is claiming the right to lead a new economic domain stretching into Central Asia.

Out of that region came the nomads who settled in Turkey in the 11th century, establishing an Islamic realm in Christian Anatolia. Today's Turks speak a language akin to those spoken by people in five former Soviet republics—Azerbaijan, Uzbekistan, Turkmenistan, Kazakhstan, and Kyrgyzstan. Black Sea Turks can usually manage to understand people from a sixth, Georgia.

"The politicians call all those people 'our brothers,'" a Turkish journalist said as we

talked in an Istanbul café. "Turkey wants to be a regional power, and I quote, 'from the Adriatic to the China Wall.'" That was a phrase spoken by President Turgut Özal, who died in April 1993, just after completing a triumphant tour of Central Asia.

Turkey is promoting itself to these republics as the model of a modern, democratic nation. The president of Kyrgyzstan has said that Turkey is "the morning star that shows the Turkic republics the way." And in Tajikistan, where the language is Persian, one Muslim leader has urged his followers to emulate Turkey, not Persian-speaking Iran.

The brotherhood campaign is paying off. Turkey has formed an alliance on economic and environmental projects that joins together the six nations bordering the Black Sea, plus Moldova, Azerbaijan, Albania and two old enemies, Greece and Armenia. Another Turkey-fostered economic bloc brings together Central Asian nations, along with Iran and Pakistan. Turkey is also working on a scheme for a 663-mile pipeline that would carry oil from Baku in Azerbaijan to Turkey's Mediterranean coast. Oil-rich Kazakhstan would hook on later.

While Turkey declares solidarity with the

Muslims of Central Asia, it simultaneously seeks full membership in the European Union, formerly the European Community. Turkey joined the West during the Korean War as a United Nations ally and in 1952 became a member of the North Atlantic Treaty Organization (NATO). Turkey and its powerful army were welcomed as a buffer against the Soviet Union on NATO's far eastern flank. But, with the end of the Cold War, neither NATO membership nor alliance with the West in the Gulf War has earned Turkey complete acceptance in the European Union. "Europeans," a Western diplomat in Ankara told me, "do not see Turks as Europeans."

**W**HAT IS A TURK TODAY? The question went around the table of an outdoor restaurant in Ankara where Ümit and I were having lunch with several of his friends.

"I don't believe anybody is Turkish, whatever that means," he said. Then, swinging his arms to take in the lunch crowd, he exclaimed, "Look at us! A mix of Turks, Arabs, Jews, Greeks, Iranians, Armenians, Kurds."

This is the legacy of the Ottoman Empire, which lasted more than six centuries. Ümit's grandfather lived in what became Lebanon; when the empire collapsed after World War I, some of the family moved to Turkey, some stayed behind. "I have relatives I cannot talk with," he said. "My mother is Turkish, but her mother was from Romania." Another man broke in: "My mother is from Greece, but she speaks Turkish. My father was born in Georgia. . . ."

# TURKEY



AREA: 300,948 sq mi. POPULATION: 60 million. CAPITAL: Ankara, pop. 2.5 million. RELIGION: Islam (99.9 percent). LANGUAGES: Turkish (official), Kurdish, Arabic. PCB: \$2,620. EXPORTS: Textiles, metals, electrical equipment, fruits, nuts, cereals, and tobacco.



**Thundering out of Central Asia** in the 11th century, Turks battled the Byzantines across what is now Turkey. Under the Ottoman Empire they took Constantinople in 1453 and reached west almost to Vienna at the height of their European expansion (above). World War I put an end to the empire, clearing the way for Atatürk's republic.



Modern Turkey is the creation of Mustafa Kemal, or Atatürk, "father of the Turks." He led a war of independence against occupying powers after World War I. Creating a republic from the ashes of the Ottoman Empire in 1923, he tried to shape a Western country from this amalgam of cultures. He curbed the civil power of Islam, insisted that Turkish be written with the Latin alphabet, and guaranteed rights for women. Even today, 56 years after his death, the image of his stern, ascetic face is everywhere in Turkey. His bust looks down in parks and plazas. Paintings, photographs, and tapestries of Atatürk hang on the walls of offices and homes.

Many Turks I talked with believe that the nation's veneration of Atatürk helps defend Turkey against Islamic fundamentalism. So does prosperity. "If you have a little money, you live better," a magazine editor remarked to me. "It's true for a family—money helps keep it together—and for a country. It's difficult for fundamentalists to get anywhere because of the economic revolution."

For the past five years that revolution has produced the highest economic growth rate of any major European nation. It also triggered a 60 to 70 percent inflation rate. Despite their drastically devalued currency, most Turks I met are optimistic about the future.

When I tried to cash a traveler's check at a branch bank in a small city, I was ushered into the manager's office. He served me coffee and a chocolate candy, then sprinkled lemon cologne on my hands. He proudly told me this was the first traveler's check ever cashed in his bank. The bank was founded in 1863.

**W**E HEADED for a wedding in Findikli, on the eastern Black Sea coast, in the heart of the country of an ancient people, the Laz. Ümit slipped a cassette into the car's tape deck. Pounding drums and male voices burst from the speakers. Paced by the drum and backed by the wail of bagpipes, men tramped through a dance. The tempo increased. We heard background shouts and rifle fire and envisioned the Laz men's dance. "We may see that dance at the wedding," Ümit said. "But there will be no guns tonight because this wedding is in a town."

One of the wedding guests, a local businessman, led us to an outdoor pavilion on the edge of town. Under strings of lights young men and

**Passions blaze** as bright as the flares that signal a soccer goal at a stadium in Istanbul. Fenced off from the field, aggressive fans cheer, whistle, wave banners, and belt out bawdy slogans in a frenzy of support for their team.

Along with religion and politics, soccer has a hold on the heart of Turkey. Live TV broadcasts of big matches leave streets empty, and final scores make front-page news. Boosting Turkey's image abroad, the success of the Galatasaray team against European rivals is a point of national pride.

women danced to the rhythm of Turkish pop, an East-West music scramble. Elders sat at tables or occasionally tried a few turns around the dance floor. Women in kerchiefs refrained from dancing. The drink of the night was fruit juice, though at a couple of tables I did see Scotch being discreetly poured.

The kerchiefs and the fruit juice suggested Islamic practices to me, and I asked Ümit if there had also been marriage rites in the mosque. He seemed puzzled by the question but relayed it to one of the guests, who answered: The bride and groom were, of course, married at the municipal offices in a civil ceremony. The businessman vehemently added, "In Findikli you will notice that the voice of the muezzin is not loud."

Here, as in several other towns I visited, people measured the influence of Islamic fundamentalists by the decibel level of the man giving the five daily calls to prayer over the





mosque's loudspeakers. I realized that in Fındıklı I had barely heard him.

Islam, the religion of nearly 100 percent of the population, gives Turks their identity, though this is not the Islam of many other Muslim states. Again and again I heard the slogan "Turkey will never be Iran!" Secularism in Turkey is complicated. The government's department of religious affairs, for example, helps arrange trips to Mecca and pays the salaries of religious leaders. The ministry of education controls religious schools.

Enrollment in those schools has been increasing in recent years. The Welfare Party, which backs Islamic fundamentalism, has 40 seats in parliament and is reaching out to countryfolk who migrate to Istanbul and Ankara. The fundamentalists appeal to conservative Turks who decry what they call moral decay. Their targets include *Penthouse* and *Playboy*, both published in Turkish editions.

Around us, a dozen or so men began stomping, shouting, and singing the Laz song that I had heard on the tape. They threaded through the crowd and, arms grasping one another's shoulders, circled the dance floor. In the darkness beyond, someone fired a gun several times. Ümit smiled, as did several other men around me. Blanks, I thought. Then I saw the shredded leaves fluttering down.

The bride, Teşrife Ufak, broke into the circle of men, along with several other women, young and old. After a few whirls Teşrife decided she had had enough. She stepped out, waited for her new husband, İldeniz Ufak, and when he did not join her, tugged him away. Times have changed for the dance of the Laz men.

Teşrife and İldeniz are settling about 750 miles from Fındıklı, in a city near İzmir where İldeniz has a job as an accountant. Teşrife hopes she will find work in the same firm.





**Hours and minutes mean nothing** to a herder who changes pastures with the seasons near cloud-capped Mount Ararat, biblical resting-place of Noah's ark. A generation ago more than half the country moved to such timeless pastoral rhythms. Today, as rural residents migrate to urban shantytowns, 60 percent of Turks look for their future in the opportunities offered by cities.



Job migration is common even in the bustling Black Sea region, the source of nearly all of Turkey's tea and 70 percent of the world's hazelnuts. Mountains rise close to the sea. Hazelnut groves march along narrow flatlands and veer up the slopes. Rivers course through valleys crosshatched with stands of pine and gleaming green patches of tea. Each long, one-road valley is a world of its own, its timbered houses perched high and scattered far apart. Tea harvesters work fields so steep they sometimes sling tethered ropes around their waists to keep from slipping.

In a co-op factory at Giresun, west of Fındıklı, machines hulled and packed hazelnuts grown by 221,000 co-op partners who own orchards along the Black Sea coast. People say the hazelnut is the source of life around Giresun, but a teacher I met there said, "Our young men are workers without work. They work only three months—harvesting from morning to night. So they go to Istanbul and find work, or they go to Germany or France. But when a man wants to marry, he returns with money."

Near Rize, truckloads of tea tumbled into a plant for crushing, drying, sorting, and shipping. "In ten days we will be finished here, and the workers will go away until May," the plant manager told me. And what will the workers do then? "Sit in the coffeehouses and play cards," he replied. Some of the idled workers were landowners, who had earned enough money to while away the next six or so months. Others were not so lucky; they played cards and lived frugally because they had given up looking for jobs.

I went to several smoky coffeehouses (misnamed, since hardly anyone ever drinks coffee), watched the swiftly dealt card games, and over countless little tulip-shaped glasses of strong tea heard the men talk and talk and talk. About what bees make the best honey. About going to or coming from jobs in distant places. About politics (an intricate subject in the land that gave English the word "byzantine"). And about the Russian traders.

**T**HE TITLE of a popular song—"Natasha"—echoes the common name for one type of "trader." The song tells the tale of a Turkish man who lost his family to the wiles of a Russian Natasha, only to have her take all his money and coldly leave him. This has happened so often in real life

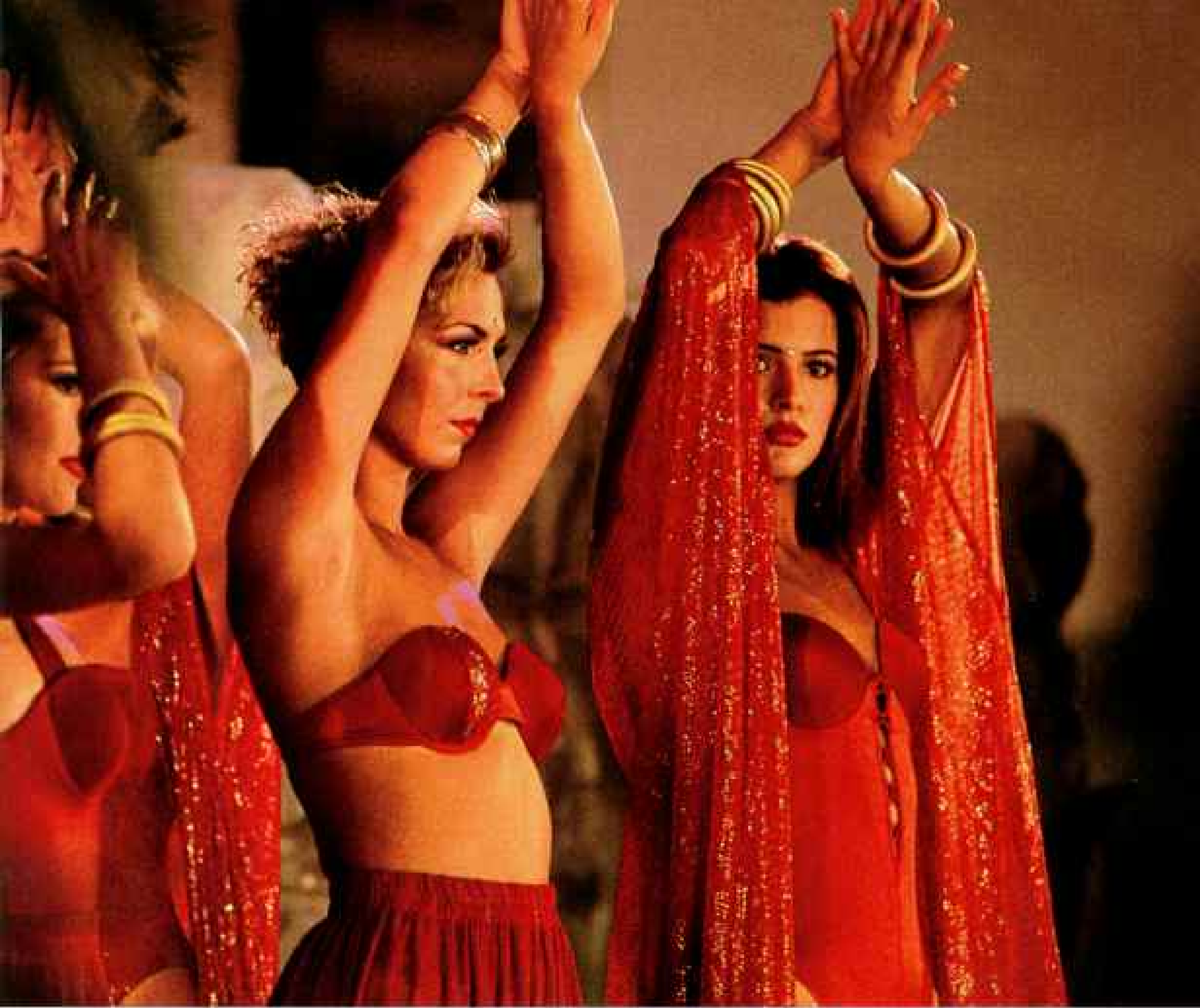
**Sinuuous moves** set the mood for the debut of new swimwear by an Istanbul clothing company. Top draw: U. S. star Cindy Crawford, who earlier joined local and foreign models on the runway. Other big names in fashion have also come to Turkey. American label Anne Klein II, for one, has used the skilled, cheap labor here to manufacture part of its line. Turkish clothing sells well in Europe too. Freer trade regulations should soon expand Turkey's share of that market and ease the way toward European Union membership.



that in some places Turkish women are working to throw the Natashas out of town.

"The Natashas I see are young, usually divorced, and need money for their children," a hotel owner in a Black Sea town told me. "They stay a few days and go back with some cash." He introduced me to Lily, who entered the hotel lobby looking at her watch. She said she was supporting a 12-year-old daughter in Georgia. Lily spends a month in Turkey as a tourist, then goes back to Georgia for 15 days and gets another tourist visa. She hoped soon to be able to stay in Turkey longer because, she said, "My boyfriend is getting me a special visa for trade." She looked at her watch again and, pale and shaky, hurried into the night. Like many Natashas, she had a steady client, a man who arranged for her to stay at the hotel until he summoned her.

Turks usually refer to Natashas and other border crossers as "Russians" whether they



come from Georgia, Azerbaijan, or the Russian Federation. These traders along the Black Sea coast are the vanguard of new economic partners. Turkey already is shifting trade away from Arab nations and looking east.

Most Russian traders begin their journey at what had been a Cold War frontier, the Turkish-Soviet border at the Black Sea. Turkey once confronted the Soviets at a checkpoint in the village of Sarp with a massive rolling gate. Now the gate, rusty and off its track, marks the porous border between Turkey and the Republic of Georgia.

Several long trucks, including two that once belonged to the Red Army, are piled high with logs destined for Turkey. Heading back to Georgia is a low-riding yellow car. A roped-down stack of packages totters on its roof. Boxes stick out where the windshield used to be. The driver peers around dozens of loaves

of bread. Behind him in the maelstrom is a rattling car stuffed with cartons of chewing gum and chocolate bars. These are the individual entrepreneurs, who drive alone because they are foolhardy or have paid off the predators on Georgia's roads.

Most of the "suitcase traders," as the Turks call them, pool their expenses—including protection money—and travel in tired old buses that carry their passengers and cargo to bazaars in every port along the Turkish coast. The men and women usually live on the buses while they spend a few days selling. They stand in covered stalls, offering a bewildering assortment of merchandise—from used door-knobs and Taiwan-made toys to Red Army generators and uniforms. They usually speak little Turkish, getting by with nods, frowns, and hand signals.

Reflecting their nation's brotherhood policy, Turkish shopkeepers tolerate the traders



and make money from them. "They usually buy a lot of food to take home, especially pasta and margarine," a Turk told me in Trabzon, site of a bazaar half a mile long. Across from the stalls another Turk had set up a travel agency for traders who did not want to ride a traders' bus. "The Russians don't like the Georgians," he said. "They feel safer on a Turkish bus."

Trabzon, a Black Sea port for at least 24 centuries, is a good example of the East-West bridge in action. At a dock there the bow of a Turk-owned ship gaped open to accommodate Russian buses. Driven onto the ship at the Russian port of Sochi, they had fanned out from Trabzon to ports as far away as Istanbul. A few days later the buses returned, presumably with richer passengers. By taking a round-trip sea route to Turkey, the Russian buses avoided "the bandits in Georgia," a ship's officer explained. And the ship holds far

more cargo than a bus does. Stacked around the dock were unmarked crates and hundreds of Turkish carpets covered with plastic.

Abdullah Malas, a Lebanese trader, was also using Trabzon as a bridge and safe harbor. "I prefer dealing in Turkey," he told me over tea. "It's dangerous across the border." He was awaiting a ship from Sochi carrying Russian iron, aluminum, water pipe, and electric cable. After Malas certified the cargo, the ship would sail on to Lebanon to pick up sugar, lemons, aspirin, patent medicines, and baking mix for the return voyage to Sochi. The barter transaction was only the beginning. "I am hoping for a deal on oil," he said.

**S**OUTH of the Black Sea coast, in the stone and solitude of Anatolia, is an older, poorer, and visibly Islamic Turkey. In villages and in large cities like Erzurum and Erzincan the voice of the muezzin is



**Alien cultures** invade an old bazaar in Şanlıurfa through television sets for sale in stall after stall. In ages past, such exotic contacts came with caravans that bore Chinese silk, Indian spices, and African ivory along trade routes spanning continents.

Now an electronic highway delivers ideas from afar. *Beverly Hills, 90210*, CNN, and the BBC reach even the most remote villages, and choices are booming—during the five months the photographer spent in Turkey, four new television stations started up.

very loud. *Rakı*, an anise-flavored alcoholic drink, rarely flows in public. Many women wear the hooded, full-length *çarşaf*. An ancient stillness fills even the sky; for days at a time I never heard an airplane.

This is what urban Turks call the countryside, the Turkey that was. When Atatürk founded the nation, about 80 percent of the people made a living working the land. In the 1970s and '80s, as the population rapidly swelled, more and more Turks headed for the cities and for foreign lands in search of jobs. Today cities and towns shelter 60 percent of the country's population, and two million Turks live in Germany alone. Turks who still toil on their land look like people of the past, families woven into a beautiful old tapestry.

Late one afternoon we drove out of Erzinçan and soon entered a high-walled valley dotted with olive trees. Layered rock gave way to scree and then to crags that loomed like

fortresses. We came upon a mosque and a cluster of houses that seemed to grow from the earth. We slowed down, and a boy suddenly appeared at the side of the road, holding out a basket of bittersweet cherries. When Ümit haggled over the price, the boy, Mustafa Altınsoy, said, "I'm a student. Don't cut my money." After a little more haggling, Ümit also bought the basket.

Toward the end of another day we were on a stony road that climbed a darkening mountain near the Black Sea coast. Somewhere in the mountains was Tülay Arın, the kind of teacher who gets kids like Mustafa ready for Turkey's future. I had last seen her at the main bus station in Ankara, waving to friends as she set off for her first job. We finally found Süleymaniye, the village she had gone to. It was not on my map.

We could see the silhouette of a small mosque clinging to a ridge. Nearby was the inevitable coffeehouse and the only phone in the village. Ümit asked a man for directions to Tülay's house. The talking stopped. Men eyed him suspiciously. He assured them he was a family friend, proving this by describing her father and his occupation. He then explained why I was there. After a discussion a village leader led us by flashlight down a muddy lane to the school supervisor. He pondered our request awhile, then took us farther down the lane to a substantial mud-brick house. There Tülay and another young teacher, Zehra Asan, were living with a family.

The main room was warmed by a wood-burning stove. A six-year-old boy shyly slipped in and out of the room. A grandmother sat in the corner. Two younger women sat on the floor snapping beans. Those three women, who never spoke, wore kerchiefs and voluminous skirts. The bareheaded teachers, who laughed and talked animatedly, wore jeans and jerseys.

Tülay and Zehra said they worked for the Ministry of National Education, which hires and assigns all schoolteachers. Tülay was teaching the fourth and fifth grades of the 130-pupil primary school.

But the walls of the school had cracked. Some people blamed a landslide; others, shoddy construction. Whatever, the school had to be abandoned. So the villagers had moved the desks, chairs, and blackboards into the only public buildings, the mosque and the coffeehouse.



**The full range** of a symphony concert carries to the top tiers of the Roman theater at Aspendos. "I could even hear the musicians' chairs moving when I was up there," says the photographer. Anchored in antiquity, ties to Europe pull Turkey's culture and ambitions westward. Its geography belongs largely to Asia, though, leaving the country uniquely balanced between the continents.





"We have not taught much yet," Tülay said. "But we will stay and teach."

Atatürk would approve of the jeans-and-laughter teachers. He wanted women liberated from the Islamic veil, and he led the fight to win them the vote in 1934.

On a plane flying out of Ankara one day I met Filiz Eyemir, an English-speaking law student. When I asked her about the number of women in her classes, she thought for a moment and replied, "About half." Seeing I was surprised, she added, "It is not remarkable." Some 20 percent of Turkey's lawyers are women, and the number is increasing. When Filiz completes law school, she plans to practice for three years and hopes to become a judge, a post that not too many years ago would have been barred to women.

Atatürk wrote sexual equality into the new constitution. But his nation was still rural and illiterate; civil rights meant little to women working the land. Today, with a literacy rate around 80 percent, a rapidly urbanizing Turkey is seeing an equally rapid change in the status of women.

Women hold key editorial posts on Turkey's major newspapers, distributed nationwide out of Istanbul. Ferai Tınç, foreign editor of *Hürriyet*, directs 13 foreign bureaus, staffed almost entirely by men. Most of her newsroom editors are women. "To work in an office requires more patience." She glanced toward the women around her and added: "But you get less money."

I asked Nurcan Akad, the news editor, if she has any problems handling male reporters and editors. "Maybe the men have difficulties," she replied. "But I don't."

**T**HE TURKEY OF THESE WOMEN is a nation of cities and change. But in the heartland of Anatolia, modern life vanishes in the dust of dirt roads. This land is so cherished that many Turks call their nation Anatolia instead of Turkey. But Anatolia's antiquity and stark splendor have made it a wondrous place to visit, not to live in.

In the province of Cappadocia, spires and pitted cliffs rise from the tawny soil. Eons ago volcanoes erupted porous rock, which filled this basin. Water and wind wore away much of the rock, leaving a moonscape—pinnacles, cones, towering toadstools, and melting pyramids.

We made our way through Cappadocia's

**A river of possibilities** comes to the thirsty region of southeast Turkey with the waters of the Tigris. Along the waterway's upper reaches, and those of the Euphrates to the west, a 32-billion-dollar system of dams now being built promises to invigorate the land with irrigation and electricity.

Flowing south, these rivers gave life to ancient Mesopotamia, watering the fields of grain that fed great city-states. Today they nourish Syria and Iraq, which wonder—despite Turkey's assurances—if their neighbor would ever turn off the tap.

busiest area, passing tourists, most on buses, a few on bicycles, a couple on horses. Ümit searched through his cassettes and chose a Bach Mass. It seemed fitting in this land where Christianity was cradled and monasteries were burrowed into cliffs. We left the highway and bounced along a dirt road. In an arid field women were clearing the land of rocks, piling them up in an endless chore. The car bumped along a steep, rutted track that ended the road to Bozcayurt, a village sprawling across a shallow valley.

"The tourists do not see this," Ümit said, pointing to the fuel for the coming winter: disks of dung drying on the roofs and walls of squat mud-brick houses. Bozcayurt's water came from four fountains, one downstream from a brook bridged by a privy. "These are people who get by selling a little wheat and potatoes. The school here was declared unsafe in 1974. They didn't get a new one until 1989."





Several men sat on chairs outside a hut that served as their coffeehouse. None of them were drinking tea. Few had cigarettes, though most Turkish men puff on them incessantly. Two men insisted on giving up their chairs to us. Someone spoke sharply to a boy, who hurried off and soon returned, scrubbed, hair slicked, and in a clean shirt. He presented us two glasses of tea.

Men told of trying to find jobs elsewhere in Turkey and in Germany and drifting back to Bozcayurt. One of them kicked at the straw-flecked dust and complained about a government plan to get them to abandon the village. Later, on a road at the edge of the village, Ümit spotted his friend Şevki Bacık, Bozcayurt's village *muhtar*, an elected leader. Şevki spoke for a moment with a woman at a nearby house, and she invited us in for a lunch of cheeses, olives, ground lamb, bread, and tea.

Şevki explained that he was trying to gather

three villages together to make a municipality, which would get government money that a mere village cannot get. "We have no water, no income, no sewers, only one phone at the post office," he said. "We are 250 kilometers from Ankara, and we are living as if in some earlier age." As a municipality the combined villages would gain a middle school, a clinic, waterlines, toilets, sewers—and the 30 government jobs that would come with the new services. "We shall live like humans," he said, looking at the silent hostess who was sharing her food with us.

Bozcayurt is on the front line in Turkey's struggle to keep people from leaving the countryside in search of a better life in cities. Government policy aims at improving village life to stem the urban migration. But tourists do not want to visit places that lose the rustic look of dirt roads and earthen houses.

To retain both tourists and villagers, the

government is trying in some places to preserve the picturesque while helping people make a living. In the mountain city of Erzurum, for example, the local public university runs a carpet school for 12- to 18-year-old girls. Village girls move to Erzurum and usually stay with relatives while attending the school. As carpet weavers the girls preserve a Turkish heritage, produce something tourists want, and learn a craft that will earn them money and perhaps keep them in their villages.

In Ümit's village, Güzelyurt, many of the 3,700 people live in the past, their hillside homes carved from Cappadocia's wondrous rock. I felt a deep peace in this place of narrow streets and wandering sheep. One hot afternoon I was sitting on a shady stone wall when a gate opened behind me and a smiling man presented me with a cup of cool *ayran*, or yogurt and water. Then another gate opened and his neighbor emerged, also smiling, also bearing *ayran*. They stood silently there, enjoying with me the presence of the ages. For those few moments I was untouched by the 20th century.

The cliffs in Güzelyurt's Monastery Valley are riddled with tiny churches hewn from rock untold centuries ago. Tourists now get to the valley on a new paved road. Ümit knows that Güzelyurt needs tourism to survive. But he is no longer sure that he wants to be buried in the graveyard that spills down the slopes of the valley. "All those buses going by," he told me. "I don't think I would like that."

**T**OURISTS ARE RARE in the southeast, especially in the capital of the region, Diyarbakır. It should be a tourist attraction. Walls of black basalt, built in Byzantine times, surround the city, which is also famous for its many beautiful mosques. But Diyarbakır, a Kurdish city, is as embattled now as when Romans fought the Persians here. Military helicopters buzz overhead, and armored personnel carriers rumble down the streets. Thousands of soldiers pass through the old wall's gates to fight in the mountains against the gunmen of the Kurdistan Workers Party—known by the initials PKK.\*

In a 12-month murder campaign against government employees, PKK terrorists killed 50 teachers in the southeast. Hundreds of schools have been closed. In village firefights

\*See Christopher Hitchens' article on the Kurds in the August 1992 *GEOGRAPHIC*.



**Panic takes over** a street party as Kurds celebrating Newroz, their New Year, flee from Turkish forces in Cizre (above). The next day plainclothes police nab a young Kurd. Security details often disrupt expressions of ethnicity in the southeast, stronghold of the PKK, or Kurdistan Workers Party, which has

waged a ten-year war for an independent Kurdish state.

Yet many of Turkey's 12 million Kurds simply want official recognition of their ancient culture. Rooted in a community that stretches into Syria, Iraq, and Iran, they have blended into Turkish society throughout the country.





**Tracer bullets blaze** past the photographer's hotel window as police and the PKK exchange night fire in Cizre. After more than an hour, the army joined in with mortars. Dawn revealed civilians wounded and homes destroyed. "This happens nearly every night. When the sun goes down, the shooting starts," says a Turkish journalist. "Both sides are making a psychological war."



between PKK gunmen and soldiers, many women and children die, and each side blames the deaths on the other. "Very paradoxically, very ironically, the PKK is not helping the situation," a foreign ministry official told me. "They have taken the lives of 8,300, and this is probably pushing the silent majority of Turkey's Kurds away from the PKK."

About 12 million of Turkey's 60 million people are Kurds, according to government estimates. They live throughout the country, with four or five million in the southeast and most of the rest in Istanbul, Ankara, and İzmir. Kurds are found at every level of society. The foreign minister is Kurdish; of the 446 active members of parliament, 118 are Kurdish. But most Kurds are on the bottom level.

Nurullah Bülbül, director of the police quick-reaction force in Diyarbakır, has seen the PKK down the sights of a gun barrel. "If they shoot at us, we shoot at them," he said. "If they surrender, we arrest them and try to get information from them." He paused. "We have a law. If someone has made an action that should be punished and says he's sorry, the government does not punish him — if he gives information."

The government could wipe out the PKK in days, he believes. "But if we do, we have to kill our own people. That's why it's been going on for ten years."

The PKK demands an independent Kurdistan — a word that cannot be legally uttered in Turkey. (I talked to a journalist in Istanbul who was threatened with a jail term for using the word in a speech monitored by government agents.) This unlikely country would take territory from Turkey, Syria, Iraq, and Iran.

The PKK gets its strength not so much from promising nationhood as from blaming the government for the poverty in the southeast. "The PKK can say, 'Look, the government has done nothing for you.' And there is danger in that," a foreign ministry official admitted. "If there were new jobs, water, better roads, it would be harder for the PKK to function."

He was referring to the promise of the Southeastern Anatolia Project (GAP in Turkish initials), one of the largest public works efforts in the world. By tapping the Tigris and

Euphrates Rivers, GAP's irrigation system will carry water to 9.5 percent of the land area of Turkey.

Two of the 19 hydroelectric plants already are producing electricity. The keystone to the project, the great Atatürk Dam on the Euphrates, is one of 22 dams of GAP, which is expected to be finished in 2005.

As GAP planners see the future, agricultural production will increase about 60 percent, and rural people will stop migrating to cities. And some places will drown so that others may prosper.

One of those doomed places is Hasankeyf, built amid the ruins of cities going back to Roman times. The modern town stretches along a great bend of the Tigris, about 60 miles southeast of Diyarbakır. An arch and huge stumps of a vanished stone bridge rise from the river.

The city's history climbs a steep rock valley. One slope is pocked with chambers and tunnels, a warren of homes until recent years. A path on the other slope leads through a great ruined gate to the remnants of a 12th-century palace. The path winds past a family's cavern home to the top of a cliff. There, in a chamber revered as a miraculous tomb, believers bring their sick. There is about this height an old air of sanctity.

Mayor Eşref Başaran of Hasankeyf had a pistol jammed in his belt when I walked into his office. In these hills the PKK is never far away. He is a sad-faced man. "As a Turk and as a human being," he said, "I want to stay here for my children and my grandchildren. Something has to be done to save the village."

**P**RESERVATIONISTS throughout Turkey, urged on by the ministers of tourism and culture, are trying to rescue Hasankeyf. But when I talked to the visionaries of GAP, they saw little hope.

"Takeoff!" a young analyst said. "We are in takeoff! That dam is at the best site in terms of hydroelectric power generation."

GAP regional headquarters — workers call it the campus — is near a buried city that fostered trade around 2600 B.C. Here too is Şanburfa, traditionally the place where Abraham

**The road to matrimony** takes a bride and her relatives over rough ground near the Mediterranean coast. Such unspoiled countryside attracts tourists, mostly from Europe, who bring several billion dollars to the economy each year despite apprehension over Turkey's civil unrest.









**A brief peace** steals across a cemetery as Cizre residents visit the graves of loved ones during Ramazan Bayramı, a Muslim festival of friendship and reconciliation. Many of the newer stones commemorate those killed in hostilities over Kurdish separatism, Turkey's most serious domestic problem, which claimed nearly 2,000 civilians, soldiers, and PKK fighters in 1993.

**Backed by** the full authority of the Turkish flag—symbol of Atatürk's efforts to bring order to fragments of a defeated empire—a policeman keeps the crowd in line at a political rally in Istanbul.

Today's leaders of

government face a similar, if broader, challenge in fulfilling Atatürk's vision: to control the forces that could undermine Turkey's future as a progressive, pluralistic nation playing a central role in international affairs.

began his trek to Canaan. And when the water flows through the Atatürk Dam's giant tunnels, the first fields to be irrigated will be at Harran, near the Syrian border. Local legend holds that Adam and Eve, expelled from Eden, learned to farm there.

Bright, inquisitive people live and work on the campus, racing time to change the future. A Kurdish businessman now living in Ankara told me what that future means to him: "When I was young and looked at Syria, I saw lights, and I looked at my land and I saw desert. Now it is Syria that looks at our land and envies us."

GAP's planners believe that with dams and power plants they are building a new Turkey. There will be new Turks too. At the campus dining hall I met Adnan Akçay, a sociologist. He specializes in transformation, a word—like "terrorism" and "traffic"—that burrows through Turkish without translation.

"The three legs of Turkish society—I am a Turk, I am a Muslim, I am a male—are all being torn down," he says. "GAP is one of the transformers."

Transformation challenges every aspect of Turkish tradition, Akçay says. But his focus is on farmers in the southeast, where some landowners act as Ottoman feudal lords, controlling people by controlling land. By bringing modern farming to the region, he believes, GAP will transform countless rural lives in ways beyond imagination.

Istanbul, Ankara, and other major cities are also transformers, changing Turks of the land into urban citizens in need of jobs. If today's population and employment trends continue, one out of every two or three urban migrants will live in shantytowns.

The Turks call the dwellings *gecekondu*, "built in the night," a remembrance of an Ottoman law that said no one could tear down



a house begun at night and finished by dawn.

Istanbul's treasures—the Topkapı Palace, Hagia Sophia, the Blue Mosque—give it glory, but this is a smoggy city paralyzed by traffic and a population nearing eight million. The storied Bosphorus stinks on days when wind and heat conspire. Someday Istanbul's sewage-treatment plant, one of the world's largest, will be finished. And someday the subway system will be finished.

But there is no transformation in sight for the *gecekondu* neighborhoods, which lie far off the tourists' path. About a 45-minute taxi ride from the center of Istanbul is a *gecekondu* sprawl along a ridge. Across the valley towers

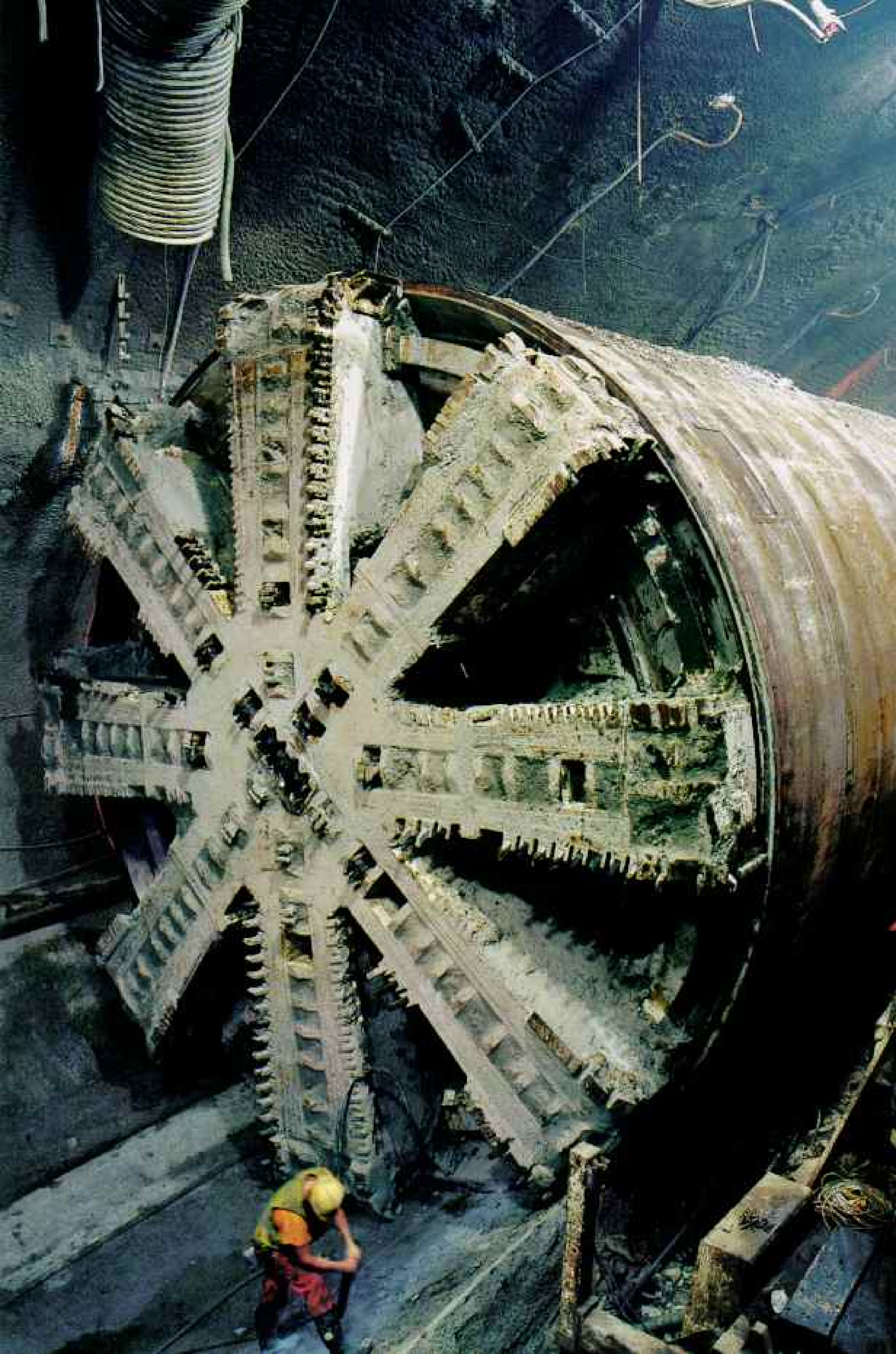


an enormous dump whose local name is Garbage Mountain. Six months before I was there, methane gas produced by the garbage had exploded, killing at least 30 people living below the dump. No one knows how many others lie under the avalanche of garbage.

An awful stench still rose from a fiery hole on the slope and drifted into the shacks around me. "On another day it will all blow up again," said Ismail Kaya, who lives in one of the shacks. "What is strange is that it is illegal to make houses here. Yet we pay taxes." He and his wife have six children. Three had to leave middle school to help him work at repairing refrigerators. The others are in a nearby

primary school. It is overcrowded, he said, and he is starting a campaign to get a bigger school. Transformation, I hoped.

That night Ümit and I had dinner in a place where a table full of men began singing. Ümit joined in and, between songs, tried to translate the words. Sometimes he could not because these were songs from folk memories too old and deep to unravel. Then they began singing a song whose words rose and fell in a cadence I had not heard before on any of Ümit's many cassettes. They sang it again and again, like an anthem for themselves and, I believe, for their country: "There is no turning back. There is no turning back." □





The big dig: A tunnel boring machine, one of 11 used to ream the English Channel Tunnel, sits in a crossover cavern on its 31-mile-long, 150-foot-deep course from England to France. The Chunnel, as it is known, opens on May 6, after seven years of construction.

GA PHOTOS

# The Light at the End of the Chunnel

By **CATHY NEWMAN**

NATIONAL GEOGRAPHIC SENIOR STAFF

Paintings by **KEN DALLISON**

**I**N A HOTEL LOBBY in Sandgate, England, not two miles from the soon-to-be-opened English Channel Tunnel, stiff upper lips trembled. For the first time since the last ice age, England was about to be linked to France.

"I'd rather England become the 51st state of the U.S.A. than get tied up to *there*," said a retired civil servant with a complexion the color of ruby port. He nodded toward the steel gray Channel out the window, his pale blue eyes filled with foreboding.

"Awful place," added his wife, lifting a tea-cup to her lips. "They drink all the time, and the food is terrible. When I go to the Continent, I take my own bottle of English sauce."

"We don't care much for the French," her husband concluded. "But the French..." Here a pause, a shudder, as the gull-wing eyebrows shot upward. "The French don't care for anybody."

On the other side of the Channel, the *entente* was scarcely more *cordiale*. In Vieux Coquelles, a village a beet field away from the French terminal near Calais, Clotaire Fournier walked into his farmhouse.

"I went to England once," he said, sinking into a chair in the dining room. "Never again! All they eat is ketchup." A tiny explosion of air from pursed lips, then the *coup de grâce*. "You can't even get a decent glass of red wine!"

Well, by grace of one of the engineering feats of the century, for richer or poorer, better or worse, England and France are getting hitched. On May 6, Queen Elizabeth of Britain and President François Mitterrand of France are scheduled to inaugurate the English Channel Tunnel ("Chunnel" for short), sweeping aside 200 years of failed cross-Channel-link schemes, 1,000 years of historical rift, and 8,000 years of geographic divide.

The 31-mile-long Chunnel is really three parallel tunnels: two for trains and a service tunnel. It snakes from Folkestone, England, to Coquelles, France, an average of 150 feet below the seabed. Drive onto a train at one end; stay in your car and drive off Le Shuttle at the other 35 minutes later. Later this year Eurostar passenger trains will provide through service: London to Paris in three hours; London to Brussels in three hours, ten minutes.

The Chunnel rewrites geography, at least in the English psyche. The moat has been breached. Britain no longer is an island.

**O**N A CLEAR DAY, which is not very often, from the top of Cap Blanc-Nez on the north coast of France, you can look across the Channel and see the faint shimmer of chalk cliffs on the English coast.

It is 22 miles to Dover, as the bluebird flies. Ninety minutes by ferry, 40 minutes by hovercraft. An average 12 hours if you swim.

But to a 19th-century writer called Valbert, the trip was "two centuries . . . of agony." On the 350-mile-long English Channel (La Manche, or "the sleeve," to the French), which separates the North Sea from the Atlantic, odds of a gale on any day in winter are one in seven. Now neither freight nor passengers need be held hostage by a heaving sea.

Queen Victoria, herself a victim of seaboard queasiness, would have approved. If it can be accomplished, I will give it my blessing, she said of a proposal that foundered.

Dreams of a cross-Channel connection have

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KEN DALLISON, a freelance artist born and raised in London, has illustrated many GEOGRAPHIC articles, including "America's Ancient Skywatchers" in March 1990. He completed this project after the death of freelancer RICHARD LEECH.

materialized, only to evaporate, 26 times before. Albert Mathieu, a French engineer, proposed the first plan in 1802: two tunnels linked to a mid-Channel island where stagecoaches could get fresh horses. Napoleon, Britain's archenemy, approved, and there's the curse. Whenever the idea of a link emerged in Parliament, so did apocalyptic visions of invasion.

"Those poor creatures who have no stomach for an hour's sea passage obviously think the retention of their dinners is more important than the safety of their country," thundered a British admiral in scuttling a 1914 proposal.

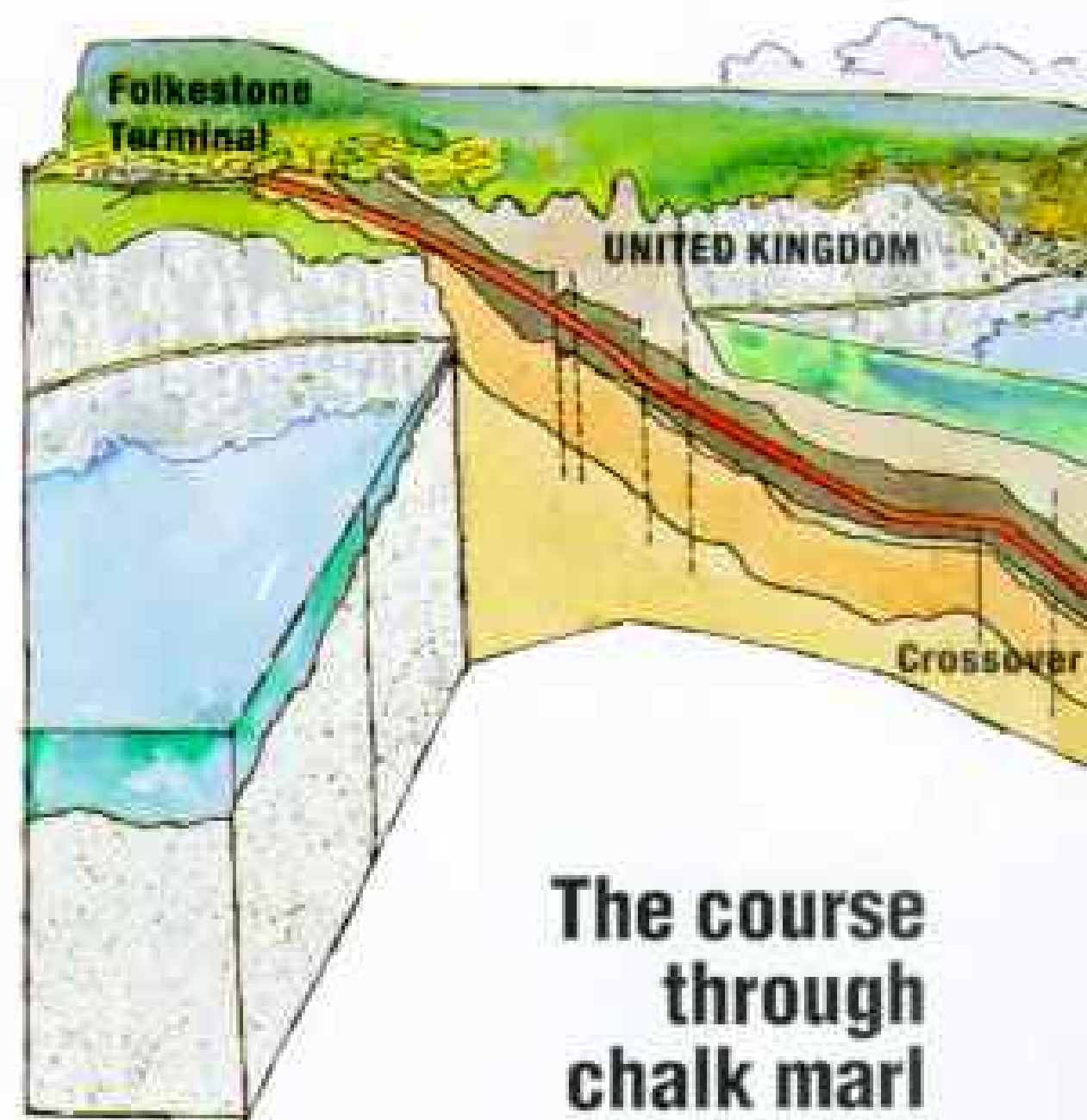
Why, after two centuries, did the two ancient foes take the plunge? A congruence of stars and planets, I suggest to Sir Alastair Morton, the British chairman of Eurotunnel—the Anglo-French company that owns and operates the tunnel.

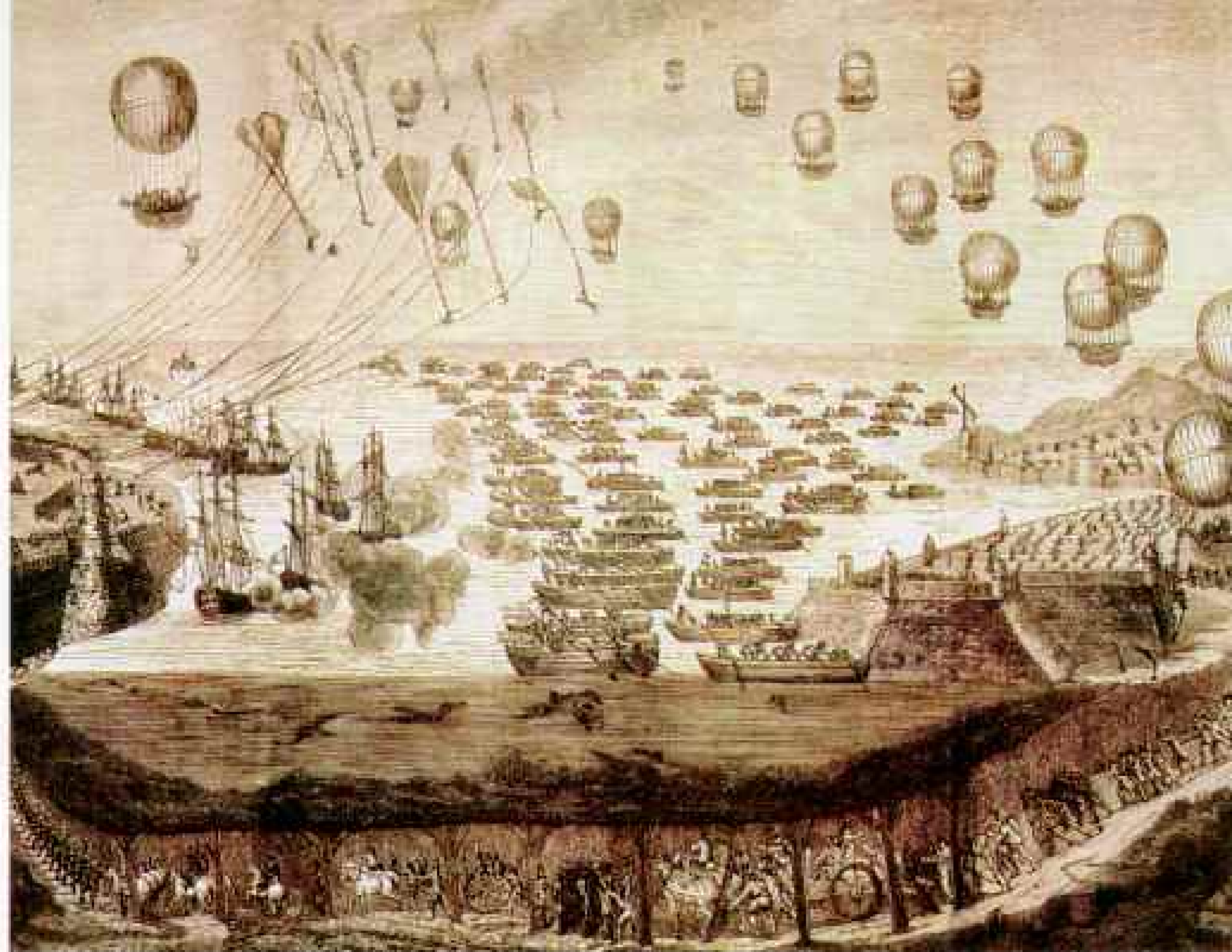
"More likely a congruence of political tides and currents," he replies. On his wall is a copy of the legendary London newspaper headline: "Fog in Channel. Continent Cut Off."

You had two leaders with private agendas, he says, referring to Prime Minister Margaret Thatcher and President François Mitterrand.

"Thatcher saw the tunnel as a monument to private enterprise. A willing Mitterrand, happy to go along with the way she thought it ought to be done, was determined to expand France's high-speed rail network."

Other converging currents: a tidal wave of 220 banks from 26 nations to finance the project. British and French industries desperate for work (the tunnel employed as many as 15,000 workers). (Continued on page 46)

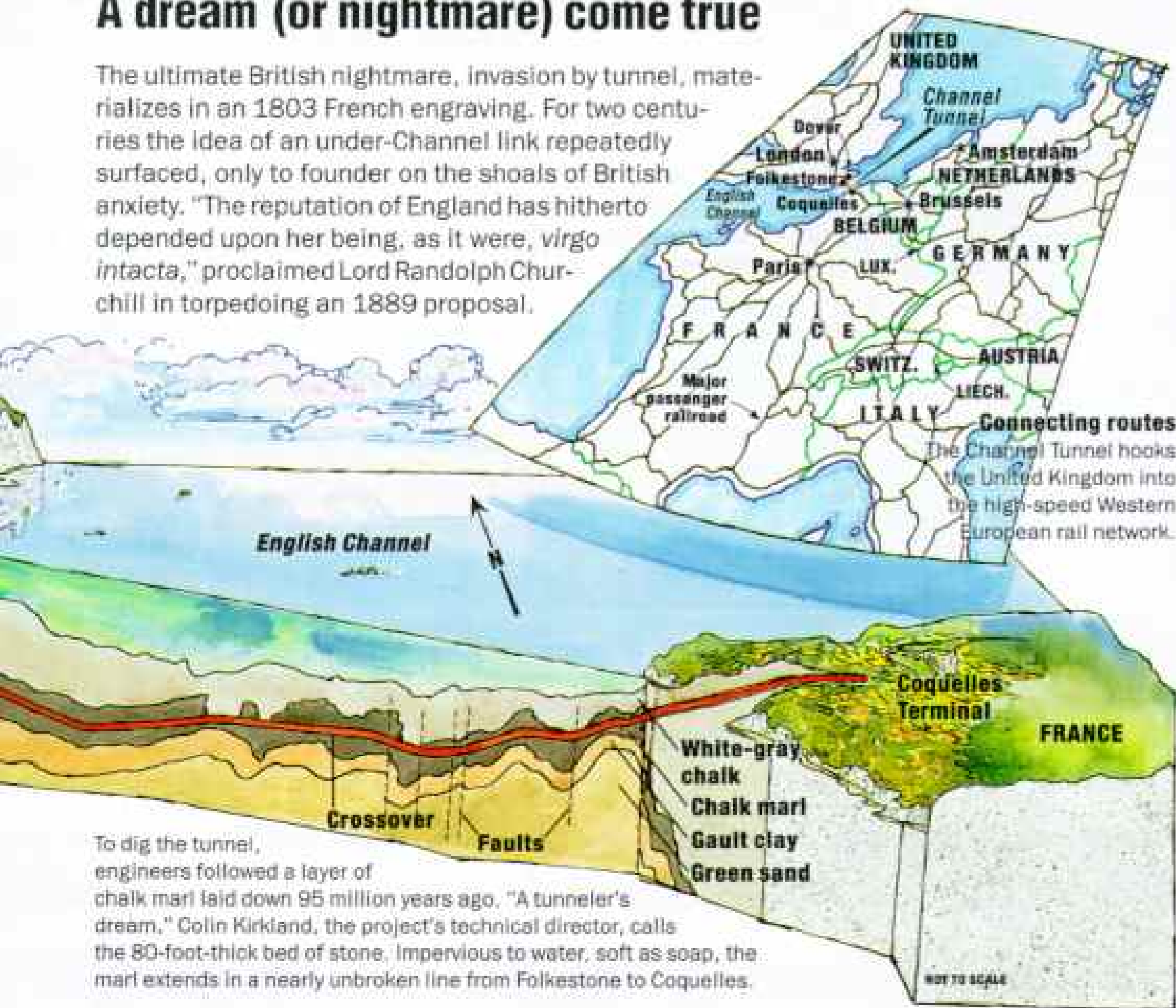




BIBLIOTHÈQUE NATIONALE, PARIS, COURTESY EURO-TUNNEL

## A dream (or nightmare) come true

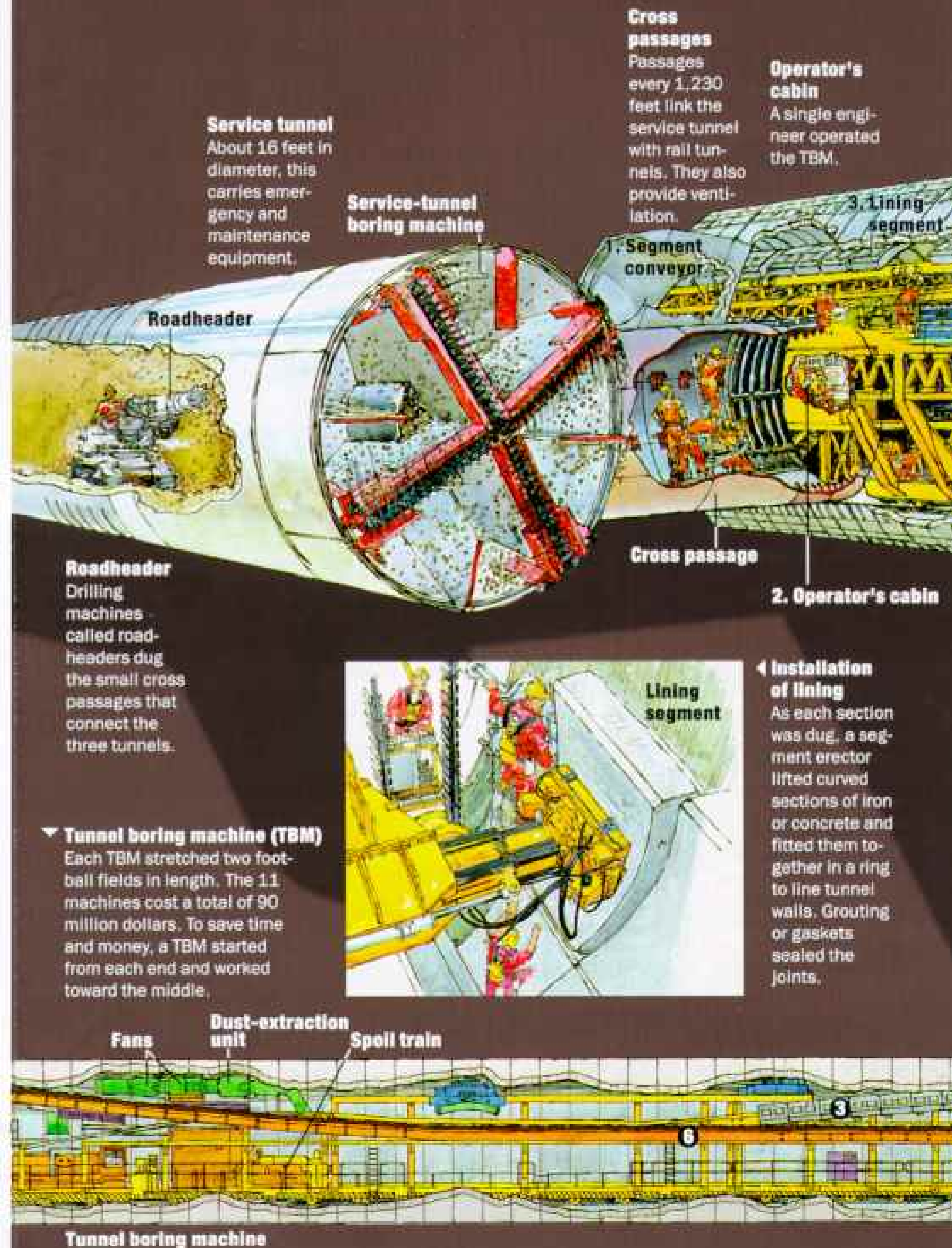
The ultimate British nightmare, invasion by tunnel, materializes in an 1803 French engraving. For two centuries the idea of an under-Channel link repeatedly surfaced, only to founder on the shoals of British anxiety. "The reputation of England has hitherto depended upon her being, as it were, *virgo intacta*," proclaimed Lord Randolph Churchill in torpedoing an 1889 proposal.



To dig the tunnel, engineers followed a layer of chalk marl laid down 95 million years ago. "A tunneler's dream," Colin Kirkland, the project's technical director, calls the 80-foot-thick bed of stone. Impervious to water, soft as soap, the marl extends in a nearly unbroken line from Folkestone to Coquelles.

# Cutting through

"This is actually an easy tunnel. It's just a long, long way," Peter Bermingham, an engineer on the project, said. The tunnel boring machines did the heavy work, digging two running tunnels and a service tunnel. Each TBM operated as a self-contained tunnel-processing plant. As it burrowed through rock, it simultaneously moved spoil back to cars and lined the hole with precast concrete segments. Boring took three and a half years.



**Service tunnel**  
About 16 feet in diameter, this carries emergency and maintenance equipment.

**Service-tunnel boring machine**

**Cross passages**  
Passages every 1,230 feet link the service tunnel with rail tunnels. They also provide ventilation.

**Operator's cabin**  
A single engineer operated the TBM.

**Roadheader**  
Drilling machines called roadheaders dug the small cross passages that connect the three tunnels.

**Tunnel boring machine (TBM)**  
Each TBM stretched two football fields in length. The 11 machines cost a total of 90 million dollars. To save time and money, a TBM started from each end and worked toward the middle.

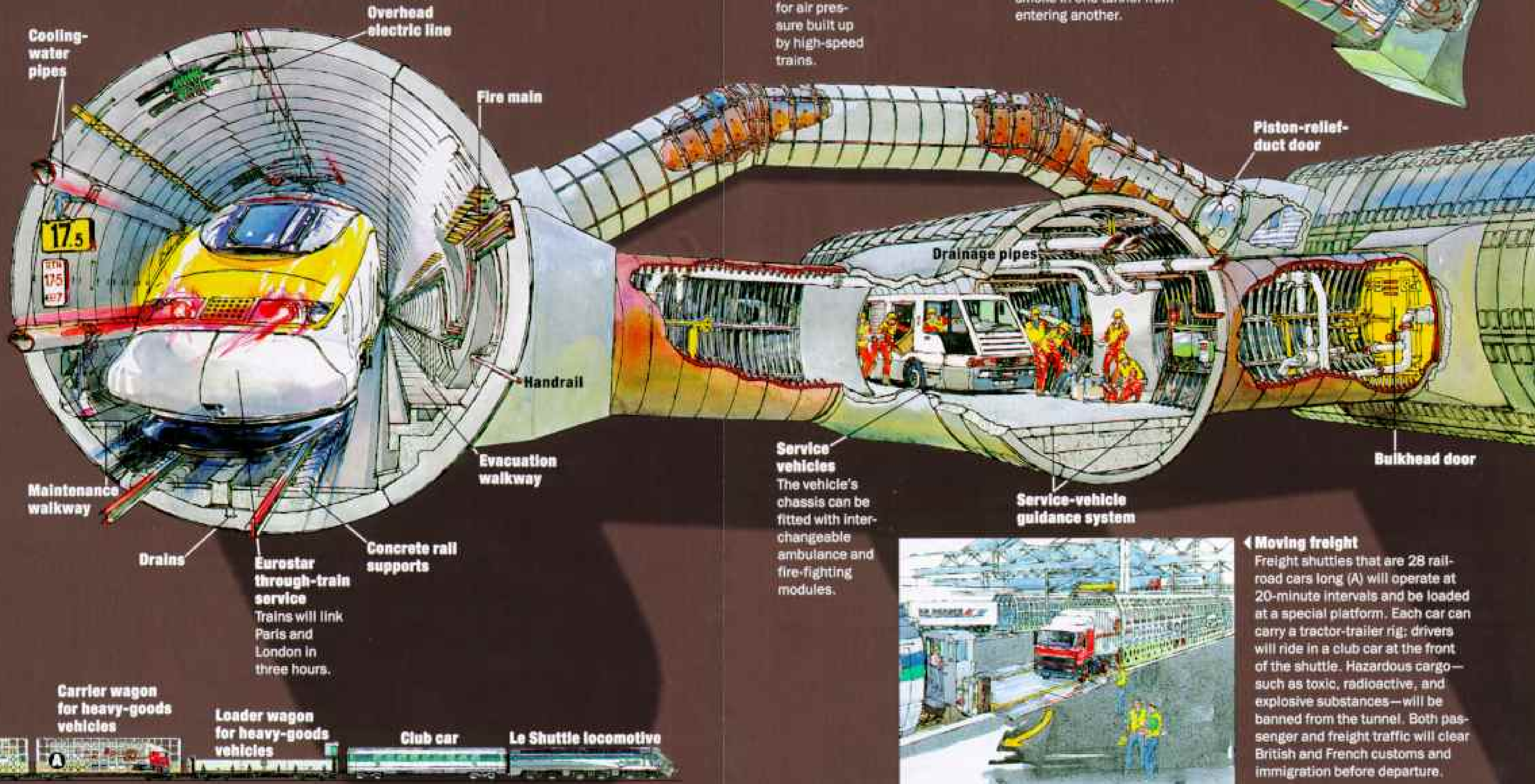
**Installation of lining**  
As each section was dug, a segment erector lifted curved sections of iron or concrete and fitted them together in a ring to line tunnel walls. Grouting or gaskets sealed the joints.

Tunnel boring machines

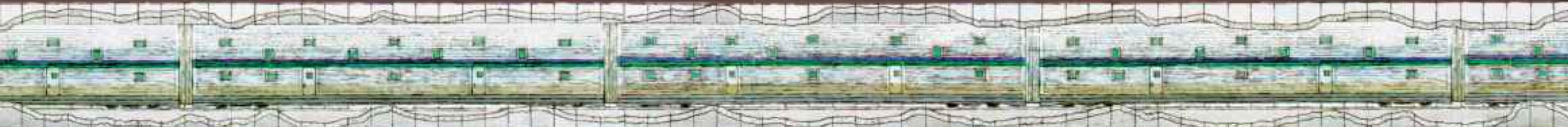


# The whole Chunnel catalog

Enter in England, exit in France—and vice versa. A rail line only, the Chunnel consists of two tunnels for trains and a service tunnel in between for maintenance and emergencies. The Chunnel will serve shuttle trains carrying buses, cars, and trucks between terminals in Folkestone, England, and Coquelles, France, as well as through trains operated by British, French, and Belgian national railways. Built entirely by private enterprise, the Chunnel rang up a tab of 13.5 billion dollars.



**← Moving freight**  
Freight shuttles that are 28 rail-road cars long (A) will operate at 20-minute intervals and be loaded at a special platform. Each car can carry a tractor-trailer rig; drivers will ride in a club car at the front of the shuttle. Hazardous cargo—such as toxic, radioactive, and explosive substances—will be banned from the tunnel. Both passenger and freight traffic will clear British and French customs and immigration before departure.



**Fixed equipment**

The tunnel includes 20,000 lights and 340 miles of pipes for drainage, cooling, and fire-fighting systems.

**Electrically driven trains**

Trains will need more than 160 megawatts, equal to the peak load of a city of a quarter million.

**Locomotives**

Maximum speed will be 100 miles an hour. Both ends of the train will have locomotives for rapid backing in an emergency.

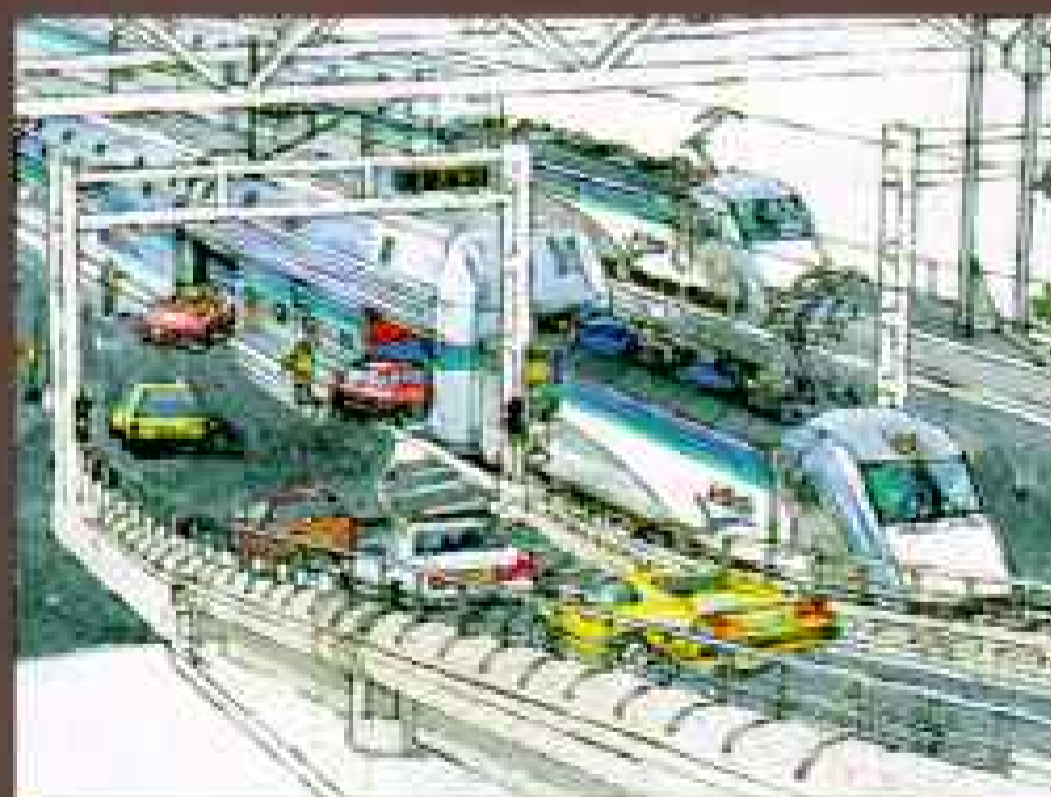


Le Shuttle locomotive

Double-deck loader wagon

**Moving passenger vehicles ▶**

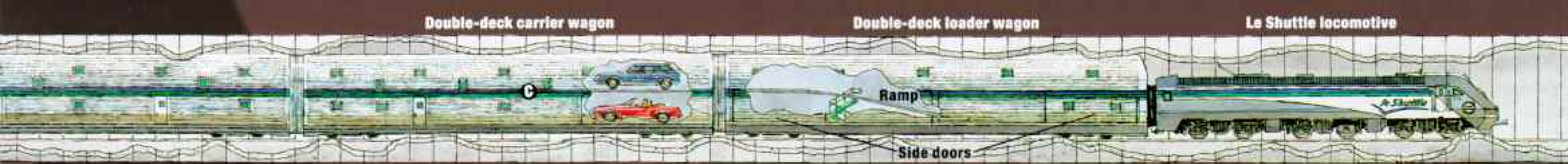
During peak periods, Le Shuttle, as it is known, will depart British and French terminals every 15 minutes. The 24-hour service will operate on a turn-up-and-go basis. Passengers will drive their cars onto a loading platform, then into the shuttle cars, and remain with their vehicles for the 35-minute trip. A shuttle usually will consist of single-deck wagons (B) carrying 12 buses and double-deck wagons (C) carrying 120 cars.



Le Shuttle locomotive

Single-deck loader wagon

Single-deck carrier wagon



Double-deck carrier wagon

Double-deck loader wagon

Le Shuttle locomotive

Ramp

Side doors

**Gripper rams**

These secured the TBM against tunnel walls when the cutterhead was drilling.

**Propel rams**

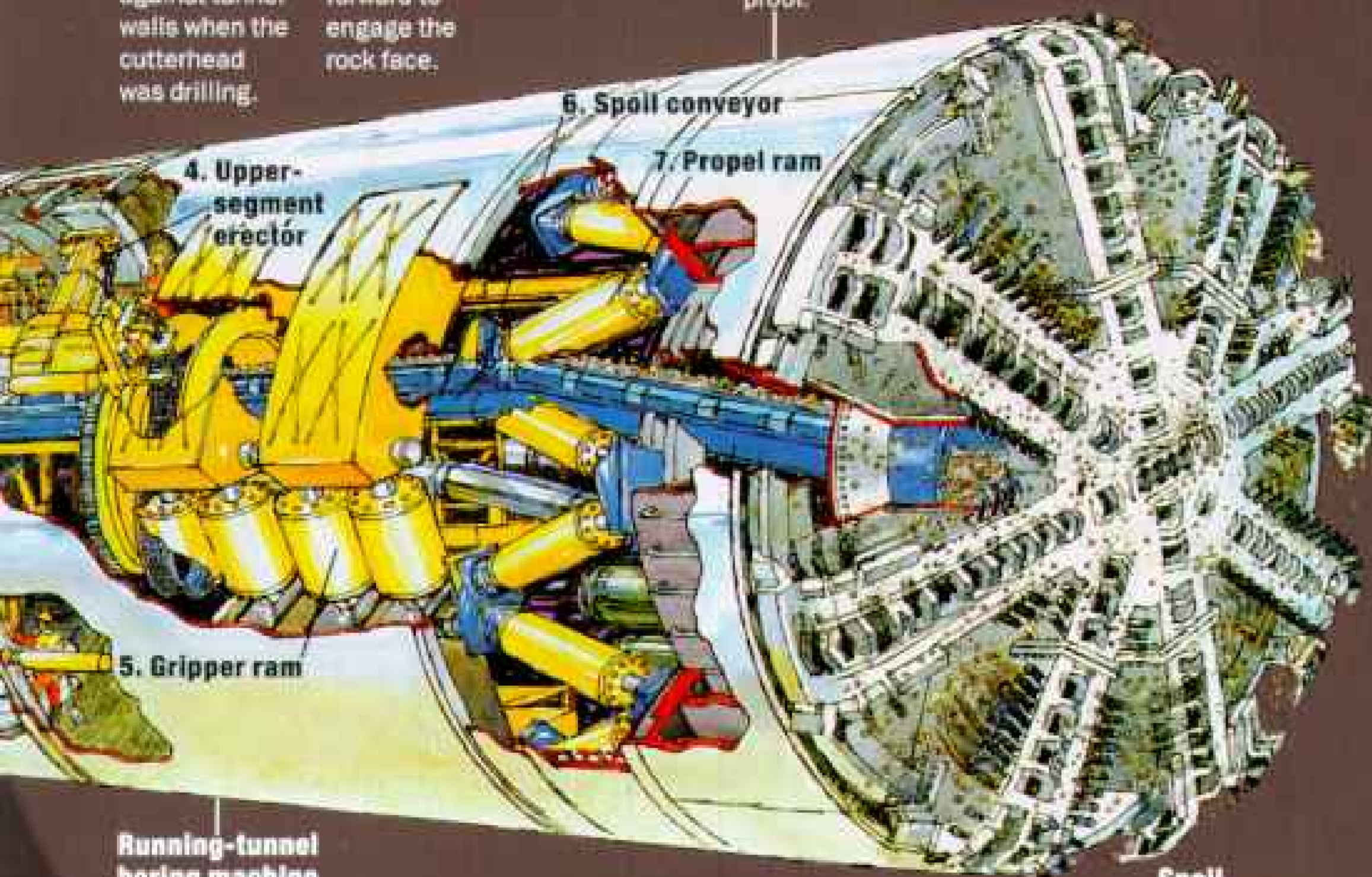
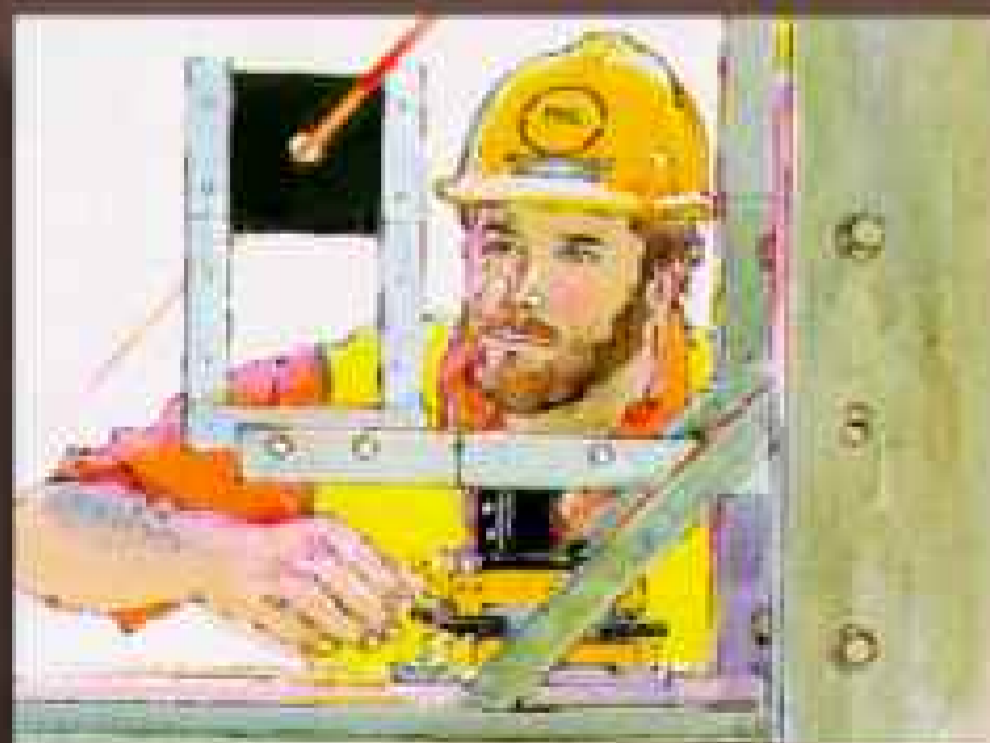
These drove the cutterhead forward to engage the rock face.

**Encasement**

Because of fractured chalk on the French side, TBMs there were made waterproof.

**Cutterhead**

Studded with tungsten teeth, the cutterhead chewed through 15 feet of rock an hour. The teeth—"biggest dentures you ever saw," says technical director Kirkland—could be replaced from behind.

**Running-tunnel boring machine****← Laser guidance**

A computerized laser-guidance system kept the TBMs on course, ensuring their meeting halfway under the Channel. A narrow drill probed the rock ahead. The service tunnel, first to be completed, took exactly three years to dig.

**Spoil**

Conveyor belts removed spoil. Digging produced ten million cubic yards, enough to fill London's Wembley Stadium nearly 20 times.



Numbers refer to numbered labels above.

Cutterhead

(Continued from page 38)

"The tunnel's come about because Britain finally feels secure," adds Sir Christopher Mallaby, Britain's ambassador to France. Still, the country just can't go it alone. Britain, which snubbed the rest of Europe for years, has joined the European Union in its drive toward economic integration. The island mentality has eased, but angst remains.

Some symptoms:

- In 1986 Thatcher and Mitterrand met in Canterbury, England, to seal the treaty allowing tunnel legislation to proceed. Demonstrators pelted Mitterrand's limo with eggs and shouts of "Froggy, go home."
- When interviewed by French television, Prince Charles reportedly sputtered over the defiling of Britain by the tunnel.
- Prompt and unanimous passage of tunnel legislation in the French parliament. Tortured debate in the British.

Professor Roger Vickerman of the University of Kent at Canterbury, who has studied the Chunnel with colleagues at the University of Lille II in France, calls it the

"garlic fog effect." "Had the tunnel linked us to the Netherlands," he says, only half kidding, "we'd have built it long ago."

**I**T'S JUNE 28, 1991, and I'm packed into a construction workers' train along with several dozen other journalists. We're headed out from the English side to the breakthrough ceremony for the south running tunnel—the last to be completed.

The Chunnel is a work in progress. The concrete walls await final installation of the power, water, and communication lines that will turn it into a transport system. White dust fills the air. The train screeches painfully. "Makes you appreciate British Rail," someone jokes.

Finally we reach the breakthrough site. The two machines that dug this tunnel started from

opposite sides of the Channel and worked toward the middle. Now we're staring at the 30-foot-diameter face of the French tunnel boring machine (TBM), "Catherine."

In one of those *vive la différence* quirks that color the project, the French gave women's names to their machines. On the British side, it's by the numbers—like TBM No. 6. Another difference: French workers wear chic, well-cut, taupe jumpsuits with red and blue racing stripes down the sleeves. The British uniform is pure grunge: baggy, bright orange.

Looking up, I imagine 180 feet of Channel above my head—ferries, tankers, a Dover sole or two. . . .

The grating of the TBM interrupts my reverie. Its cutterhead—a huge wheel with tungsten-tipped teeth—chews into the last trace of rock separating England from France.

Music blares, and lights glare. Several Frenchmen scramble through. Thunderous applause erupts as dozens more follow. Strangely moving, this connecting of countries. Champagne corks pop, and French workers hug British counterparts.

"I might have opposed it 30 years ago, but now it's my tunnel," an Englishman says.

French tunnelers are still climbing through. "So many," I say, turning to a French official.

"And there are 56 million more behind them," he replies.

*Après le tunnel, le déluge?* Eurotunnel hopes so. It predicts eight million passengers a year by 1996. The flow will be lopsided. Only 30 percent of the traffic will be headed to Britain. "The French don't take holidays in England," explains Jeanne Labrousse, a Eurotunnel executive.

Hmmmm. Why do the French visit Britain? For the food? The weather? Fashion?

Mme Labrousse seemed thoughtful.

"Of course," she brightened, "we will work on selling the idea."



Fright at the end of the tunnel: the French reception.

Selling the tunnel as an investment to the French was a piece of cake. French holders of Eurotunnel stock outnumber the British four to one. Did they know something the British did not? No, in part it's the French love affair with high technology and public projects.

"The French man in the street believes *les grands projets* will make life better for his grandchildren," a British executive with Eurotunnel says. "He believes in Ariane rockets, nuclear power, and the Channel Tunnel."

In France, support for such projects is considered downright patriotic. At a Eurotunnel stockholders meeting in Paris, a woman asked when the first dividend would be paid. Not till century's end, she was told. A man jumped up. "How can you ask such a thing?" he demanded. "Better you should ask if they need more money."

Talk about pouring money down a hole. At the height of construction, Eurotunnel forked out 4.5 million dollars a day. The bill at opening day will ring up to 13.5 billion dollars—nearly twice the original estimate.

Was someone's math a little shaky?

"The nature of the beast," explains Professor Vickerman. "Large construction projects have large cost overruns."

The out-of-control tab turned into a bitter dispute between the Eurotunnel owners and Transmanche Link (TML), the consortium of ten British and French contractors that built it. "Despite the overruns," says Vickerman, "they were amazingly close to schedule."

Well, sort of. When work kicked off in December 1987, Eurotunnel trumpeted that service would begin May 1993. Sorry, make that August . . . well, perhaps December. . . .

Finally, Eurotunnel refused to name an opening date at all. As rancor between Eurotunnel and TML shifted to high gear, work shifted to low gear. Bankruptcy rumors wafted over the tunnel like a whiff of ripe Stilton.

Last July the Bank of England played headmaster and prodded both sides to get on with it. The money dispute went to arbitration. Civility and work resumed.

**T**HE TUNNEL crystallizes a moment in history," André Bénard, Eurotunnel's French chairman, mused in his Paris town house. "We've brought Britain closer to Europe. There's no turning back."

In Le Transmanche, a bar down the road from the Coquelles Terminal, owner Nadine Cottié-Bourbiaux dusts off the welcome mat

for travelers who'll stop in for a *pastis* or two. "Once it bothered me," she says, indicating the tangle of highways leading toward the sleek, white terminal buildings. "Now, it's our landscape."

In London, property agent Miles Maskell, who specializes in French real estate, rubs hands in hopes of more and more British bargain seekers who'll snap up French châteaux and farmhouses, "at one-third the cost of here," he enthuses, flipping through a

photo album of listings. "The tunnel brings France closer!"

On both sides, blueprints for freight terminals, shopping complexes, and offices await an upturn in the economy to be transformed into concrete and steel.

Chunnelphobia subsides. The prognosis improves. Best to follow Voltaire's prescription: "Let us forgive one another's follies."

A highly improbable, if totally logical, connection has been forged. What God put asunder, man hath joined together. A tide of passengers, freight, and commerce will follow. In time, perhaps, a wisp of tolerance as well.

There's supposed to be light at the end of every tunnel. If this one brings a little understanding, what's 13.5 billion dollars between friends? □



**Touché:** French tunneler Philippe Cozette and British counterpart Graham Fagg, whose names were drawn from a hat, make contact at the service-tunnel breakthrough on December 1, 1990.

# Rice

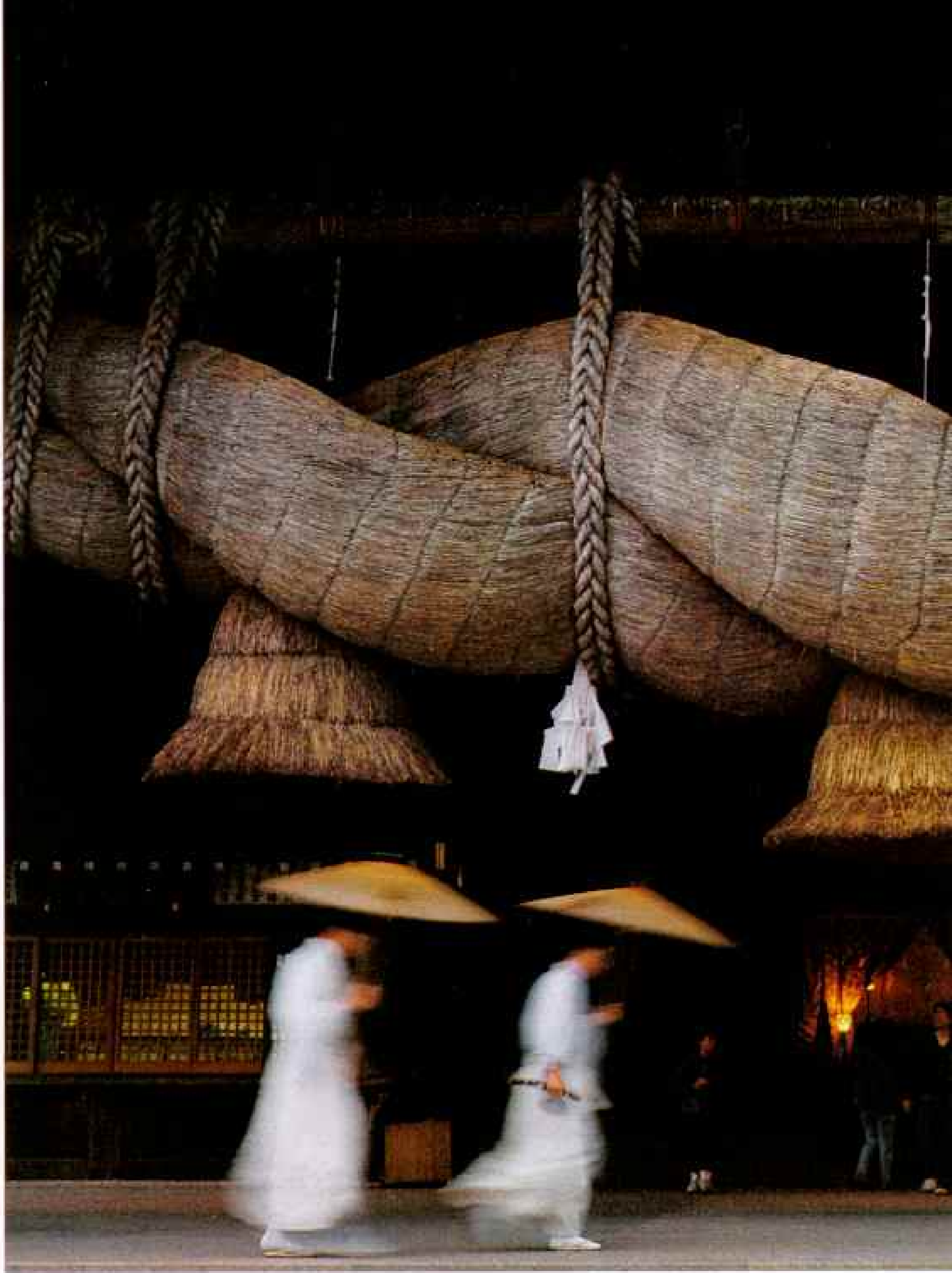
## THE ESSENTIAL HARVEST

Flinging a golden blizzard of rice, an Indian farmer trusts wind to winnow chaff from grain. The world's most vital food crop will feed the future — if growers coax more kernels from less land.

By PETER T. WHITE  
ASSISTANT EDITOR

Photographs by ROBB KENDRICK

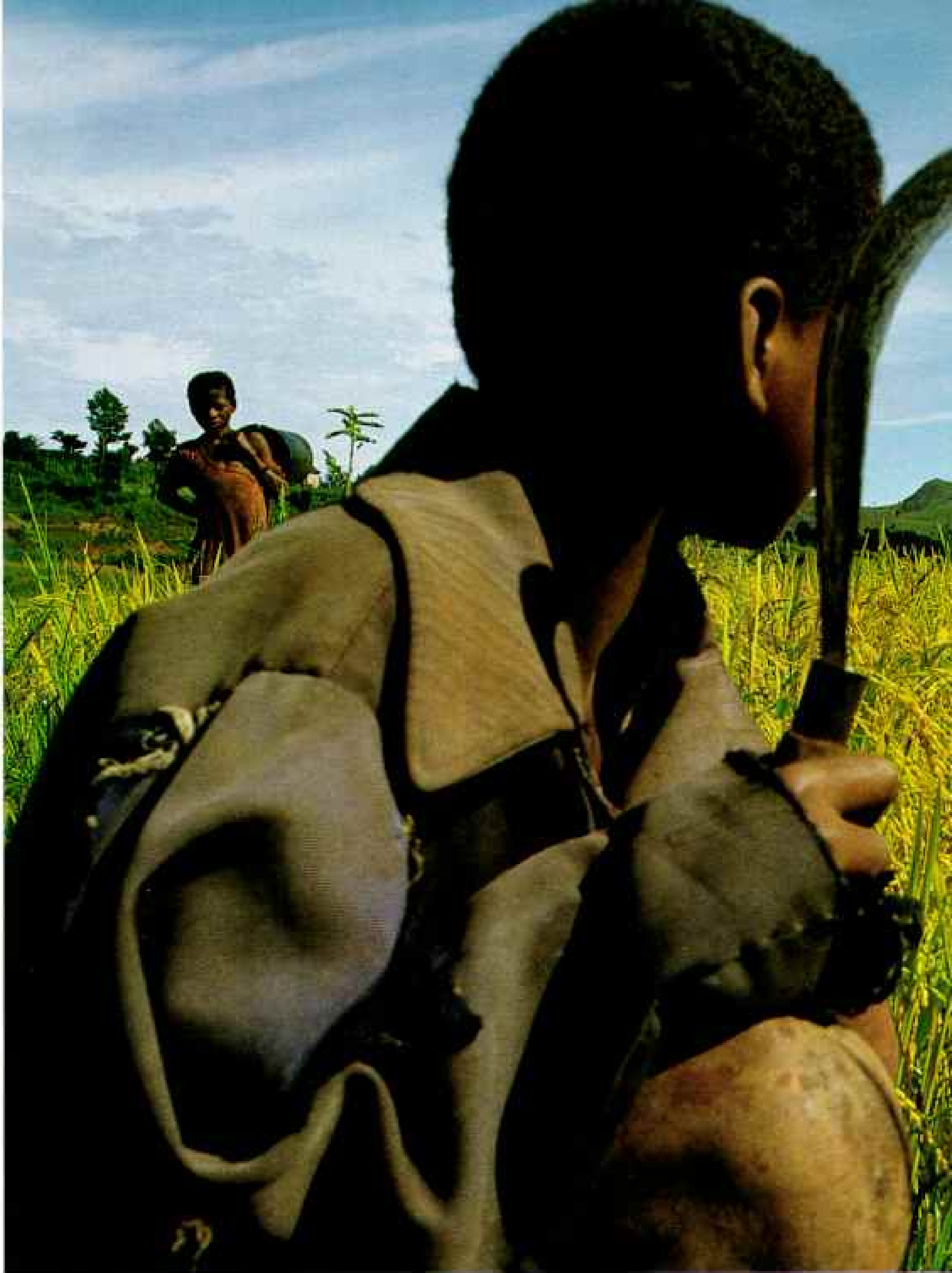


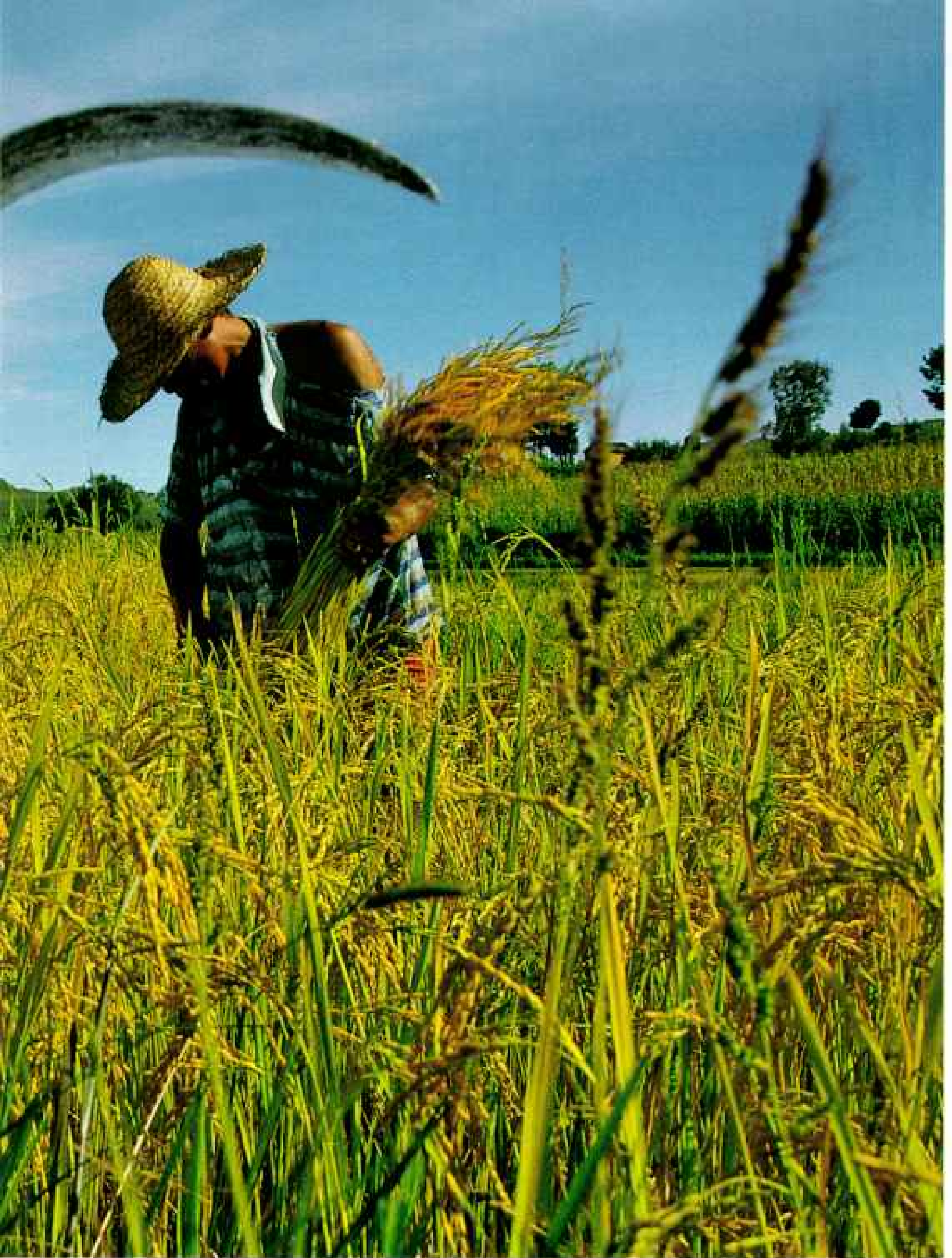




**COLOSSAL STRANDS** of rice straw entwine over an entrance to the Izumo Shinto shrine, one of Japan's oldest. Denoting a sacred place, the rice-straw rope—or *shimenawa*—is the world's largest at six metric tons. Grown in Japan for more than 2,000 years, rice is woven through culture, diet, even politics. Small *shimenawa* often hang over doorways to ward off evil. One evil the nation cannot stop: skimpy harvests, which in 1993 forced Japan to ease its sacrosanct restrictions on rice imports.







## THIN REAPERS

in threadbare clothes carve out a hard-earned rice harvest in Madagascar. Cool temperatures, poor soil, sporadic rains, and manual labor — with scythe and bullock instead of machines — keep yields below one ton per acre, among the world's worst. Still, the Malagasy people rank among the highest in rice consumption, eating an average of 260 pounds a year. Desperate for cropland, farmers turn forested hills into paddies, leaving rivers awash in mud.

**W**HAT IS SHE DOING, this bewitching young woman of Bali? Moistening her forehead with holy water, then her temples and her chest just below the throat. Now she sticks on a dozen luminously white kernels of uncooked rice. On her copper-colored skin they gleam like jewels.

What's the idea? She smiles. "*Mula keto*," she says—that is what is done. A priest in the Hindu temple at Sukawati, where I just saw scores of other women, and men and children also, doing the same, tells me why: "Rice is the embodiment of Dewi Sri, the rice mother, goddess of life and fertility. This is a symbolic way for our bodies to absorb the life force she gives us. Without it we would be dead things."

In a sense this can be said not only of the three million Balinese but of much of humankind. Rice provides 25 to 80 percent of the calories in the daily diet of 2.7 billion Asians, or half the world's population. Last year rice harvested around the globe amounted to 520 million metric tons, nearly all for human consumption. (That's 573 million U. S., or short, tons, but in international trade statistics grain is measured in metric tons.) The wheat crop was somewhat larger—560 million tons—but 20 percent of that went to feed livestock; out of 529 million tons of corn, animals got 65 percent. In short, rice is the world's number one food crop. And to me the most intriguing.

For one thing, it's been so adaptable. To the hot Australian and Egyptian deserts, to the cool Himalayan foothills of Nepal. Hill tribes in Southeast Asia plant it on slashed-and-burned forest slopes; that's upland, or dry,

rice. At floodtime in Bangladesh it will thrive in eight feet of water, thanks to the efficient passage of air from tiny openings in the shoots to the roots. To keep pace with rising floods, such "floating" rice plants can elongate eight inches a day, to ten feet or more.

But most of the world's rice areas—the lowland rain-fed sort (roughly 25 percent) and the irrigated kind (55 percent)—are level ground where rice grows in just a few inches of water held in by small dikes. These fields are called

paddies. (The word paddy, of Malay origin, also means "rough rice"—rice that hasn't been through the mill.) One more set of figures: 90 percent of the world crop is raised and almost entirely eaten in Asia—a third of it in China, a fifth in India.

Here are some facts that surprised me:

The grass species *Oryza sativa*—sown, or cultivated, rice—is thought to exist in 120,000 varieties. Some are red, some black. The "wild rice" prized by gourmets looks like rice but isn't; it's a grass of a different genus.

A tenth of the seven million tons of rice grown in the U. S. each year goes into beer. Ground up and boiled, it's put into mash tanks along with barley malt, before hops are added and fermentation begins. Why rice? "For lighter color and more refreshing taste," says an Anheuser-Busch

brewmaster. "It's a significant element in what makes Budweiser Budweiser."

And as I was to learn in globe-girdling travel to get a grip on rice, so to speak, its cultivation has been influential in ways I hadn't envisioned. Fostering a courtship pattern in Italy. Shoring up family ties in West Africa. Benefiting ducks and geese in California. . . .



MULTICOLORED HANDFULS of seeds barely hint at the thousands of varieties preserved at the International Rice Research Institute (IRRI) in the Philippines, which breeds hybrids to boost yields and hardiness. A child's breakfast in China's Zhejiang Province is no surprise: The nation grows and eats one-third of the world's production.



ANCIENT EARTHWORKS still provide in Ifugao, Philippines, where farmers maintain water-trapping rice terraces created centuries ago. As a girl slowly winnows rice much as her ancestors did, farm animals feast on the chaff. Outside Manila anxious IRRI scientists look to tomorrow. Says Director Klaus Lampe: "We must make rice growing a more attractive profession."

**I** START OUT in the Philippines, at IRRI, the International Rice Research Institute, near Manila, where dramatic rice history was made. Financed by the Ford and Rockefeller Foundations, it opened in 1962 amid fear that because Asia's population growth was outstripping its food production, there would be widespread famine. To avert such a calamity, IRRI did something of far-reaching consequence. It transformed the rice plant. Its principal plant breeder, Gurdev S. Khush, tells me how: Height reduced from about five feet to three, so that when more fertilizer makes for heavier panicles, or clusters of rice grains, the stalks won't fall over. Growing period reduced from about 160 days to 110, so that in warm climates, if irrigation is available to supplement seasonal rainfall, there can be two or three crops a year instead of one. "We also bred in resistance to disease and insects—to blast and bacterial blight, to plant hoppers and stem borers."

IRRI's new dwarf varieties were so productive, and so widely adapted, that in the 25 years from 1967 to 1992 the world rice harvest doubled. "The outstanding case is Indonesia," says Dr. Khush. "From 15 million tons to 48, more than triple!" This, along with a similar upturn in wheat, has been called the green revolution.

But now, he adds, the rice plant must be redesigned once more. To keep pace with Asia's still rising population, rice production will have to increase another 60 percent by the year 2020. The current dwarf varieties have 20 to 25 stalks, but only 15 or so produce panicles, with about a hundred grains, or seeds, each; the rest are sterile. "We are aiming for what we call an ideotype—one with fewer stalks but thicker, stronger ones, each

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Freelancer ROBB KENDRICK of Austin, Texas, has illustrated GEOGRAPHIC articles on Nepal's Sherpa people (December 1992) and the restoration of a historic U. S. Antarctic station (March 1993).

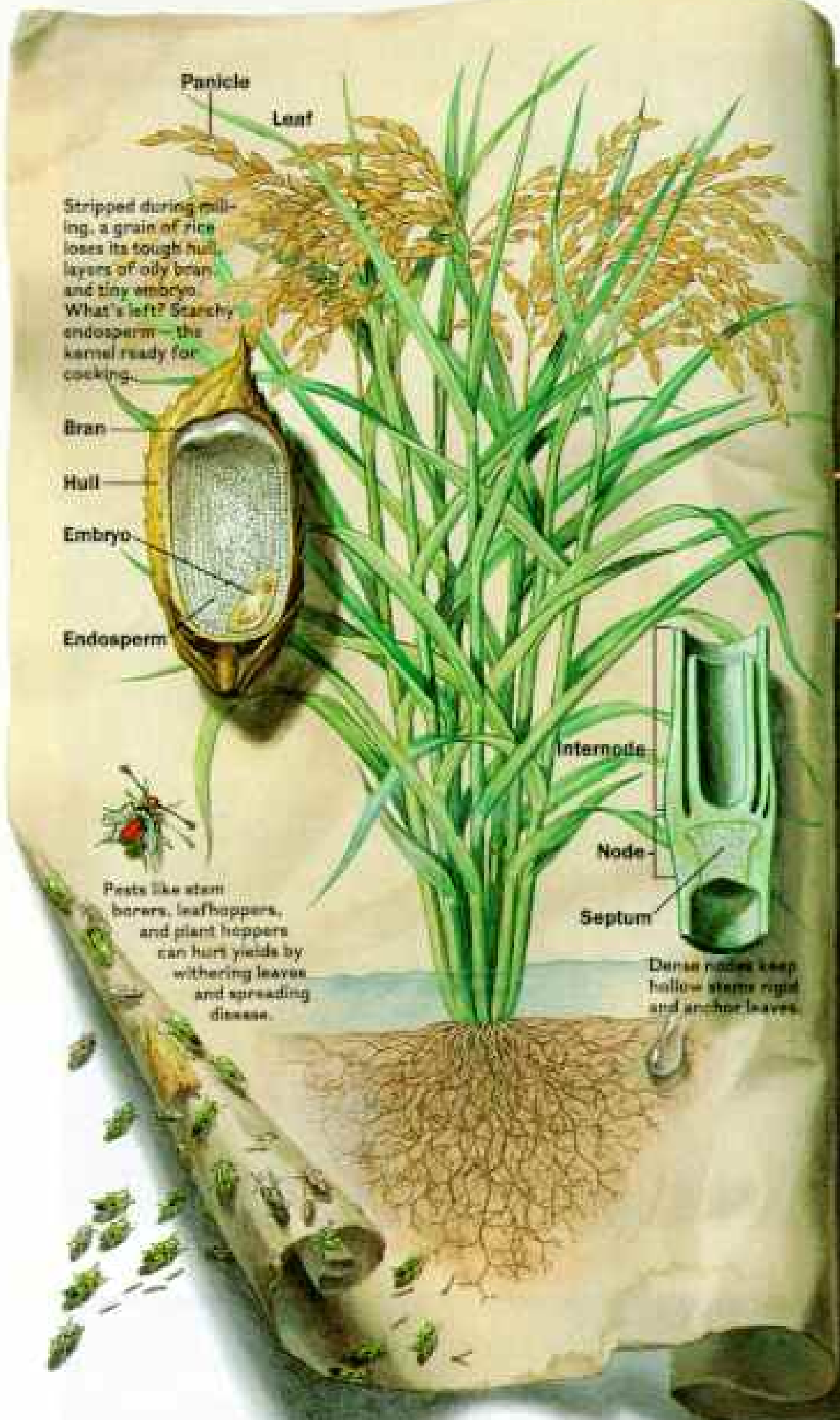


bearing a panicle with twice as many grains."

The building blocks for this science-directed evolution are the seeds in cold storage at IRRI's Genetic Resources Center—some 80,000 rice samples. Thousands are crossbred each year. Most of the resulting plants will be discarded, and only a few with the most desirable qualities kept to be grown again until, after six generations, they'll "breed true"—having become new varieties. Seeds of the most promising will be sent to some of the 89 major rice-growing countries for testing under local conditions and possible breeding with local varieties.

Nowadays the march toward the ideotype is also aided by advances in biotechnology and genetic engineering—the transfer of genes from one plant directly into the cells of





**REINVENTING RICE**  
 Born in the lab, high-yielding varieties of irrigated rice have been bred to be sturdy, fast growing, resistant to blight and bugs — and to swell with two to three times the grain of traditional varieties. Now yields must jump again to meet demand.

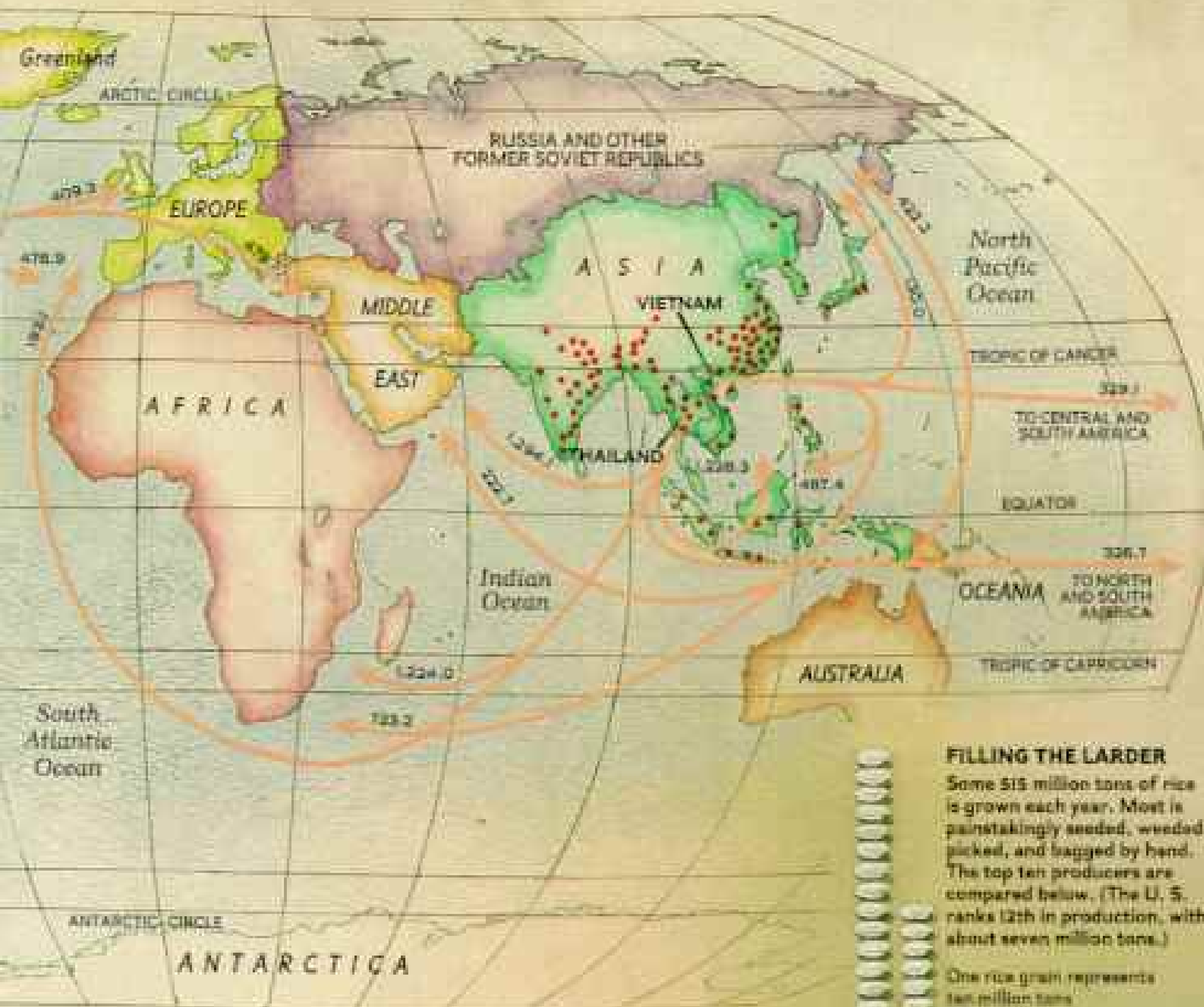
another, to reduce breeding time or to transfer traits that cannot be incorporated by conventional breeding methods. For instance, if scientists want to cross a variety of *Oryza sativa* with a true wild rice, say *Oryza officinalis*, which is especially resistant to insects, there is a problem of genetic incompatibility. If the two are crossed, the resulting seed will shrivel—and so the embryo that's attached to it, and which it was supposed to nourish, will die.

"But now we can rescue those embryos," says Darshan S. Brar, and I watch him do so. Under a stereomicroscope he cuts a tiny

lump—the embryo—from a shriveling seed. He then puts the embryo into a test tube with chemical nutrients. "It will grow into a seedling and eventually into a rice plant with the traits of both parents."

**I**N THE CENTRAL LUZON PLAIN north of Manila, where paddies stretch for miles along both sides of the National Highway, I get impressions of labor-intensive rice cultivation in the lowland tropics—it's mud, sweat, and more mud.

A young man plows with his water buffalo,



**FILLING THE LARDER**

Some 515 million tons of rice is grown each year. Most is painstakingly seeded, weeded, picked, and bagged by hand. The top ten producers are compared below. (The U. S. ranks 12th in production, with about seven million tons.)

One rice grain represents ten million tons.



PRINTING BY PHILIP T. CRAFT

# THE GLOBAL GRAIN

Rice's roots reach far. Grown from sopping lowlands to arid plains, rice is heavily cultivated in 89 nations. Nearly all is eaten locally—staple food for half the world. Only 4 percent is traded, with Thailand, the U. S., and Vietnam the chief exporters. Expected to be the biggest buyer this year: Japan.

sometimes ankle-deep in gooey black mire, sometimes knee-deep. Couldn't he wear rubber boots? No, they'd slip or get stuck. He's 28, he says, and his wife works as a housemaid in Hong Kong; every two years she's back for a month. "She'll do it two more years; then we'll have enough money saved to buy a tractor, and she'll stay home and we'll have three children."

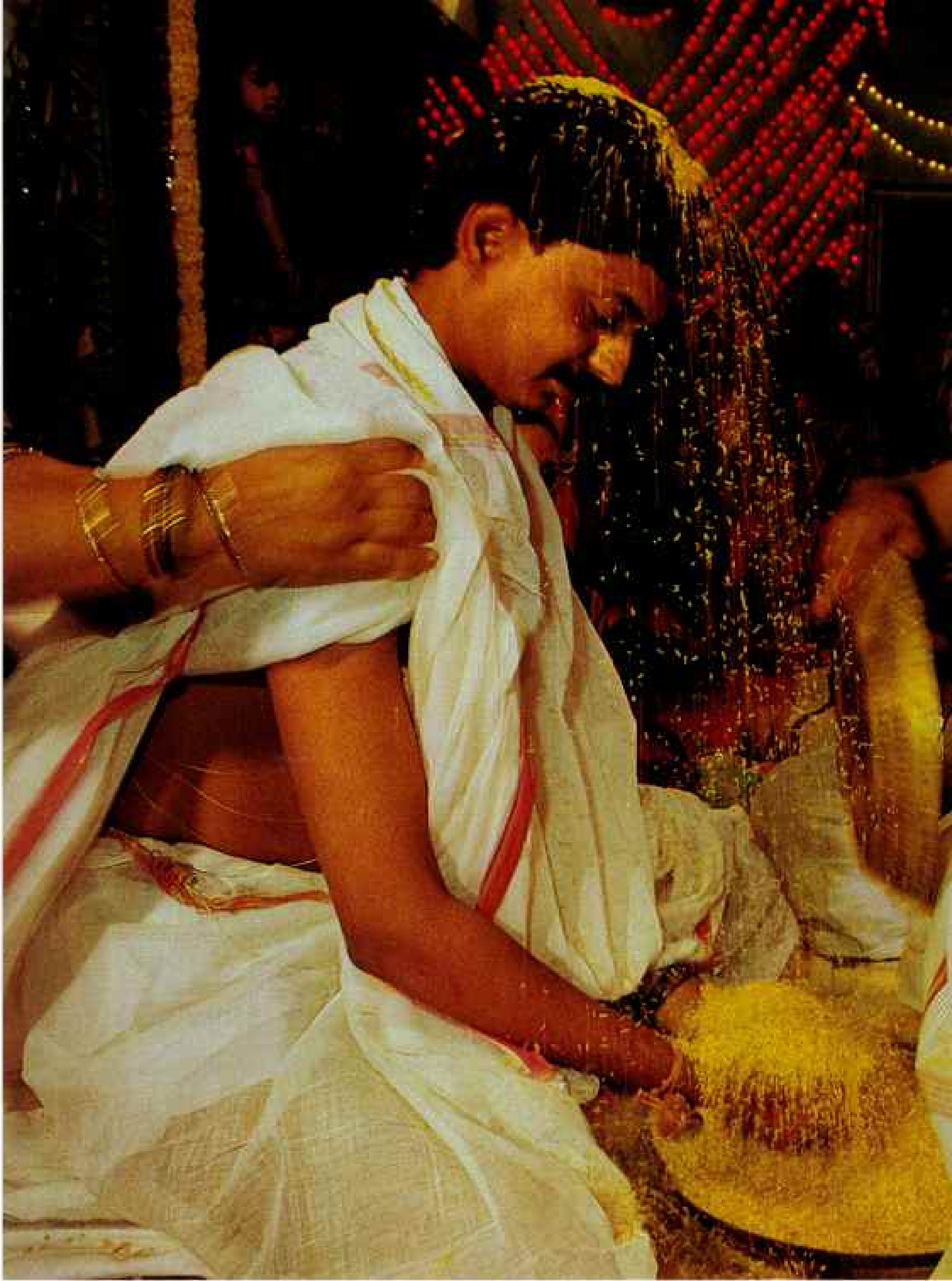
There's reliable irrigation here; it's always warm, and so, with cultivation going all year-round, different stages of the rice cycle occur simultaneously. Atop narrow dikes bordering

the fields, I walk—carefully—to where young people transplant seedlings brought from a seedbed. Like this:

Hold a bundle of foot-long seedlings in the left hand, bend forward 45 degrees, legs kept straight, and with the right thumb and index and middle fingers push in a couple of seedlings at a time—into the mud, in neat rows.

It's done rapidly, and it's hard on the back. I clock one young man: 98 insertions in 72 seconds, before he straightens up to get the next bundle. Oops, his right leg abruptly sank a foot deep.







**GOOD WISHES** go with the grain at a Hindu wedding in Hyderabad, India. Rice tinted golden with turmeric and blessed by a priest was repeatedly poured on Raghu Iruvanti by his bride, Padma, and he returned the favor. "It's for prosperity and happiness," Raghu said of the ceremony, called *talambralu*. "But it's also to break the ice between the couple. It gets to be like a game."





Why this laborious transplanting? So the rice will have a head start over the weeds. If seed were sown directly, you'd need much more seed and have bigger weed problems, requiring increased herbicide use. Where labor is cheap and chemicals are expensive, transplanting is in.

I see rice standing emerald green and three feet high—the immature grains are filling with milky fluid. In other places they're already golden beige and full of starch, ready for harvest in fields now drained. I see stalks cut with sickles and brought to a portable threshing machine. The bagged rough rice goes to mills in the villages and towns along the National Highway; part of the road is covered with it, spread out in the sun to dry a bit before milling.

TRAILING MELODIES and a resplendent bull, an itinerant father and son beg rice donations in Andhra Pradesh, India. A doorway bears *muggu* designs, created with rice powder each day in hopes of good fortune. To please their gods, villagers in Bali (bottom) hoist an intricate offering—made of 240 pounds of dyed rice paste—after driving it three hours to Besakih Temple.

Let me digress a moment. Milling scrapes off the rice seed's hull and then successive layers of bran—which coat the kernel—and also the embryo, until what's left is only the shiny white kernel itself. That's about 80 percent starch. The rest is mostly water, plus protein and minute amounts of phosphorus, potassium, calcium, and B vitamins. If some bran is left on, you have brown rice, which contains additional minerals and vitamins in the bran.

Millers sell the bran for cattle feed. Japanese use oil extracted from it in salads and for cooking; they believe it promotes longevity. In the U. S. the bran is sold in health food stores and also goes into pharmaceuticals and cosmetics, in India and Egypt into soap.

As to the starch in the kernel: IRRI researchers found that its makeup determines the cooking quality—specifically, the percentage of the starch component called amylose. If it's low, 10 to 18 percent, the rice will be soft and somewhat sticky, as preferred in Japan, Korea, Taiwan, China. If it's high, 25 to 30 percent, it'll be hard and fluffy, to the taste of India, Pakistan, Sri Lanka. In between tends to be the preference of Southeast Asia—Indonesia, Thailand, Malaysia—and the U. S. and Europe. Laos likes it extra low, about 2 percent—very sticky, glutinous, gluey, *but* every kernel distinct. So if you're served a clump of mushy, shapeless rice, don't blame the amylose, blame the chef. That rice was cooked with too much water, or simply too long—and when that happens, it'll come out this way, no matter what its starch composition.

**N**OW I'M ON A HILL IN BALI, looking down on a valley with terraced rice fields rising one above the other—a mosaic in shades of green, a sunny panorama of bucolic peace. But it's more than that; it's a manifestation of human beings striving to stay in harmony with nature, with the supernatural,

and with one another. And rice is never far from their minds.

Water from higher up, from 3,300-foot-high Lake Batur, feeds springs and streams and then flows down through networks of dams, tunnels, and pipes to narrow channels and tiny weirs, so that each field can get a share. To make sure of that, hundreds of farmers' irrigation associations apportion who'll get how much and when. Each association, or *subak*, maintains a temple at its water source; there are smaller temples at outlets down the line and little shrines in individual fields. All these are for rituals at every stage of the rice cycle—plowing, transplanting, harvesting.

"Such rituals are the main characteristic of Balinese agriculture," I'm told by Nyoman Sutawan, a professor of agricultural economics at Bali's Udayana University. "Praying and making offerings unite the farmers so they'll cooperate, which is essential."

The making of offerings in Bali never stops—at shrines in the family compound, at clan temples, *subak* temples, and hundreds of village temples, at full moon, at new moon, on auspicious days, on every 15th day when possibly harmful spirits are especially prevalent. And rice is invariably involved.

Every morning, after cooking the daily rice, housewives put some on small pieces of banana leaf and set these down where spirits are likely to be. On the kitchen stove, in the courtyard. In Guang village I follow a young woman as she leaves more offerings at the compound entrance and on the road outside. A little white dog traipses after her and gobbles up the rice. "The spirits must be fed so they'll be happy and not bother us," she tells me. But didn't the dog do the eating? That doesn't matter, she says, the spirit had already enjoyed the essence of the offering.

To temple anniversary festivals women walk with elaborate offerings balanced on their heads—round constructions three to six feet high, made up of fruit, flowers, incense sticks, and a variety of rice cakes dyed brown, yellow, green, pink. I see the women put their offerings down to pray, then carry them home again; they've been blessed by the gods, and now the family will enjoy eating all that's edible in them.

For a big wedding, or a tooth-filing ceremony, or purification after a cremation, Balinese may order huge offerings fashioned from dyed rice-flour paste molded into panels with a

profusion of geometric designs or figures of animals, humans, or gods. A lady says it takes her and half a dozen helpers three days to make one that's eight feet high, with 33 colors. The biggest she's seen, a temple offering, measured 15 feet.

How much rice do the Balinese eat? An average of a pound a day each—and that's before it becomes heavier as it takes on water in the cooking. In Myanmar it's a bit more than a pound; in Thailand and Vietnam about three-quarters; and in Japan a little more than a third. Americans, by contrast, consume an average of 22 pounds *a year*.

CULTIVATED RICE, so scientists theorize, originated in more than one place along a broad arc from northeastern India to Myanmar, Thailand, Laos, and Vietnam to China. Solid evidence in the form of rice grains 4,000 or more years old has been unearthed from 31 sites in China. The most significant of these is in the lower Yangtze River plain at the village of Hemudu in Zhejiang Province, because it also yielded sophisticated tools of animal bone and wood—signs of a highly developed Neolithic civilization of 7,000 years ago.

Farmers digging a flood-control ditch in 1973 came upon pieces of pottery and called an archaeologist. Lin Hua-dong of the Zhejiang Academy of Social Science remembers his amazement at what he found 12 feet down. "A mass of rice grains looking fresh and yellow," he tells me. "But in a couple of minutes, on contact with the air, they turned dark brown, and soon they were black." A museum at Hemudu displays dozens of those slender black grains. They look as if they'd been burned.

Outside the museum with this ancient rice, farmers raise rice of the newest sort—rice with hybrid vigor, a remarkable Chinese achievement. Fifty-five percent of the country's rice land is planted in such rice, with a considerable increase in yield. These lands turn out two-thirds of all the rice in China. Researchers at IRRI and in India, Japan, and the U. S. are still trying to catch up.

The key factor is this: First-generation hybrids produce seed in very high quantities. But this seed, while good for eating, is not good for planting; it would produce a poor crop. To grow a good crop the following year, you need a fresh supply of first-generation hybrid seed from a nursery. And in China, that would call

ARM'S LENGTH offers scant protection to an Indian worker spraying insecticide. Skin, eye, and lung ailments afflict many rice farmers in developing nations—where protective gear is not required and chemicals are subsidized. Health-related costs often outweigh any gains in yield. And because insecticides kill natural predators of rice pests, spray use is in decline.



for huge amounts of seed. Even given the country's plentiful manpower and land, and a centralized economy, how could it be done?

To produce hybrid seed is cumbersome. The rice plant is self-fertilizing—that is, it has both male and female organs. To cross two varieties, you must normally remove the male parts from one variety and then fertilize it with pollen from the other, all by hand. This is manageable on a small scale, for plant breeding; it would be impractical for turning out the huge quantities of seed needed by farmers.

But in the 1970s Professor Yuan Long-ping found a way. To oversimplify a bit: An assistant discovered a wild *Oryza* species on Hainan island with natural male sterility. Seeds of male-sterile rice developed from that species were planted in a row next to a row of *Oryza sativa* and were fertilized by wind-carried pollen from the second row. By planting alternating rows of the two types,

plentiful production of seed was achieved.

I visit Professor Yuan, who directs the Hunan Hybrid Rice Research Center in Changsha, and ask him if that discovery on Hainan wasn't just luck. "It was by lucky chance," he replies, "but we knew what we were looking for. And—as Louis Pasteur said—chance favors the prepared mind."

His success, he adds, has a good and bad side. "In the past we had great food shortages, so this is a good change. But now we have overproduction, rice is stored all over the place, and we're changing our strategy—keep the high yield but improve the quality. Too bad the government won't give us as much research money as before."

In Changsha, I hear that the Hunan Institute of Cultural Relics and Archaeology has evidence of 8,000-year-old rice. That would be the oldest ever found! I rush to see Pei An-ping, who excavated at Pengtoushan, near Lixian,

120 miles northeast of Changsha. He shows me a pottery fragment with the impression of a rice husk—the grain disappeared in the firing, leaving only the impression. Carbon dating put its age at between 7,800 and 8,200 years.

Scientists from Japan, the U. S., and Britain have seen this, says Dr. Pei, and they couldn't decide whether it's from a wild or cultivated variety. Dr. Pei believes it is the latter.

Back in Zhejiang Province, I'm in time for something big at CNRRI, the Chinese National Rice Research Institute, near the capital, Hangzhou. It's a three-day rice evaluation tasting, supervised by Professor Shen Zongtan. "We have 150 samples from 15 provinces," he says. "Some may look good but do not have very good eating quality."

Four dozen evaluators from all over China sit at four tables and pass around small aluminum boxes, each with a number, to rate their contents on tally sheets for smell, appearance, and taste, from five for the best down to one. Occasionally they sip a little water and spit it into a basin.

At first I don't detect many differences, and so I get a little bit of coaching. White and bright is good, a little yellow not good. When you chew it, is it springy? Good. Or does it stick to your mouth? Not so good. After chewing does it dissolve smoothly—it should. Or does it stay a little lumpy?

Soon I sniff and taste, sip and spit, and evaluate. "Very soft, doughy, a two. Soft but with character, slightly sweet fragrance, a four. . . ."

Once the results are tabulated, says Professor Shen, "we'll take the ten best, consider yield, pest and disease resistance, and growth duration, and choose which to popularize." As for me, whenever eating rice since then, I've been silently giving it a number. Any fives? Just one, in Washington, D. C.: Firm, springy, fragrance of butter and chives—Uncle Ben's brand, cooked by my wife.

LIGHT-YEARS from Asia's puddled paddies, a plane soars over laser-leveled fields in California's Sacramento Valley, showering seed an acre a minute. At harvest, a combine equipped with a stripper header, which plucks grains but leaves stalks standing, can haul in as much as 250 tons of rice in one day. If combine owner Milt LaMaifa had to do it by hand? "We'd be out of business."

NEXT STOP, JAPAN. At the Grand Shrines of Ise, 190 miles southwest of Tokyo, the most revered precinct of Japan's Shinto religion, white-robed priests cook rice twice daily and present it to the sun goddess, Amaterasu, who, they say, is the ancestor of the imperial family.

"The goddess brought a handful of rice from the heavens," a senior priest tells me, "so that we may grow it and prosper." He adds that in the first ceremony performed by each new emperor, he steps behind a screen to meet the goddess and emerges as the embodiment of Ninigi no Mikoto, the god of the ripened rice plant. Then every autumn the emperor sends to Ise the first stalks harvested from the rice field he himself has planted on the imperial palace grounds. All Japanese, says the priest, owe their *kokoro*—their spiritual









TIGHTLY SWATHED against airborne flakes, a woman in the bowels of a Balinese mill bags rice hulls to fuel her brick kiln. "It's itchy work," she says. Hook-wielding workers at Capital Rice Company in Bangkok position 100-kilo sacks on stacks up to 35 bags high. Thailand leads the world in rice exports, shipping 4.5 million tons a year.



essence, their Japaneseness—to the goddess, “and they maintain it by eating rice, rice grown in Japan.”

Japanese law, in fact, long restricted the importation of rice. “Rice is a very special case,” explained Koji Futada, then parliamentary vice minister for agriculture, forestry, and fisheries. “It is our staple food, and so we must have a reliable supply as a matter of national security. That is why we politicians favor self-sufficiency, the domestic growing of all the rice we eat.”

Also because the farmers exert disproportionate influence in elections?

“Yes,” he said, “that is also true.”

And so the government buys rice from the farmers at about ten times international market prices. It also subsidizes part of the cost to consumers. Still, Japanese consumers pay about four times as much as they would if they could buy rice in a California supermarket. All

this cost the government about 2.5 billion dollars in 1992. One result is that land will stay in rice production that might otherwise be available for housing, which is in short supply. About 5 percent of the city of Tokyo is classified as farmland, worked by 13,000 families. That would be space enough for tens of thousands of new homes. Does all this mean that Japanese rice farmers are rolling in money?

Thirty miles north of the capital, in the Kanto Plain, I visit the Kimura family in the town of Kisai—typical of most of Japan’s 3.5 million rice-farming households: Rice is not a major part of their working life. Grandfather Shoiichi, 83, along with his son Takeo and Takeo’s wife, Iwako, both in their 50s, look after a prosperous gardening-supply business; grandson Masao, 25, commutes to an office in central Tokyo. Three out of four rice-growing families hereabouts have become “Sunday farmers,” relying on income from other





## **SANDWICHED BY HIS BURDEN,**

a rice farmer strides through a veritable city of straw stacks in China's Guizhou Province. Developing nations exploit the rice plant from root to leaf tip. Straw provides fuel and bedding as well as fodder for cattle. Skillful hands use it to fashion apparel, rope, bricks, handicrafts, and toys. Rice hulls cushion fragile goods during shipping, and bran yields an oil used for soaps and cosmetics.

sources, mainly jobs in factories that sprang up nearby in the past ten years.

The Kimuras farm two and a half acres—this modest size is typical too—and they tell me the work is not arduous: Except for planting seeds in boxes in a shed, they do it all with machines—transplanter, tractor—in about ten working days for one person, plus a few hours for spraying fertilizer, insecticide, and herbicide. “Harvesting is no work at all. We hire a combine.” What do the Kimuras get out of it?

“Enough rice for us to eat for a year,” says Shoichi. “But no profit. Zero.” Expenses go up, rice prices don’t. It’s the same for most farmers around here. “We do this only because we inherited the land.”

But nature and international politics are forcing a change. An unusually cold and rainy summer reduced Japan’s 1993 harvest by some 25 percent, so more than two million tons of rice will have to be imported before the end of this year. And after that, a newly revised global treaty—the General Agreement on Tariffs and Trade, or GATT—will oblige Japan to allow annual imports of 4 to 8 percent of its rice requirements. But will the domestic rice price drop? Hardly. The government still sets the wholesale price, and that’s likely to stay high.

**S**INCE MOST RICE IS EATEN in the countries where it’s grown, the amount in world trade is small, only about 4 percent. The biggest exporter is Thailand, with 4.5 million tons a year, and among the dozens of firms with huge warehouses along the Chao Phraya River at Bangkok, one of the biggest is Capital Rice. Milled rice arrives by truck from the north—I see 100-kilo bags stacked 27 high—to be cleaned, sorted, graded, and packed for shipment to the Middle East, Europe, Africa.

I congratulate the young manager, Chongchai Buranapatimakorn. He sold 130,000 high-grade tons to the government of Iran, for \$305 a ton; but he held off buying the rice from his suppliers until the delivery time, three months later, and by then the price had dropped \$25, so he made an extra three and a quarter million dollars. “It was something of a gamble and could have gone the other way,” he says. “Nobody can predict prices even one month ahead.”

The number two exporter is the U. S., with 2.2 million tons, and third is Vietnam. Until

1988 much of Vietnam suffered shortages, but then the communist government lifted restrictive rules and price controls; production soared, and since 1989 Vietnam has been exporting more than a million tons a year.

**E**UROPE FIRST HEARD ABOUT RICE from writers who’d been to India with Alexander the Great. Later, Greek authors of medical texts influential in imperial Rome, and in the West and the Arab world through the Middle Ages, prescribed rice for gastrointestinal complaints, citing its cooling and astringent effects. Doctors today endorse this notion of rice’s effects and recommend giving rice powder mixed with water and salt to children suffering from diarrhea in nations such as Bangladesh and Pakistan, and in the Middle East. It helps the patient retain body fluids.

Today Europe’s biggest producer is Italy, notably in the Piedmont region, in the province of Vercelli. Here a great plain, once marshy, but drained since Renaissance times, inclines gently from the foothills of the Alps southward to the Po River, crisscrossed by a gigantic irrigation network. When the fields are flooded in spring, I’m told, villages appear as islands afloat on shimmering mirrors.

Now in September the fields are beige. Among them here and there rise tile-roofed quadrangles, each once the center of a rice property with stables for oxen and horses, dormitories for workers, a church. Young women from all over Italy came to work here from April to October—it was a respectable way to earn a dowry. They were called *mondine*, cleaners, because they did a lot of weeding. Also transplanting and harvesting. Quite a few married local young men. All that ended as mechanization spread in the 1960s.

At a quadrangle that once housed 300 women and 50 men I hear that the landowner in Genoa rents out his 1,200 acres—now seven people take care of it all. And I meet a *mondina* who came from the south—Maria Manfredato, 60, squat and lively, with curly black hair piled high. Yes, it was hard work, she says—long hours with your feet in mud and water, constantly bent over. “But we sang while working. If you didn’t sing, your back would hurt more. When I tell young people, they say I was crazy, but I enjoyed it—we had a lot of fun.” And yes, she married a man from Vercelli.

DANCING FLAMES ease morning chill in Nepal, where a young boy plays in the glow of a fire built to burn off last season's rice straw. Burning controls pests and clears soil for tilling. While most Nepalese rice is grown along the low-lying Ganges Plain, some sprouts at 10,000 feet—the world's highest paddies.



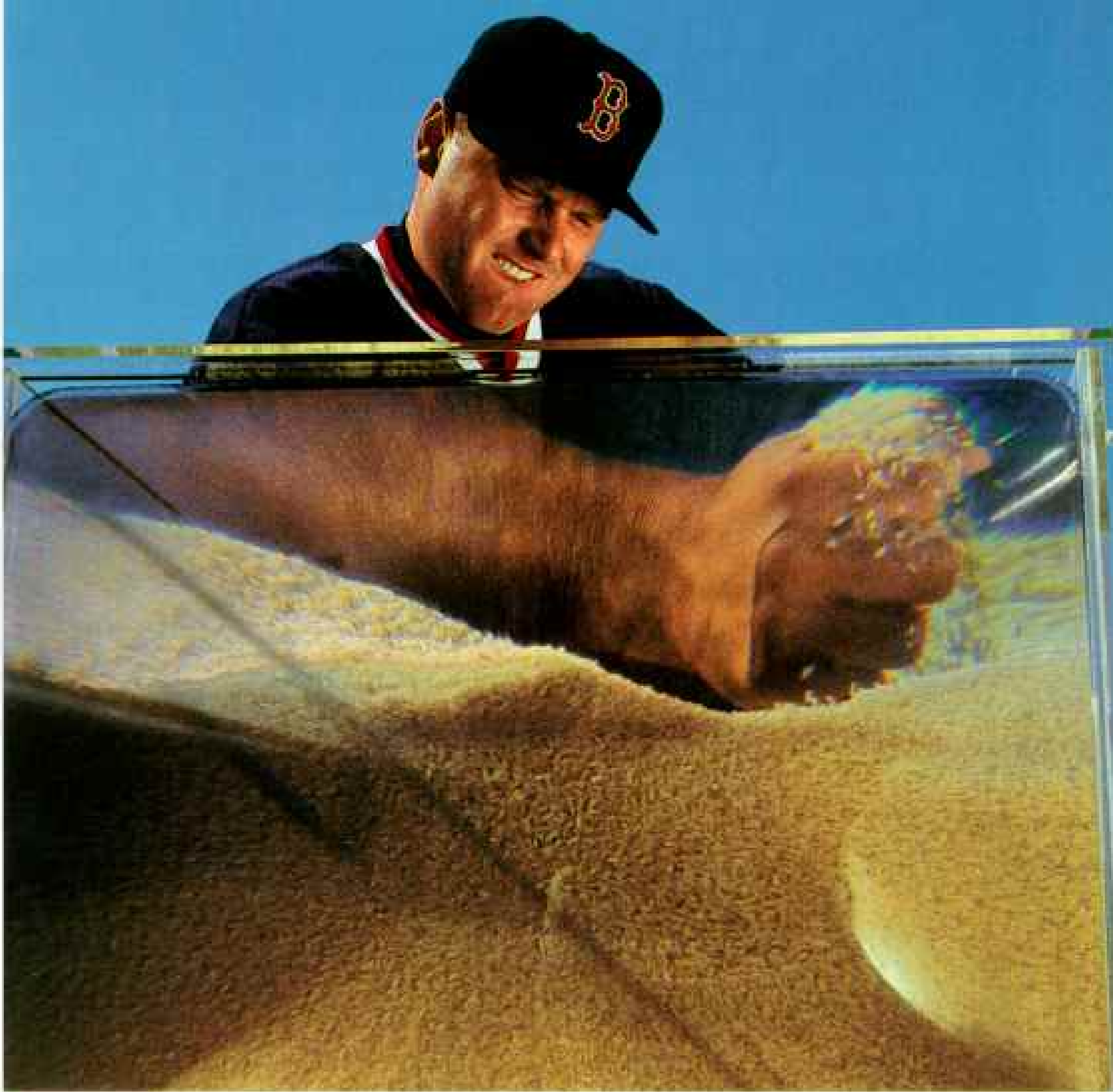
**I**N CONTRAST TO ITALY time seems to have stood still in Senegal, on the southern bank of the wide Casamance River, where I find the Esudadu Jola people, remarkable for their thousand-year-old way with rice.

When brackish water from the mangrove swamps seeps through their dikes, they flush it out with rainwater piped from field to field through conduits made from hollowed-out trunks of the *Borassus* palm. To cultivate during the rainy season, they use no plows, no animals. Our cattle, they say, are not for work, only for sacrifices at ceremonies. Their tool is the *kajando*, or fulcrum shovel, an elongated wooden spade with a metal edge and a six-foot handle. You slice into the wet clay soil and lift sizable chunks by levering against your left leg just above the knee. Then you turn the chunks over as you drop them to the right and left, building up ridges. The dug-out space becomes a furrow.

At the village of Samatit, I see a dozen men slice, lift, and turn, and in a few minutes they've transformed a diked field overgrown with rice stubble and foot-high weeds into neat ridges and furrows. Soon it'll all be flooded, and women will start transplanting.

The fastest man with a *kajando* is Kuñarigei—age 36, six feet tall, barefoot and wearing only a loincloth, his skin glistening in the humid 93° heat. He is a science teacher in a secondary school in the faraway capital, Dakar. For the three months of the school vacation—from July to October, coinciding with the rainy season—he returns to the village to help his father, Suti, the 65-year-old village chief, who works in the fields from dawn to dusk.

Nowadays most of the older boys go away to city schools, but they also come back to help, says Kuñarigei, and so do most of the girls who work as domestics in Dakar. "They do a lot of transplanting with their mothers.





Some have had to quit their jobs and now will have to find new ones."

**T**HE JOLA and other West Africans skilled in rice growing, shipped as slaves to colonial America, were instrumental in building a prosperous southern rice-planting society, notably in tidewater South Carolina. It flourished in the 18th and 19th centuries and began fading after the Civil War. Today U. S. production is concentrated in Arkansas, Louisiana, Texas, Mississippi—and California, one of the most efficiently mechanized rice producers in the world and for a long time the most controversial.

"Our yield is wonderful, 8,500 pounds per acre," says Bob Herkert of the California Rice Industries Association. That's among the

AMERICAN AS BASEBALL AND BEER, rice helps fuel both. Boston Red Sox pitcher Roger Clemens adds muscle to his 95-mph fastball by squeezing fistfuls of rice. "If done properly, it's exhausting," he says. Anheuser-Busch, the world's largest brewer, uses rice to brighten its beers. "Bud Light's my best seller," says Sharon Smith, a vendor at Busch Stadium in St. Louis.

highest anywhere. As we drive in the Sacramento Valley, between the Coast Ranges and the Sierra Nevada, Bob makes appointments for me over his mobile phone and ticks off some pluses of this great American rice bowl.

Poorly drained clay soil, for one thing. That's ideal for rice because it holds in the precious irrigation water from the Shasta and Oroville Dams. Precision leveling of the fields with laser-controlled earthmovers. That eliminates high and low spots, so less water will be needed; all in all, water use is down 30 percent.\* "We seed by airplane, and depth of water is critical—say, five and a half inches," he adds. An inch lower and weeds will outgrow the rice. An inch too much and the seed won't get well enough established.

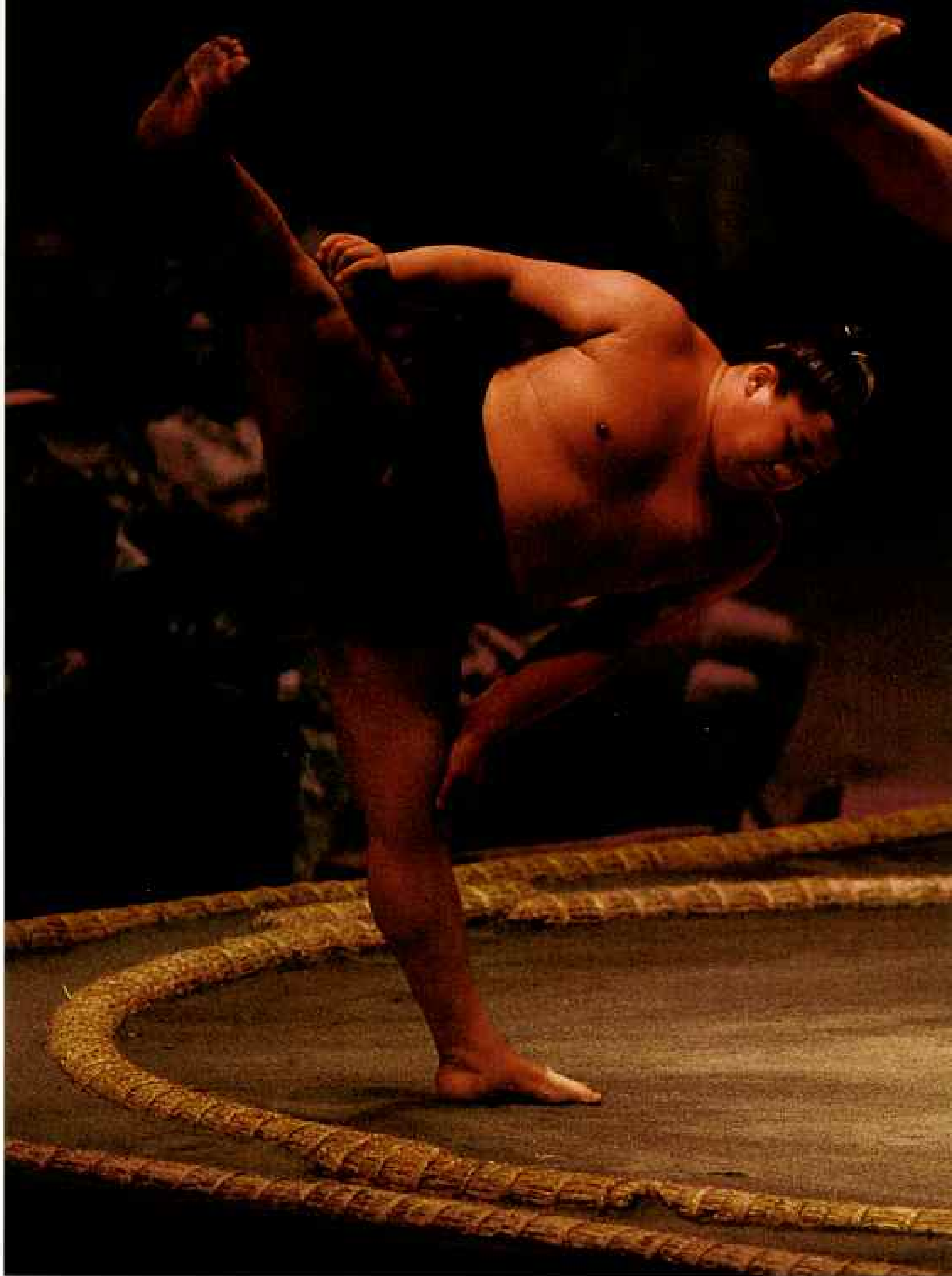
"Environmentalists hated us," Bob goes on, "but no more." When the fields were drained, a lot of herbicide went into the river, and the city of Sacramento had to treat its drinking water heavily. To some it tasted awful. "We thought we had to drain after seven days or the chemicals would hurt the crop. But we found that if we keep the water moving, with pumps, we can hold it for 28 days and the chemicals break down naturally." Now the herbicide discharge is down by 99 percent.

Not that the California rice growers have no critics any more. One big complaint: Why put rice into a semiarid valley and use 1.5 million acre-feet of water a year—that's nearly half of what 16 million people use from metropolitan Los Angeles all the way to San Diego! Replies Marc Reisner, an environmentalist author who criticized the rice growers but recently changed his mind: "Rice uses much less water than does cotton in the San Joaquin Valley farther south, and that provides no environmental benefit. But rice can."

How so? The California rice bowl, I learn from Jack Payne, a biologist from Ducks

\*See "California: Desert in Disguise," in the November 1993 Special Edition on Water.







**A BEEFY BALLET** precedes a sumo match in Hawaii as wrestlers perform the ritual *shiko* exercise. Victory in this honored Japanese sport comes when one behemoth topples the other or pushes him out of a 15-foot-diameter circle ringed with dirt-packed rice straw. Competitors bulk up at tables groaning with rice. From sushi to sake to simple fare, the grain dominates the Asian diet, providing at least a fourth of the calories for much of a continent that grows by 55 million people a year.

**GENTLE TOUCH** from a trained elephant named Vellamma bestows a blessing after a schoolgirl leaves a gift of cooked rice at Nataraja Temple in Tanjore, India. In Sanskrit, the country's ancient language, the word *bohuvrihi* means a wealthy person, as measured in rice. Such wealth will be sorely needed in this fast-growing nation, which already has 900 million mouths to feed.

Unlimited, can be a boon to waterfowl migrating from Alaska and Canada along the Pacific flyway. Now there's a pilot project: With practically all of California's natural wetlands gone, some rice farmers in the Sacramento Valley, where fields lie fallow from October to February, let them flood early, so mallards, pintails, widgeons, snow geese, and tundra swans will come and winter here. . . .

At Williams, I visit an energy plant fueled by rice hulls. They're piled up outside in beige mountains, partly covered with black plastic. "Electricity for 30,000 homes," says a manager. Yes, it's the biggest operation of its kind.

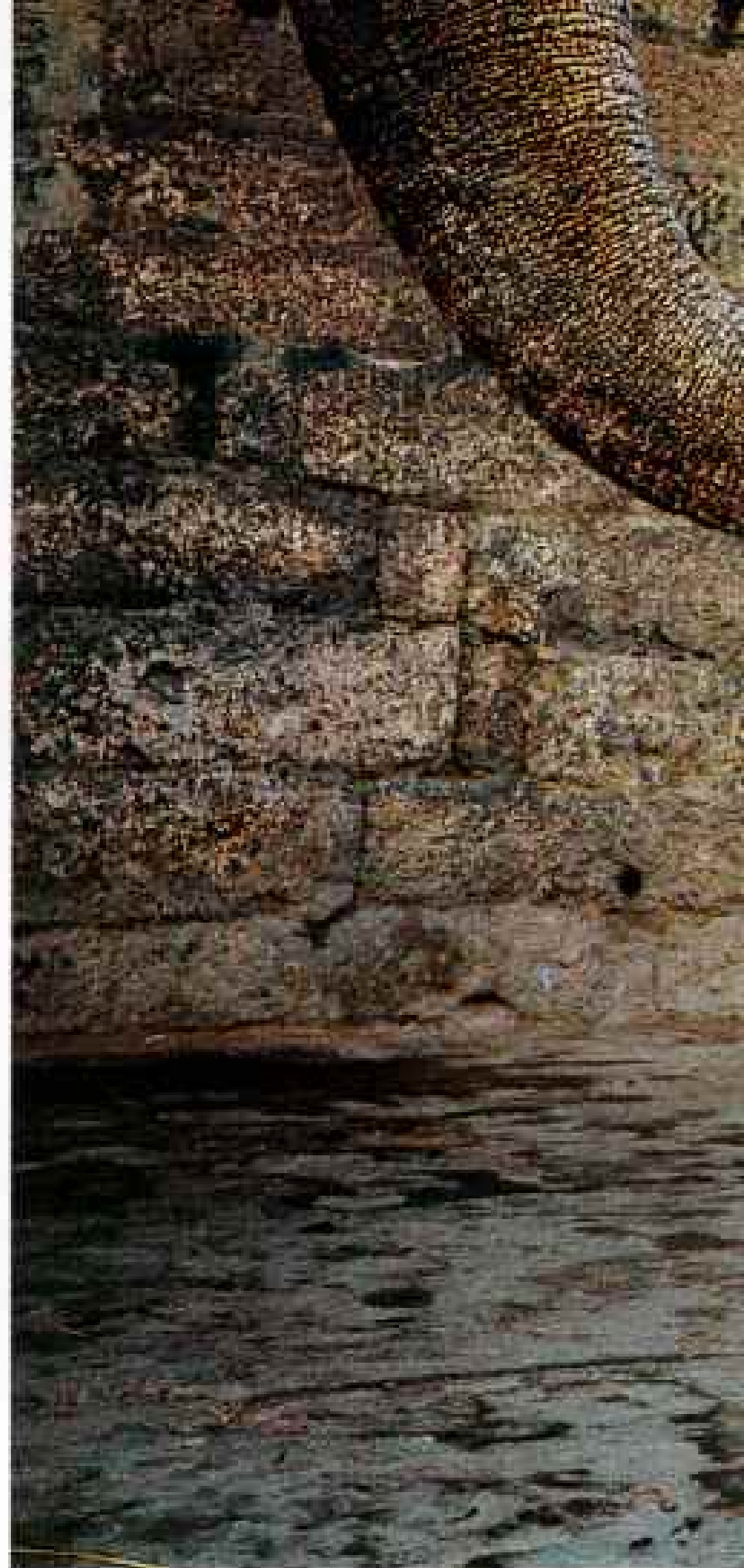
Near Marysville, Michael Rue, who with his family farms 2,000 acres, shows me the latest technological wrinkle—a stripper header on his combine. It doesn't cut the whole plant but just strips off the grain and harvests twice as fast. Speed is important, Rue says. "If rice stays too long in the field, it becomes too dry and too many kernels break in the milling."

I see how fast it goes as I ride along, 14 feet up, in Rue's combine operated by Antonio Placencia from Mexico. He keeps going as he eats a sandwich for lunch; he says he wants to do 160 tons a day. How does he like working here? Fine, he says; he comes from May to November and in 15 years has saved enough from his wages to build a house and a furniture store back home in Guadalajara. Every ten minutes or so a "bankout wagon" comes alongside and receives the combine's rice through a tube while both vehicles keep moving.

As I drive off again, I notice a big gray cloud on the October horizon—smoke from burning rice stubble. That also used to upset environmentalists; it made smog that sat on the valley like a lid. Now such burning must be approved by a county pollution-control officer. Today it's OK; there's no temperature inversion, so the smoke will disperse quickly. A new law requires that burning be reduced each year until nearly all is stopped by 2000. That's

where those migrating birds should be of help. In the rice fields they'll feed on waste grains, aquatic insects, snails—and at the same time stamp down the rice straw, helping decompose it. "They're our partners," says Steve Dennis, who farms at Maxwell. "They leave little deposits of fertilizer." A great swoop of white-fronted geese has just set down nearby and is starting to feed, stamp, and fertilize.

Rice consumption in the U. S. is rising. While the annual per capita rate is nowhere near those in Asia, it has come up from 14 pounds to 22 in the past decade. That an increasing proportion of the U. S. population is of Asian and Latin American background may have something to do with this. Also, rice has begun to be seen as part of a healthy diet, with gourmet possibilities. Just about every





year there's a new rice cookbook. Imports of a fragrant Thai rice called jasmine are up. Also of basmati from India and Pakistan, which not only has a pleasant aroma—I've heard it called exotic popcorn—but a striking appearance too: In cooking, its grain grows to almost twice its length. A basmati-like variety now grows in Texas, trade named Texmati; it's aromatic but doesn't elongate much. The growers say they've been working on it; an elongating version should go on sale next year.

**A**T THE END of my rice travels I remember what I was told by Klaus Lampe, the director general of IRRI. He said that because population expansion is not yet under control, research will have to find ways to grow more rice on less land and with

less water in view of increasing urbanization. And with fewer inputs of chemical fertilizers, insecticides, and herbicides, for environmental reasons.

Also with less labor, because, in the poorer areas of Asia, many of the next generation may not be willing to walk 50 miles in the mud behind a water buffalo just to prepare two acres for planting—they'll move to the cities.

"So we have to make rice production more attractive work—with mechanization and with pay comparable to a factory job, for example. And to make the economics of rice such that a farmer can produce so much at so low a cost that it will be affordable for both the rural and the urban poor." Dr. Lampe thinks it can be done.

And I want to believe that it will be. □

Wrangell-St. Elias  
National Park

# Alaska's Sky-High Wilderness

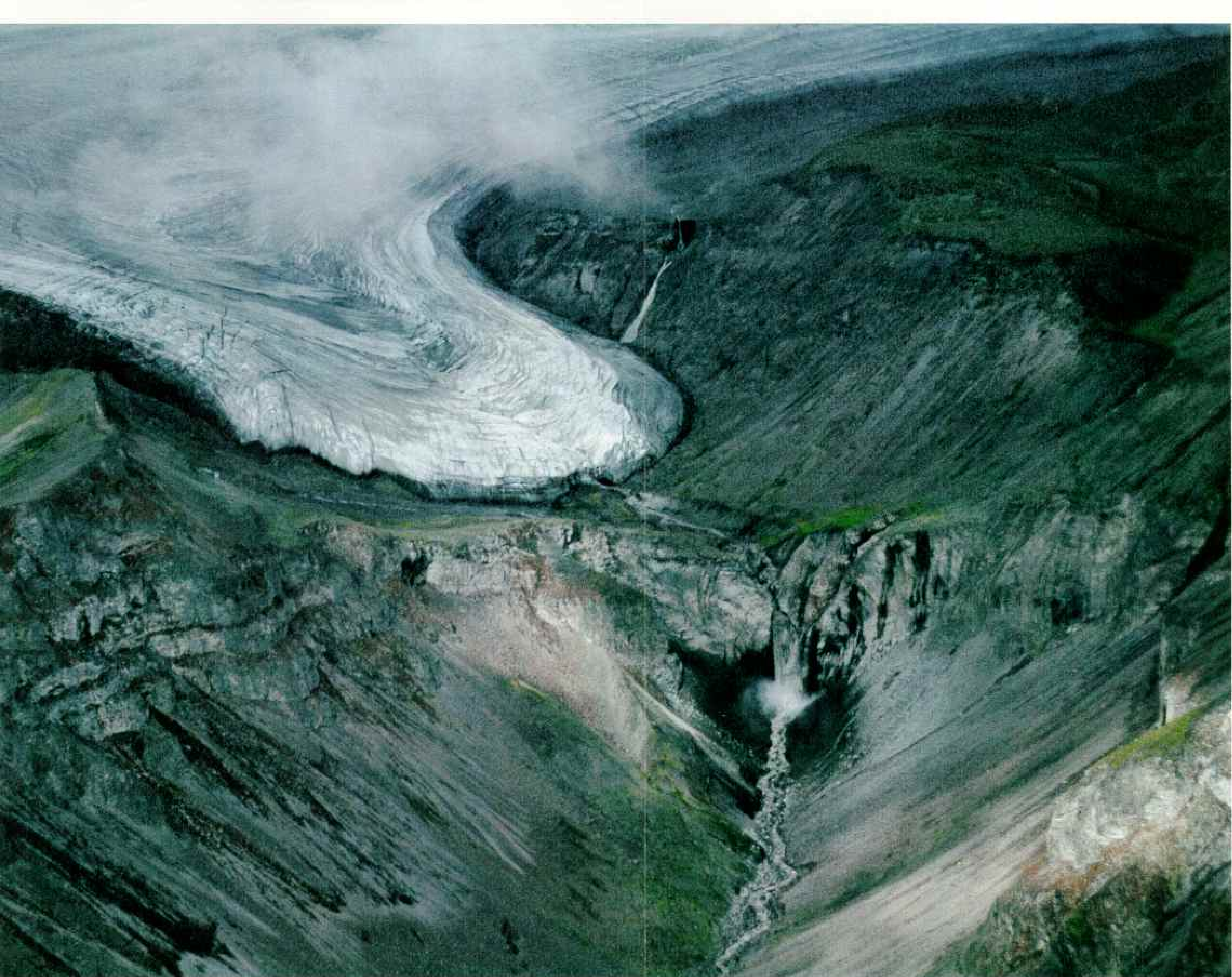


*Meltwater from Cheshnina Glacier pours over the lip of a natural ladle in Alaska's Wrangell Mountains. Where miners once rip-roared is now a mother lode of national park land: Visitors to the onetime boomtown of McCarthy are greeted by a swallow perched outside the lodge.*

BY NOEL GROVE  
NATIONAL GEOGRAPHIC SENIOR WRITER

PHOTOGRAPHS BY  
GEORGE F. MOBLEY  
NATIONAL GEOGRAPHIC PHOTOGRAPHER







*dunes (below) that choked out a spruce forest along the Tana River.*

*The tortured landscape of Wrangell-St. Elias National Park and Preserve—named for the two mountain ranges that form its backbone—makes fine habitat for the surefooted mountain goat (left). Its most lethal predator comes on two feet: Poachers risk fines to hunt goats and prized Dall sheep. Illegal hunters keep one eye on their prey; the other looks out for rangers patrolling by plane.*

*Honed by glaciers that ground its rocky blades, the Granite Range (top) saws through the sky. Stone worn to dust by glacial pressure washes downstream to form deltas veined by braided channels that snarl over a 40-mile stretch of the Chitina River (opposite).*

*Dust is also carried by wind; relentless downhill currents deposited*







I CAN'T GET OVER the feeling that I'm the last person on earth. Or maybe the first. In the sweep of an eye from Chitistone Pass I see not one human sign, only snow-packed peaks, gray stone ridges, and, far below, a broad

green valley. Through the valley winds a river born from a dripping glacier.

It is mid-June, but at 5,822 feet I slog through patches of snow. A grizzly has left its signature in them as well, long claw marks fringing oval paw prints. Like me, it is moving from the Wrangell Mountains to the St. Elias, for Chitistone Pass marks the meeting point of these two ranges in southeast Alaska.

I prepare to yield to that humpbacked monarch, the griz, just as the nation has yielded to nature in these rugged mountains. In 1980 Congress established Wrangell-St. Elias National Park and Preserve and ordered that it remain essentially undisturbed. The result is our biggest national park — 13.2 million acres, an area larger than New Hampshire and Vermont combined (map, page 88). Wrangell-St. Elias is perhaps our wildest and least known park, home not only to grizzlies but also to wolves, wolverines, caribou, moose, mountain goats, and, its best known wild denizen, the snow-white Dall sheep.

Here bigness is a trademark. Nine of the 16 highest peaks in the U. S. are found in Wrangell-St. Elias. The park could swallow five Yellowstones. Lands privately owned within its borders total a million acres, most of them set aside in the Alaska Native Claims Settlement Act of 1971. Yet fewer than a hundred people live here year-round.

This could be the tail end of the last ice age. Down the valleys creep more than 150 separate glaciers, a collection unmatched outside the polar regions. The most spacious, Malaspina Glacier, is larger than Rhode Island.

"Many of these valleys were filled with ice, and not very long ago," I had been told by Ed LaChapelle, a glaciologist. "The cool northern climate here delayed its disappearance, and glaciers are receding as the great ice sheets did before them. So if you want a glimpse of what Wisconsin and New York were

like 12,000 years ago, you can see it here."

It is not entirely so, for humanity has left its mark on these mountains. Slow-healing tire tracks mar the alpine bowl at the top of the pass; a scientific team in the 1960s had helicoptered in a motorcycle to speed their rounds to research stations. Thirty miles west, the copper-mining complex at Kennicott employed as many as 550 workers for a quarter of a century, and a small suburb, McCarthy, sprang up a few miles away.

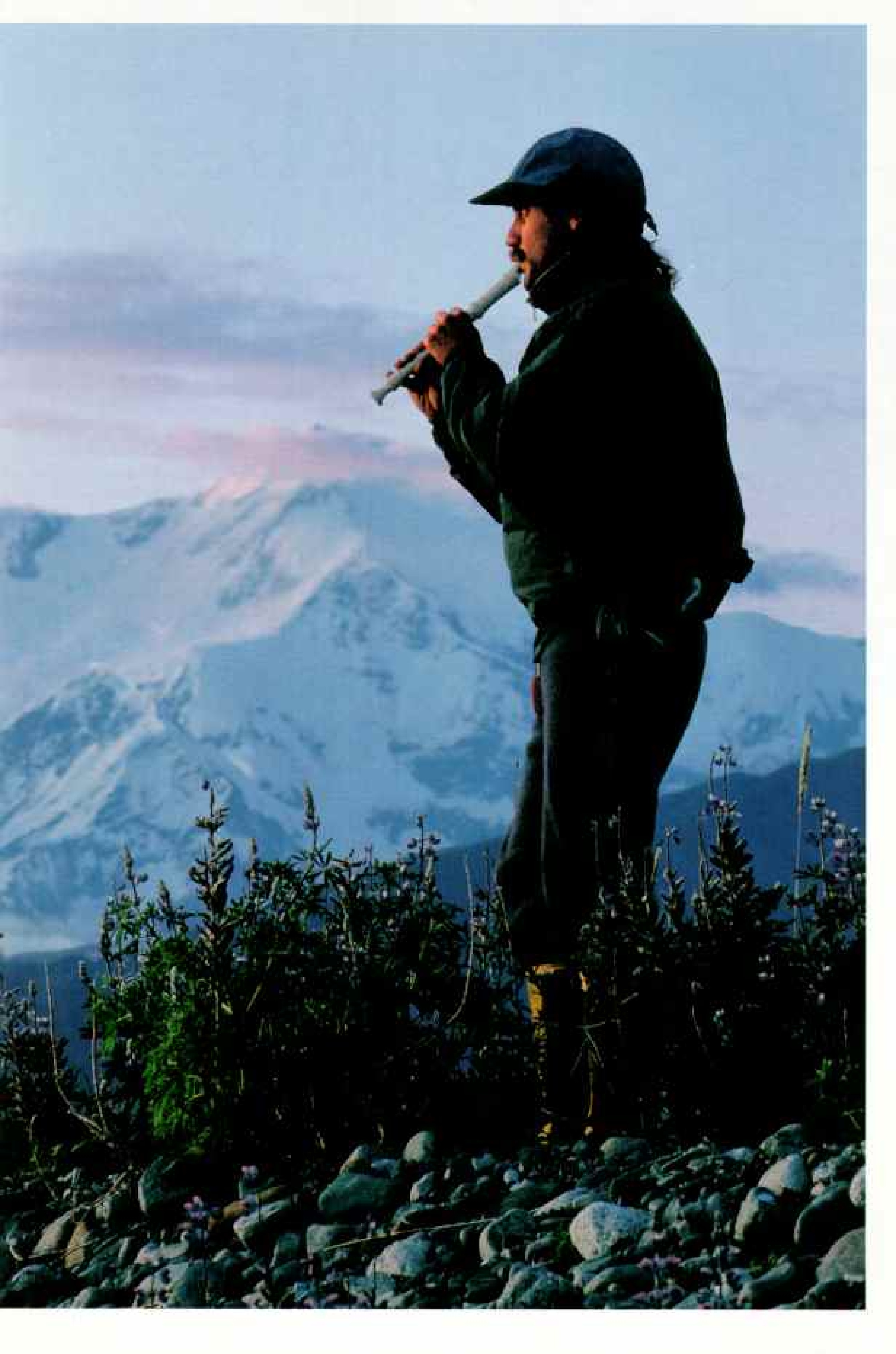
Wonderfully empty as Chitistone Pass appears to me now, it was once a thoroughfare for prospectors heading for goldfields two days north. It was part of a route that some called "a hideous nightmare." Among the hundreds who survived the quicksand, icy rivers, and precipitous "goat trail" between McCarthy and Chitistone, half turned back when they saw that the way lay over a glacier split by deep crevasses. Of those who forged ahead, some 50 died. I wanted to gain a sense of what had drawn them.

Like most of today's travelers in Wrangell-St. Elias, I shortcut my trip to the gold by bush plane. From 1913 to 1915 the boomers turned Bonanza Creek upside down, in a time of quick fortunes and even quicker suspicions. The latter, at least, has not changed. When I arrived at the cabin of one of only two active miners north of the pass, I was met by a .30-30 rifle and the command, "State your business."

Grace Byrd apologized later. "We didn't go to the claim today with my husband, Paul, and

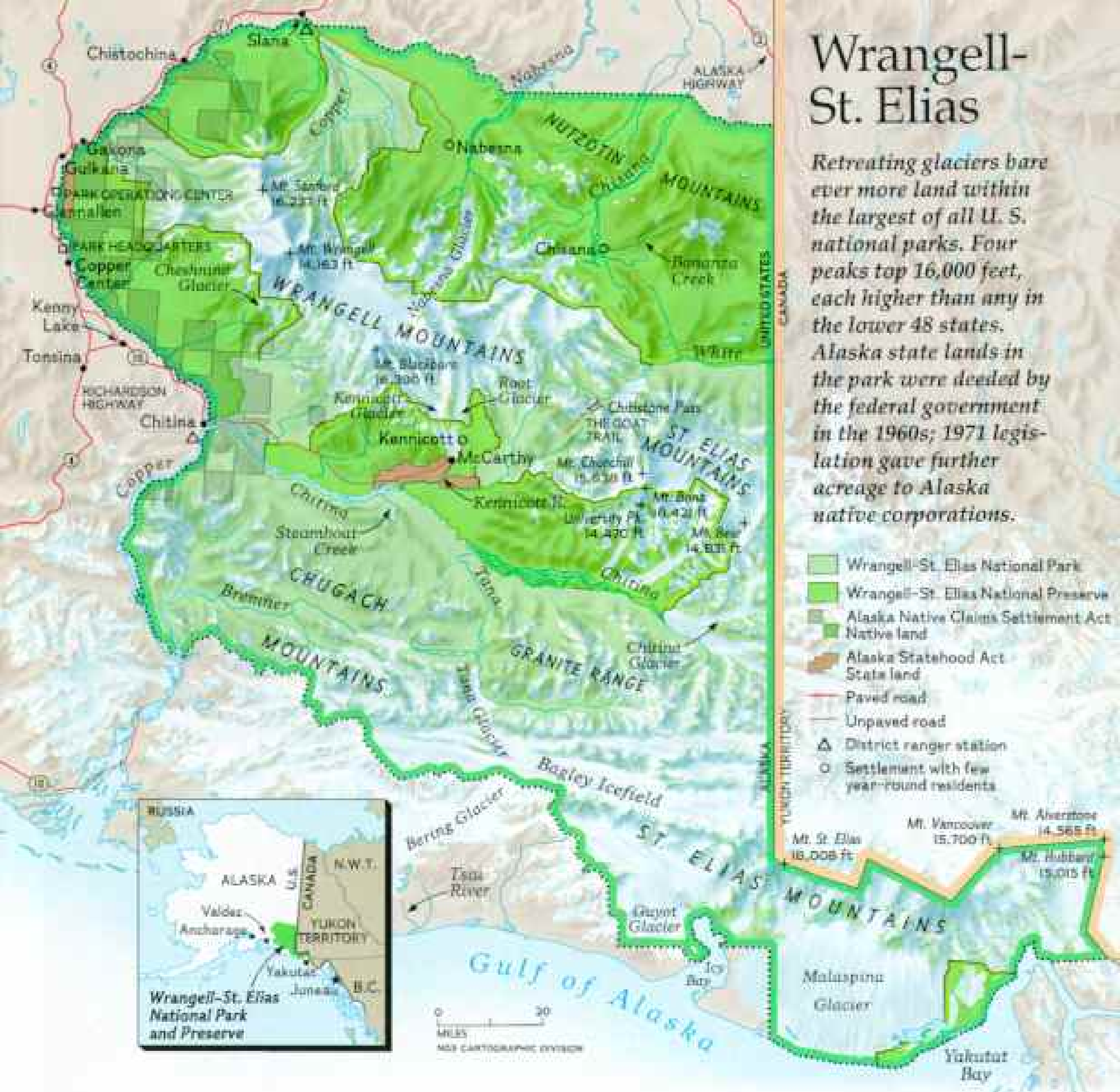
*S*erenading Mount St. Elias, the park's highest peak, guide Andy Romanoff improvises near Icy Bay: "The recorder has

a spiritual sound, and this is a spiritual place." He also works with a group that wants to limit logging in southeast Alaska.



# Wrangell-St. Elias

Retreating glaciers bare ever more land within the largest of all U.S. national parks. Four peaks top 16,000 feet, each higher than any in the lower 48 states. Alaska state lands in the park were decided by the federal government in the 1960s; 1971 legislation gave further acreage to Alaska native corporations.



When half the town parades on the Fourth of July, that leaves about 40 other McCarthy residents plus tourists to cheer them on. A magnet for rugged individualists, McCarthy harbors citizens who may not mind summer's tourist cash but are getting a little testy about growing congestion.



he told me to meet any visitors with a gun." She served me a plate of ham and beans while her 14-year-old daughter, Blyss, stoked the wood-burning stove.

A rangy Vietnam veteran, Paul Byrd prefers wilderness to a society he believes has gone rotten. "This is therapy, being out here," he said that evening, wearily tipping his chair against the wall. "The gold is just a bonus."

Therapy began the next morning with a two-mile walk to the claim on Bonanza Creek. Paul squirmed into a diver's dry suit and pulled on a mask (page 91). Then he went head down into waist-deep water that was 36°F. A chugging motor ran a compressor supplying air to his mask and a pump that sucked pebbles and sand onto a riffle board at the back of a small raft. The heavier flakes of gold fell between the bumpy slats. Grace watched from the bank. Blyss read a book on a sunny rock. "My mom says this experience will make a better person of me," she told me.

After 90 minutes in the water, Paul climbed out to wrap his numbed hands around a cup of coffee from a thermos. "An ounce of gold is a good day for us," he said. "It's not much money for all the hardship, but I consider it a privilege to be out here. It takes a raw kind of person for this life."

**T**HIS IS NO PLACE for the Winnebago crowd. Only two roads enter the park, both gravel, with bumps that can turn a camper's dishes into scree. One road spears into the park's heart from the west and stops a mile short of the little village of McCarthy. The other arcs 45 miles in from the north and ends at the airstrip and houses of the Ellis family, hunting guides. Wrangell-St. Elias is one of 52 areas (out of 367) administered by the National Park Service that allows sport hunting in designated preserves. To keep populations healthy, guides are assigned an annual quota of customers who can shoot only a specified number of each game species.

In this profound wilderness, campsites don't welcome a wanderer, marked trails don't point the way. There are valleys that have never been walked, peaks never scaled.

The Alaska National Interest Lands Conservation Act of 1980 made a park out of the wilds of Wrangell-St. Elias, formerly administered by the Bureau of Land Management. The legislation directed the Park Service to maintain unimpaired the scenic beauty and

quality of the mountains, valleys, lakes, and streams "in their natural state."

"When people ask where they can backpack, I tell them they must know how to use a map and compass," said Peg Pattee, a seasonal ranger. "We try to get a feeling for their level of experience, and if it's good, we sell them topographic maps. If not, we discourage an unguided hike."

Despite the rugged terrain, Park Superintendent Karen Wade told me she considers Wrangell-St. Elias "highly accessible," thanks mostly to the skills of Alaska bush pilots. Private fixed-wing planes can land anywhere pilots feel they can safely set down, an access forbidden in national parks in the lower 48. Hunting guides fly clients to postage-stamp landing strips, jump-off points for stalking Dall sheep, goats, bears, and moose. Mountaineers and their gear are flown to the base of their goal. A few "flight-seeing" services offer aerial views.

The Clauses, a modern frontier family, operate a fly-in lodge on the Chitina River, just south of the center of the park. John and Paul, father and son, pilot planes for hunters and vacationers while wives Eleanor and Donna manage the home base of six log cabins, called Ultima Thule. A third generation, Ellie, eight, and Jay, five, are schooled at home in books and bear avoidance. My wife, Barbara, and I joined the Clauses for an unforgettable week of aerial exploration.

Paul Claus's second home is a Super Cub, the cloth-covered, single-engine plane designed 45 years ago that can land at speeds under 50 miles an hour. With two passengers squeezed in behind him, he parks it on glaciers, sandbars, and alpine meadows. His landings and takeoffs could often have been done on a baseball infield.

One day we landed alongside a river named the Tsiu and hooked eight-pound sockeye salmon, broiled for supper that night at the lodge. A Shangri-la valley and gleaming lake pulled us down another day to a green meadow. Sharp ridges collared by cottony clouds lined either side, and a waterfall brushed a nearby cliff like an angel's wing. Barbara cast a gaudy lure into the lake and a silver bullet shot from the depths and struck it savagely. We flew home hours later with several one-pound rainbow trout—"breakfast fish" John Claus called them. And they were.

We soared over unnamed, untouched



valleys laced with creeks and gleaming with wetlands. Trumpeter swans rowed the air below us. Moose cows and their long-legged calves ducked their heads in shallows and came up munching salad. In flights over the mountains I often saw the park's star herbivore, the Dall sheep, sought for the trophy of thick, curved horns. From the Super Cub they were mere snowflakes against a high green lawn. I wanted a closer look at the animal that draws hunters from all over the world.

Afoot, Barbara and I zigzagged slowly upward through loose rubble and steep grassy slopes and finally bellied up to a high ridge and peered over. Six rams rested in the sun, a bachelors' club in summer, to be head-butting rivals for ewes within a few weeks.

We set up a spotting scope and studied the horns that continue to grow throughout the animal's life span of 10 to 14 years. One set had completed its first spiral, and the tips now

extended ahead of the old ram's eyes, beginning a second curl. Forty-plus inches in length, they would gladden the hearts of most sheep hunters. The current record is 49.5 inches.

Poaching for trophy sheep remains a major problem. "We have only four rangers for fieldwork," said chief ranger Jay Wells, "and they are often busy with other duties, from answering complaints to rescue operations.

"And in the past the fines have been around \$500. That's nothing to a person who pays \$5,000 to \$8,000 to a guide to get a sheep, not counting travel expenses and licenses. We've heard that guides are offered up to \$100,000 for a trophy sheep, found most easily in the park where they shouldn't be hunted."

Fortunately the courts are starting to up the ante in terms of fines statewide. Two recent convictions carried fines meaningful even to a well-heeled hunter. One was assessed \$5,000 for taking a sheep outside the preserves,



*“Graybeards and striplings and women” joined Alaska’s gold rush, wrote Robert W. Service—and they still come. Summering in a 1930s miner’s cabin, 14-year-old Blyss Byrd helps parents Paul and Grace prospect in Bonanza Creek. The stream was abandoned by miners more than 50 years ago, but a portable*

*suction dredge (below) enables the Byrds to glean leftovers (right), up to an ounce a day. They keep less than half; the rest goes to Anchorage businessman Jim Moody, who owns 16 local claims.*

*“It’s not quite profitable—park rules make it difficult to use a backhoe,” says Moody, whose claims were grandfathered*



*when the area became a national park. “I’ll keep at it. Things might loosen up.”*



Another paid \$50,000 for altering a young ram’s horns to make them appear legal.

Even in the hunting preserves—about a third of the total park acreage—the horns are not easily taken. The terrain is steep, the hazards often sudden and unexpected.

A pair of likable, athletic sheep-hunting twins from Anchorage joined us for dinner one night. Ask quiet, sandy-haired Mike Phelps a question, and he would grin as dark-haired, gregarious Marty answered. Next morning they headed into the hills, two brothers as close as they were different.

Marty was in the lead five days later when they walked up an unnamed canyon, staying near a glacier wall to hide themselves from sheep on the opposite slope. “There was a noise,” Mike said later, “and Marty turned to me and said, ‘We’d better get out of here—’”

Truck-size chunks calved off the glacier, tipping outward and onto the Phelps twins.

Protected from the tons of ice by a small depression, Mike clawed his way free. Hearing no response to his frantic shouts and unable to move the ice, he raced 30 miles to a hunting camp, calling Marty’s name all the way.

Rescuers returning with him noted that more of the glacier leaned over the break-off point, dangerous for digging attempts. Marty Phelps’s body remains under the shattered ice.

From the air Paul Claus and I retraced Mike’s agonized marathon a few days later, over deep-cracked glaciers, lumpy moraine, through bogs, spruce forests, and an icy river. We landed on the glacier to pick up Marty’s backpack, left by Mike in the futile hope that his brother might have survived somehow and would eventually crawl free.

“Those two did nothing wrong,” said Paul, as we looked upward at gray walls of stone reaching toward low, dark clouds. “This is just very unforgiving country.”



*Forget the three-hour drive along an abandoned railroad bed. The real challenge involves using a hand tram across the roaring, frigid Kennicott River to reach the village of McCarthy.*

*Still, thousands of the park's 45,000 annual visitors pull across each year—on busy holidays waiting as long as three hours for a turn. The intrepid find a lodge, a pizza parlor, and—five miles into the hills—an*

*abandoned copper mill.*

*Most locals support plans for a footbridge, but if officials try to erect a vehicular span, "We'll fight tooth and*

*nail," declares resident Nancy Green.*

*Though bone cold, the silty river leaves sun-warmed mud flats irresistible to local*

*youngsters Gaia Thurston-Shaine (below, at left) and Tyler Green. "Once I got stuck," says Tyler, "but Gaia pulled me out."*





**I**T IS ALSO broken country, majestically broken, tilted in a monumental collision between earth's shifting plates of hardened crust. The vertical terrain discouraged much human settlement. Liberally managed by the Bureau of Land Management, it became a wild resource for locals who hunted on it, cut firewood, and mined for gold. When Congress created the park, Alaskans saw it as a lockup of a huge tract they had felt free to use. Sport hunting was restricted to preserves, firewood was off-limits except for subsistence, and most gold mining was shut down under the Park Service's strict environmental guidelines.

The first park employees reporting to duty more than a decade ago met hostility. A Park Service plane was torched, and some restaurants in Glennallen just outside the west park boundary refused to serve park employees.

Burly park ranger Jim Hannah has stayed to see relations improve. In uniform he joined me for lunch in a Glennallen sandwich shop,

where the cook joked with him about the day's specials and a few other customers lifted their arms in greeting.

"First day I arrived, a service station attendant refused to sell me gas," he said in a deep voice that never varies in pitch. "Now people complain about park policy, but it's not personal. I think they've gotten somewhat used to having us around."

But not entirely. Aware that protests continue, Karen Wade occasionally hears out park residents. I followed the tall, soft-spoken superintendent and her chief ranger, Jay Wells, to the little settlement of Chisana (pronounced shuh-SHAH-nah), a scattering of log cabins accessible only by airplane or a week-long hike. Residents who work as outfitters or own homes elsewhere drifted to the open-air meeting, bringing complaints about hunting guidelines, construction permits, and restricted use of all-terrain vehicles (ATVs).

White-bearded Glenn DeSpain in a Copenhagen tobacco cap tucked snuff behind his lip and glowered. "Because of the demands you people make, soon there will be nobody here, just the way you want it."

"Everybody will have moved back to Los Angeles," offered tall, lanky Ivan Thorall, whose gold-mining operation the Park Service shut down.

"Bein' fed their mush," barked Glenn. "Bein' regimented."

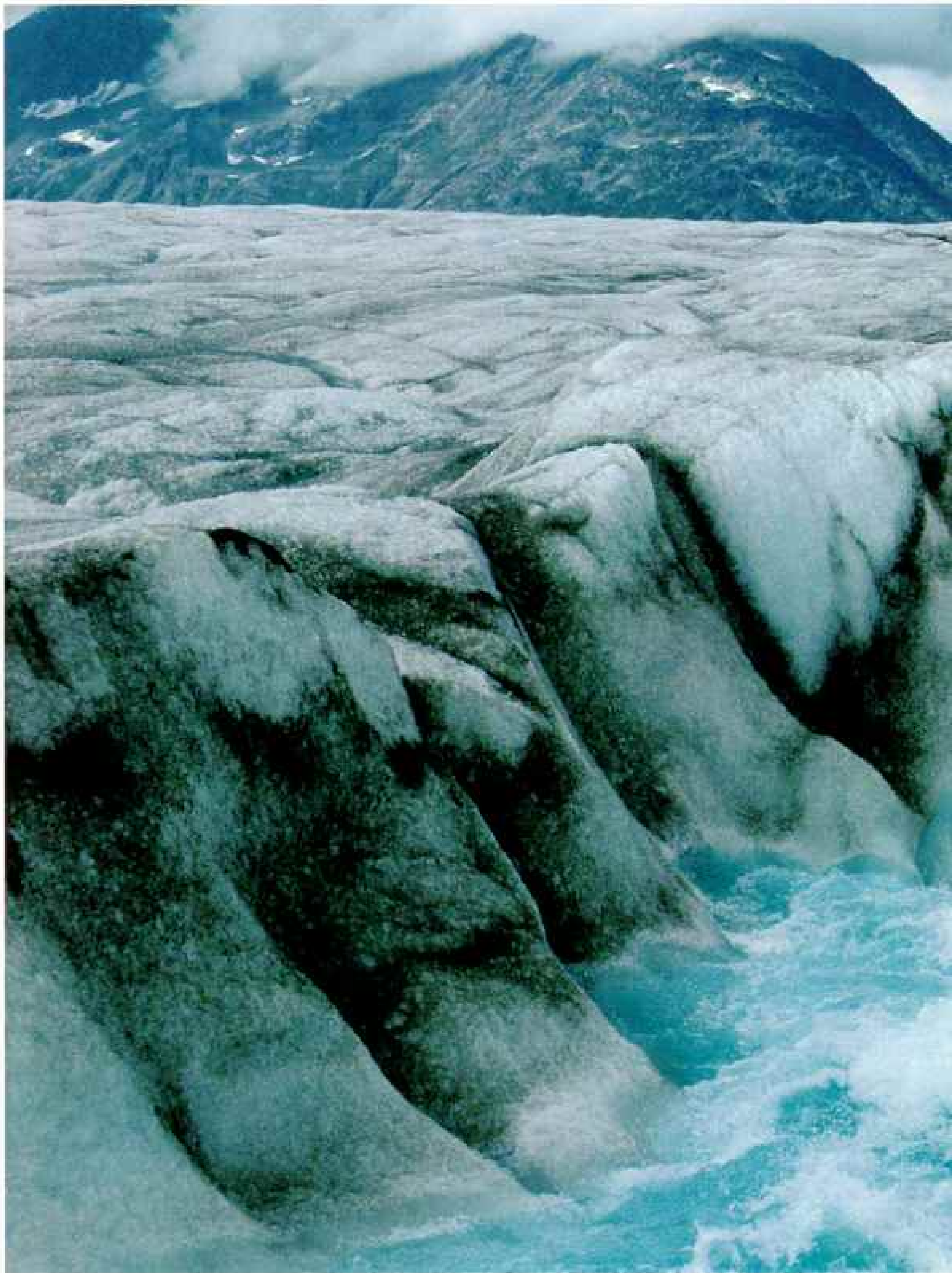
Outfitter Terry Overly strolled over, dressed in black from cowboy hat to boots.

"I see a lot of legalities being carried out here, but no justice," he said, never raising his voice. "You chase away a poor miner when mining is part of the culture. You worry about ATVs tearing up the land when Caterpillars that came here for the gold mining tore it up worse and it healed itself. You call this public land, but pretty soon nobody will be able to use it but the Park Service."

"Terry gives it to you straight," Jay Wells said later, "but he's wrong about the land healing itself. The vegetation is completely different where those Cats tore it up. People here forget that legislatively we're required to protect the park against human damage."

The Greater Copper Valley Chamber of Commerce at Glennallen would like to see campsites, more roads, marked trails, and guided tours to attract tourist dollars. "Thousands of visitors drove through here last year on the way to Valdez, and most didn't even





*"If you fall in here, we won't bother even looking for the body," says guide Paul Claus, edging up to the frozen brink of an abyss on the Tana Glacier. As summer sun melts ice atop the glacier, rivulets disappear into*



*surface holes. In time trickle becomes torrent, and a hole widens to a moulin, a gaping cave that plunges into the bowels of the ice—likely more than a thousand feet in this case.*



know the biggest park in the U. S. was right across the street," said Connie Sackett, who operates an information booth in town.

"None of us want to see this area ruined," said John Downes, chamber president. "But we feel more access to the park would bring more people here."

"Wilderness is disappearing faster than people think," I was told in Anchorage by Paul Haertel, associate regional director for national parks in Alaska. "Wrangell-St. Elias is a treasure worth preserving, a large intact ecosystem rarely found any more. We see ourselves as bankers, saving it for the future."

No feathers are more ruffled than those of hunters. In addition to limiting sport hunting to preserves, officials have limited shooting caribou, long a meat source for Alaskans. Surveys show the park's estimated 6,000 caribou have been whittled to fewer than 2,000 within the past decade.

"For 20 years I took caribou around Gul-kana," a hunter told me. "Now they tell me I can't do that any more because the animals are decreasing. But the wolves are causing that, and the Park Service protects them."

The park has become a laboratory for a study of wolf predation.

"Although there are many environmental and behavioral factors at work, we believe wolf populations drop when their prey decreases, and the caribou numbers then gradually increase," explained park biologist Kurt Jenkins. "Trouble is, we don't know how long this takes, maybe longer than the lifetimes of the biologists studying it. In the meantime, we've complicated the process by adding people as a caribou predator."

"We're not here to guarantee an opportunity to shoot an animal," Jay Wells said patiently one afternoon. "We're here to maintain a natural system."



**A** hungry harbor seal in his sights, Rudy Pavlik takes aim from his fishing boat in a tidal creek off the Malaspina Glacier.

"They'll raid your nets as fast as you put them in," says Rudy. He, two brothers, and their father are allowed to support their commercial fishing operation from a cabin on park land because they had been at it for decades before the park was designated.

Rudy has taught the trade to his five sons, including 13-year-old Jeremiah and 12-year-old Jonathan (left). Yet he feels park regulations make doing business tougher each year.

"They really just want to edge us out of here eventually," he says. Meanwhile, each fall the Pavliks fill their

boats with salmon (below) and fly the fish across Yakutat Bay to Yakutat for sale. In summer they cross by boat, sometimes

braving 15-foot seas. Rudy has lost a brother in the perilous crossing: "But the fish don't do you any good where you can't sell them."



**F**RED EWAN remembers when his people lived off the animals they shot. He is one of the Ahtna, a group of Athapaskan Native Americans, possibly the first people to use the valleys after the ice left. The oldest campsites found in the park date back thousands of years.

"It's good they made the park," the 77-year-old told me in the Ahtna settlement of Gulkana. "Good for the animals. There were too many people shooting them.

"We ate moose, caribou, sheep, ducks, and swans," he said. "Also berries, the roots of wild rhubarb, and wild onion. We caught salmon in fish traps made from spruce branches the size of your thumb. Now the young people eat white man's food."

Most of the million acres of private property within park boundaries are held by the Ahtna native corporation. Plans to harvest spruce along the road to McCarthy offend both park

personnel and environmentalists. The only road approaching the center of the park, they argue, should not be lined with stumps.

"It's Ahtna land; they have a right to use the resource," said John Devenport, land manager for Ahtna, Inc., which plans a 20,000-acre harvest. "And most of those trees have been infested by the spruce bark beetle."

At the southern edge of the park another logging operation by the native Chugach Alaska Corporation is opposed by a coalition of environmental groups called the Alaskan Rainforest Campaign. Lawsuits pit habitat protection against the corporation's attempts to reorganize after bankruptcy.

"We're not against Alaska natives developing their lands," said Steve Kallick, head of the coalition. "But we don't believe logging is a wise use of the Chugach lands, environmentally or economically. Recreational use would provide revenue without harming the area."

So far the courts have opened the way for the logging project.

**W**ITH THE ECONOMIC ventures of Alaska natives now under fire, the road to financial gain in Wrangell-St. Elias has come full circle. Word that the Ahtna used implements made of copper brought white prospectors by 1898, and claims were filed.

Bankrolled by a syndicate of the wealthy Guggenheims and J. P. Morgan, a bold railroad builder named Michael Heney punched tracks through from Cordova on Prince William Sound to the Kennicott Glacier, where copper ore was spilling down a green-tinged ridge. At the end of the line the mining town of Kennicott sprang up, and, along with it, the Kennecott Copper Corporation (the *i* in Kennicott was inadvertently changed to an *e*).

The new company town had its own power plant, hospital, stores, bunkhouses for the workers, houses for supervisors, and a school for children. Drink and female companionship, however, could be had only in McCarthy, four and a half miles south.

From 1911 until 1938 the quiet of the wilderness was shattered by the roar of rock crushers, the *carrump* of dynamite, and the shrilling of shift whistles. A quarter billion dollars in copper traveled the tracks out of Kennicott. This ended when dwindling reserves and low copper prices closed the mines. When the last train pulled out on November 11, 1938, employees who believed the mines would surely reopen took minimal luggage, and much heavy machinery was left in place.

"It was not so much a ghost town as a town that appeared to be sleeping," I was told by photographer and engineer George Herben, who walked into forgotten Kennicott with his wife 16 years later. "It looked like any minute the shift whistle would blow and workers would pour out of the factory.

"In the company store, there were hats in the window and groceries on the shelves. We camped in one of the houses, and that night we just pulled back the blankets and slept on a bed with clean sheets."

At Kennicott the cast-iron drive wheels and oil furnaces stand like silent monuments to industrial expansion against great odds.



**S**harpening skills, climbers scale a 50-foot ice wall on Root Glacier (right). Often

mountaineers stop here before tackling the park's icy peaks—some of the world's most

demanding. Snow-fed Steamboat Creek is not much warmer than its source, but that doesn't

keep rafters from a bracing splash during a three-day Chitina River trip.





German visitors peer through the boarded-up windows as if discovering Machu Picchu. A private foundation spearheaded by the owner of the rebuilt Kennicott Glacier Lodge has raised \$600,000 to shore up the buildings.

The former sin den, McCarthy, has now become the destination point, the sagging mining town to the north its ghostly suburb.

Fewer than 30 people remain to brave below-zero temperatures when snow covers the road from the west. In summer, thousands of tourists arrive. Cars and campers park on the far side of the bridgeless Kennicott River, and the passengers pull themselves over the angry water on a hand tram (pages 92-3) and walk a mile into town.

The attraction is a living daguerreotype:

dirt streets, log houses, a false-front hotel called Ma Johnson's, and moose-horn decor. Entry to the bar of the McCarthy Lodge is through batwing doors. A gift shop sells chunks of copper ore. A pizza parlor opened down the street in the summer of 1993.

**W**ILL SPILLOVER spoil the wilderness? Every year more visitors come, disturbing both local residents who came for solitude and park lovers who fear too much intrusion. "If it continues, we'll probably move to another remote location," said Betty Hickling, who offers rooms and meals at the McCarthy Lodge. But Karen Wade feels the vastness can handle more people.



*Nearly midnight on Icy Bay, and late June twilight still mixes with moon glow. Glaciers that covered this spot 90 years ago continue to carve new features on the many faces of Wrangell-St. Elias.*

of the Wrangell Mountains Center in McCarthy, which promotes environmental education. "In a world as crowded and harassed and polluted as ours, this place can give people a taste of true wilderness and a better understanding of themselves."

My biggest taste came in a weeklong trip through Icy Bay at the south end of the park, where an ice age has retreated within my lifetime. When copper was first mined at Kennicott, most of the bay was still cloaked in glaciers. Now they have withdrawn 20 miles inland, letting in an arm of the sea, leaving land scraped raw in some places, barely greened by young shrubs in others. Photographer George Mobley and I joined ten kayakers paddling for several days to see those glaciers calve into the bay.

Wildlife has quickly claimed the new land. Two bears blundered into our first campsite, galloping away at the sight of us. Moose hoofs clove the soft ground, and harbor seals muttered from ice floes as we carefully maneuvered through them.

"Your life is reduced to a few essentials on a trip like this," said Jeffrey Mann, an emergency-room physician in New Jersey. "I need a return to a simpler existence once in a while to keep my sanity."

Twelve-foot tides left ice chunks high on the beach, and in the sun. We left our canteens under them to fill with melt—cold, pure water that had fallen many years before.

We watched ice thunder into the bay as we perched on a hillside above Guyot Glacier. Twice, after quarter-hour silences, I turned to see if my companions had fallen asleep. Were they quieted by the drama of collapsing ice or by their thoughts about the passage of time as seen in the end of the glacial journey? Or was it the sheer cliffs rising from an ice-flecked sea and the sight of 11 mountain goats walking like flies across the face of one?

"I've seen it happen before," said trip leader Andy Romanoff. "Sometimes people are just struck speechless out here."

As if they were the last people on earth. Or maybe the first. □

"We're not going to develop it like a Yellowstone," she tells me. "But we foresee cooperative arrangements with private property owners inside the park who might want to offer lodges, horseback riding, and camping areas. The short season limits the number of visitors, and the place is so huge that limited activities should not affect it much."

A new visitor center, scheduled to open in 1998, will showcase the park and help hikers plan their trips. "Whatever happens to Wrangell-St. Elias beyond that will require a change in legislation," Karen said. "For now we won't do anything to detract from its natural beauty."

"People who come here are struck by the power of these mountains," said Ben Shaine



OUT OF THE DARKNESS

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MICHELANGELO'S

# LAST JUDGMENT

BY MEG NOTTINGHAM WALSH  
PHOTOGRAPHS BY VICTOR R. BOSWELL, JR.  
BOTH NATIONAL GEOGRAPHIC STAFF

COURTESY OF THE VATICAN MUSEUMS, WITH SPECIAL CONSENT OF  
NIPPON TELEVISION NETWORK CORPORATION





ARCHIVO - ANAGRAFIC - VATICANUM - APPLICAZIONE

LOOMING ABOVE THE ALTAR OF THE SISTINE CHAPEL, MICHELANGELO'S THUNDEROUS VISION OF THE APOCALYPSE, SHOWN BEFORE ITS CLEANING, HAS NOW BEEN FREED FROM THE CRIME OF CENTURIES.





**T**HE POWER AND GLORY OF THE SON OF MAN ARE REVEALED IN AN EPIPHANY OF COLOR AS CHIEF VATICAN RESTORER GIANLUIGI COLALUCCI CLEANS THE FRESCO'S CENTRAL FIGURE. BEGUN IN 1990 WITH FUNDING FROM NIPPON TELEVISION NETWORK CORPORATION, THE "LAST JUDGMENT" PROJECT COMPLETES A 14-YEAR EFFORT TO RESTORE MICHELANGELO'S SISTINE CHAPEL MASTERPIECES.

AND HE SHALL SEND HIS ANGELS WITH A GREAT SOUND OF A TRUMPET, AND THEY SHALL GATHER TOGETHER HIS ELECT FROM THE FOUR WINDS, FROM ONE END OF HEAVEN TO THE OTHER.

MATTHEW 24:31

**W**hen the “Last Judgment” was unveiled in 1541, nearly three decades after the completion of the Sistine ceiling, an awed Pope Paul III fell to his knees in prayer. Others were scandalized: The powerful, beardless Christ looked like Apollo of Greek mythology, the angels had no wings, and the saints had no clothes. Where conventional artists of the time depicted the Second Coming with orderly rows of angels, saints, and martyrs, Michelangelo unleashed a tumultuous sea of jumbled bodies.

In a scene from the lower left corner of the fresco (shown partly cleaned below) the dead slowly awaken, summoned by trumpeting angels. One of them (right) holds a small volume, the Book of the Blessed—the Book of the Damned is much larger. Condemning sinners with his upraised arm, Christ the Judge, surrounded by saints and martyrs, looks on impassively as muscular angels batter the damned down to the mouth of Hell.

As with the ceiling, the “Last Judgment” project was forced upon Michelangelo. He tried to get out of it when Pope Clement VII, who had commissioned the painting, suddenly died. But Paul III, Clement’s successor, declared that he had waited 30 years to

employ Michelangelo—and commanded him to begin.

The preparation of the altar wall alone took a year. Two windows were blocked up, and 15th-century frescoes by Perugino, as well as part of Michelangelo’s earlier work, were sacrificed to accommodate the gigantic fresco. Michelangelo ordered that the wall be slanted inward so that dust could not accumulate. Without Michelangelo’s consent, Venetian artist Sebastiano del Piombo persuaded the Pope to have the wall prepared for oil painting. Not eager to begin his task, Michelangelo waited until that work was completed before



demanding that it be redone for fresco, declaring that oil painting was “a woman’s art and only fit for lazy well-to-do people like . . . Sebastiano.”

Sixty-one when he began the fresco in 1536, Michelangelo was forced to climb six or seven levels of scaffolding each day. Near the end of the project he fell, badly injuring a leg. Locking himself in his home, he refused all treatment until a physician friend forced his way in, finding the artist “in a desperate state.” Nursed back to health, Michelangelo at last completed a fresco that would forever change the course of figurative art.

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*New Light on Michelangelo*, a four-volume work chronicling the restoration of the Sistine Chapel, is being published by R. C. S. Rizzoli Libri S.p.A., Milan; Editions Citadelles and Mazenod, Paris; Mercatorfonds, Antwerp; Random House, Inc. (Alfred A. Knopf), New York; Faksimile-Verlag Luzern, Lucerne; Ediciones Encuentro, Madrid; Wydawnictwa ALFA, Warsaw; and Nippon Television Network Corporation, Tokyo.





VATICAN MUSEUMS

PAGE NUMBERS REFER TO SCENES SHOWN ELSEWHERE IN THIS ARTICLE. THE IDENTITY OF THE FOLLOWING FIGURES IS WELL ESTABLISHED:

ST. JOHN THE BAPTIST (1), ST. LAWRENCE (2), VIRGIN MARY (3), CHRIST (4), ST. BARTHOLOMEW (5), SELF-PORTRAIT OF MICHELANGELO (6),

ST. PAUL (7), ST. PETER (8), ST. BLAISE (9), ST. CATHERINE (10), ST. SEBASTIAN (11), CHARON (12), MINOS (13).

**M**ore than 350 figures—some wearing the faces of Michelangelo’s contemporaries—populate the 43-by-47-foot fresco. Because drips and spills are inevitable when painting wet plaster, Michelangelo worked from top to bottom, starting at the upper left, above angels who bear the Cross and the crown of thorns.

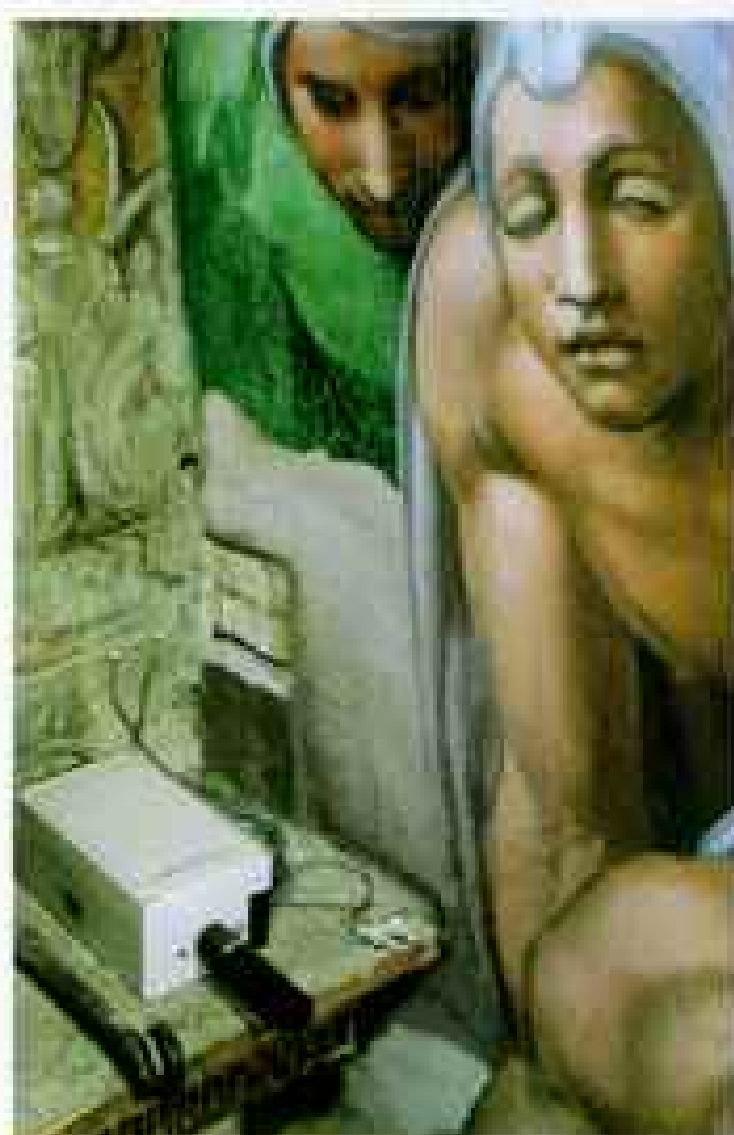
Holding the instruments of their torture, martyrs and saints encircle Christ and the Virgin. Although Jesus is the focal point, Peter and John the Baptist are rendered larger, which helps push them forward in space. For centuries the illusion of depth was flattened by a smoky veil of dirt and soot from candles that illuminated the high altar.

Unlike the ceiling, this fresco was easily accessible and so endured frequent retouchings by early restorers. They applied varnishes made of animal glue, which temporarily brightened the fresco, and they darkened shadows in an attempt to maintain contrasts.

Before the restoration of the “Last Judgment” began in 1990,

the Vatican team tested different solvents and lengths of application (right, patches at center), choosing a gentle but time-consuming cleaning method: First they wash an area with deionized water followed by ammonium carbonate and an organic solvent. The next day they sponge on more ammonium carbonate through layers of absorbent paper, which keep the solution in contact with the fresco. Twelve minutes later they remove the paper and wipe away the loosened dirt, finally rinsing the area with water.

To preserve the Sistine frescoes, the Vatican has installed a climate-control system that



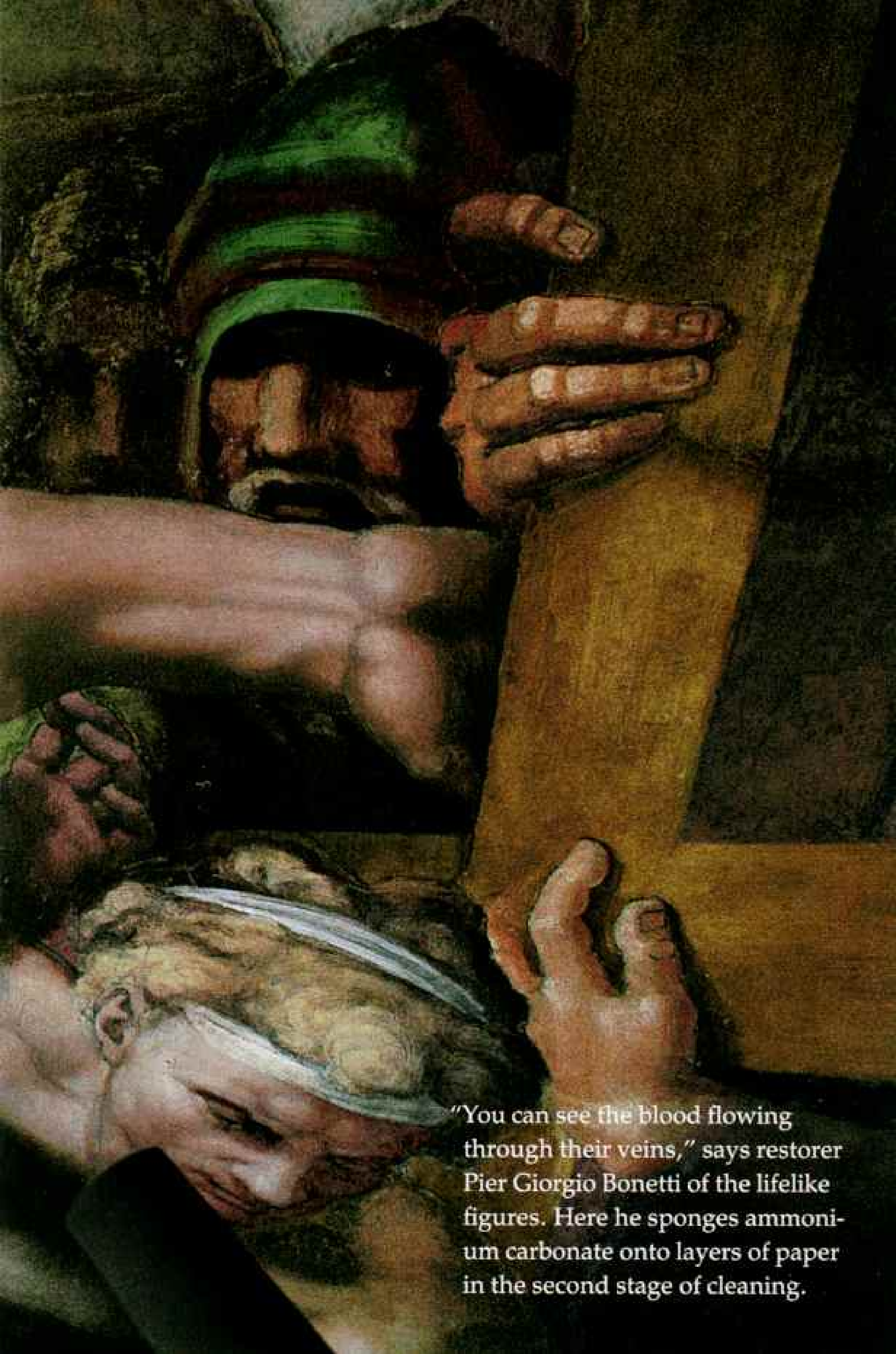
filters dust and chemical pollutants from the air. Ninety-two sensors (above) monitor temperature and humidity to ensure that no moisture condenses on the frescoes—a major concern in a room that receives as many as 19,000 visitors a day.

The greatest danger is a rapid change in conditions, so the artificial environment of 55 percent humidity must be scrupulously maintained, explains Vatican engineer Stefano Marino. "Once you push the button, the system must work forever."









"You can see the blood flowing through their veins," says restorer Pier Giorgio Bonetti of the lifelike figures. Here he sponges ammonium carbonate onto layers of paper in the second stage of cleaning.



## Master of human form and divine color

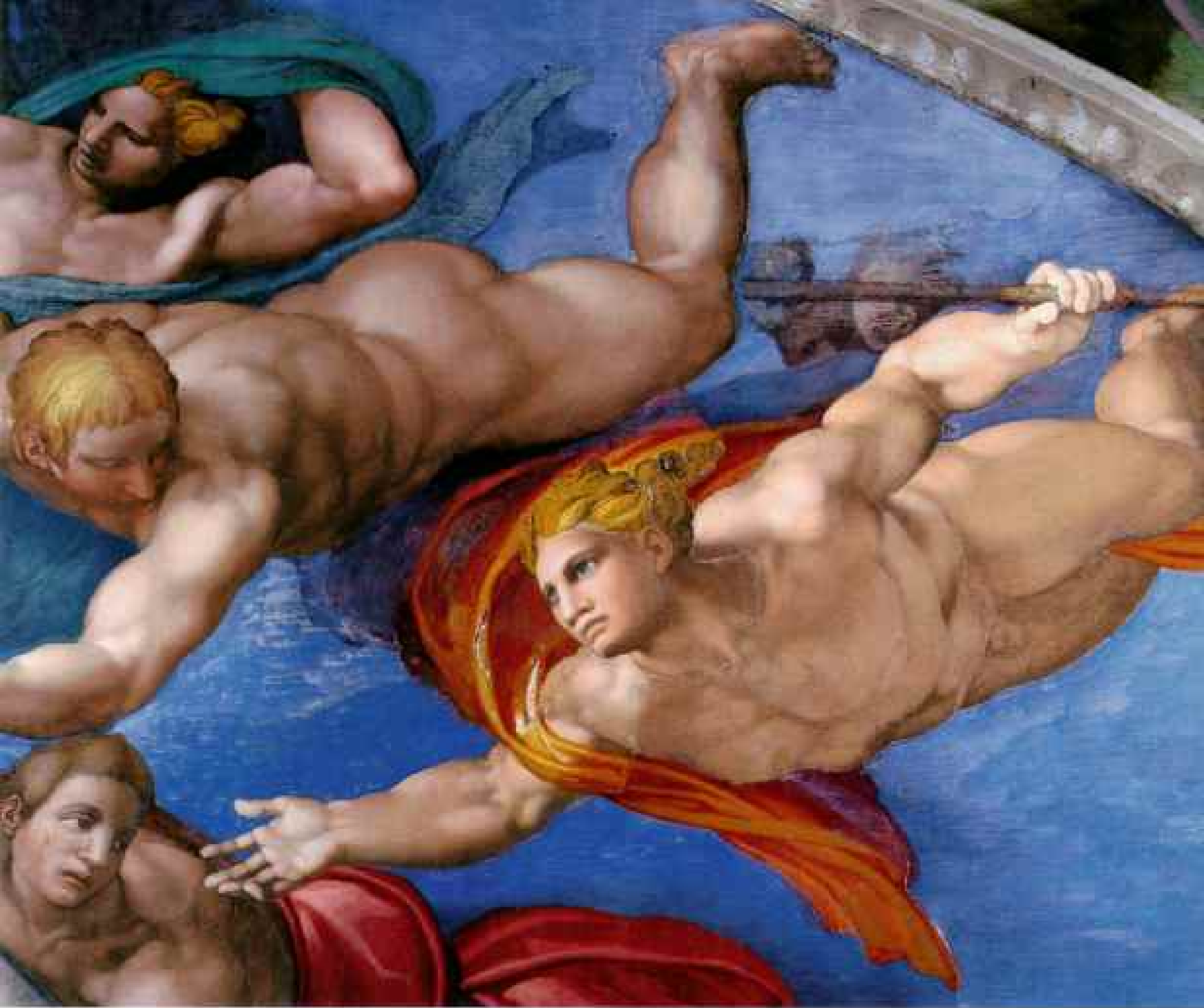


BRITISH MUSEUM

“**I**n this work Michelangelo expressed all that the art of painting can do with the human figure,” wrote biographer Ascanio Condivi in 1553.

Athletic angels (above and sketch, left) struggle with the column of flagellation—a symbol of Christ’s Passion. Michelangelo acquired his intimate knowledge of anatomy by dissecting corpses, a practice Condivi said the artist finally abandoned “because his long handling of them had so affected his stomach.”

A detail of the Virgin (opposite) reveals the hand of the



master. Black marks remain where he transferred the outline of her face by pouncing charcoal dust through perforations in a preparatory drawing, or cartoon, he had placed on the wet plaster.

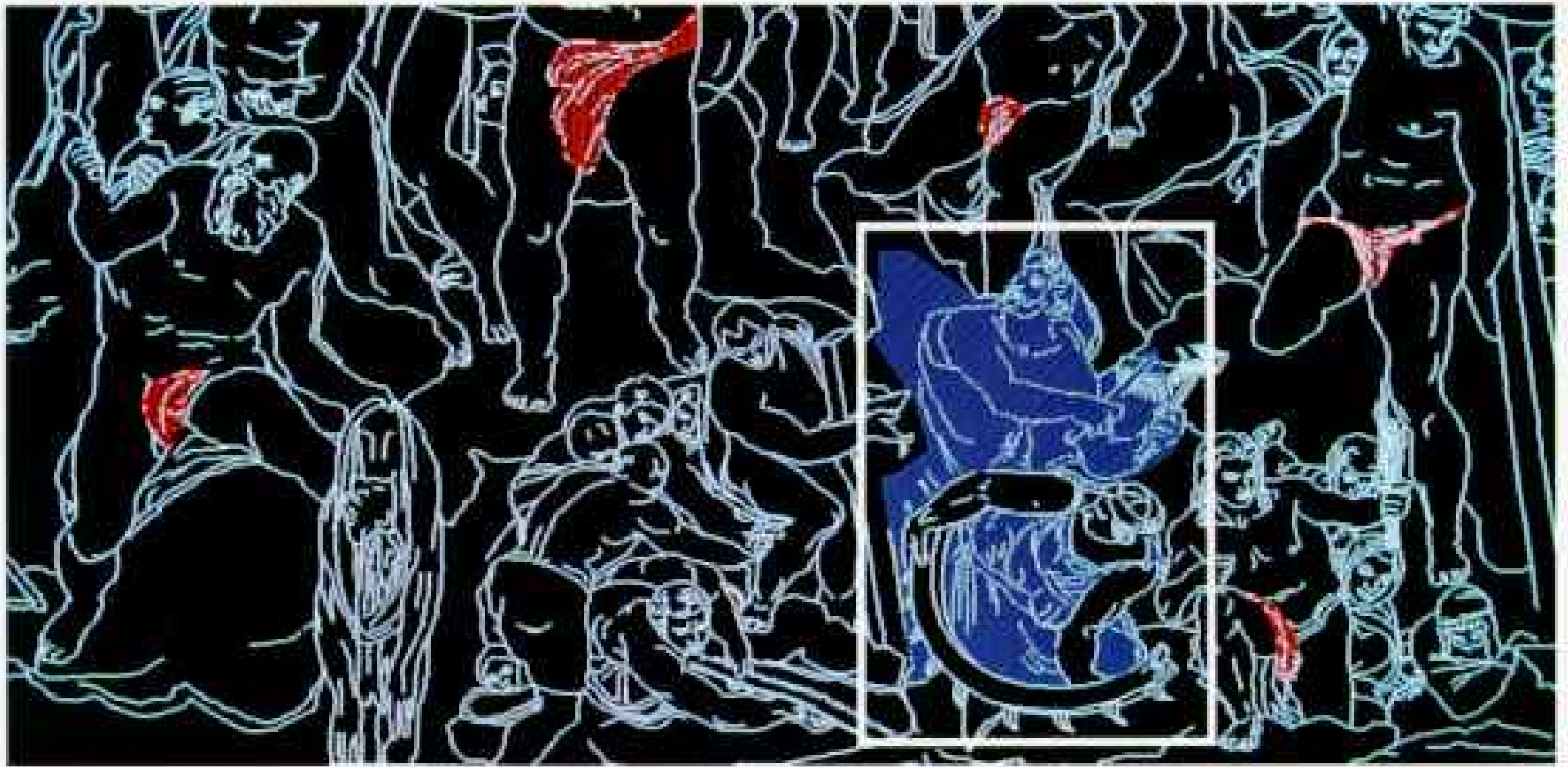
Michelangelo brushed on his paint in a rich impasto and made many *secco* alterations after the fresco dried—a technique notably different from his work on the ceiling. For the sky he used crushed lapis lazuli, a semiprecious stone, applied in two layers. The vivid blue has faded because early restorers abraded the *secco* layer of pigment when cleaning the fresco—already filthy by the 1560s. Says restorer Maurizio Rossi, “We can do everything except make color grow where it is no longer.”





Embracing in fear and wonder,  
the saved are reunited in Paradise.  
Biographer Giorgio Vasari wrote  
that Michelangelo had painted  
"all the emotions that mankind  
can experience."





## A matter of modesty: censoring Michelangelo

**A**ccusations of obscenity were leveled against the “Last Judgment” even before its completion. One attack berated the exposure of genitals, charging that the work “did not belong in a papal chapel, but in public baths or brothels.”

Pressure to alter the fresco grew, and when Pope Paul IV was elected in 1555, he immediately sent word to Michelangelo to “make it suitable.” The defiant artist sarcastically replied: “Tell the Pope that this is a small matter and it can easily be made suitable; let him make the world a suitable place and painting will soon follow suit.”

The dispute was settled by the Church’s Council of Trent, which decreed that the nudity must be covered. In 1565, a year after Michelangelo’s death, artist Daniele da Volterra added the first of many coverings, earning him the nickname “britches maker.”

St. Blaise and the naked St. Catherine (opposite, in an early copy of the “Last Judgment” by Marcello Venusti) were radically altered. Volterra turned St. Blaise’s head toward Christ and

clothed St. Catherine, chiseling out the original fresco (computer diagram, in blue). When Volterra mixed his paint each day, he had trouble matching the green of her dress (below), says restorer Bruno Baratti. “The spirit of Michelangelo came back and switched paint pots on him.”

Thirty-eight other coverings

were painted over the original fresco (above, in red)—some added as late as the 18th century. Many have been removed. According to Fabrizio Mancinelli, director of the Sistine restoration, “The britches added because of the Council of Trent are part of history, but the later alterations are not.”

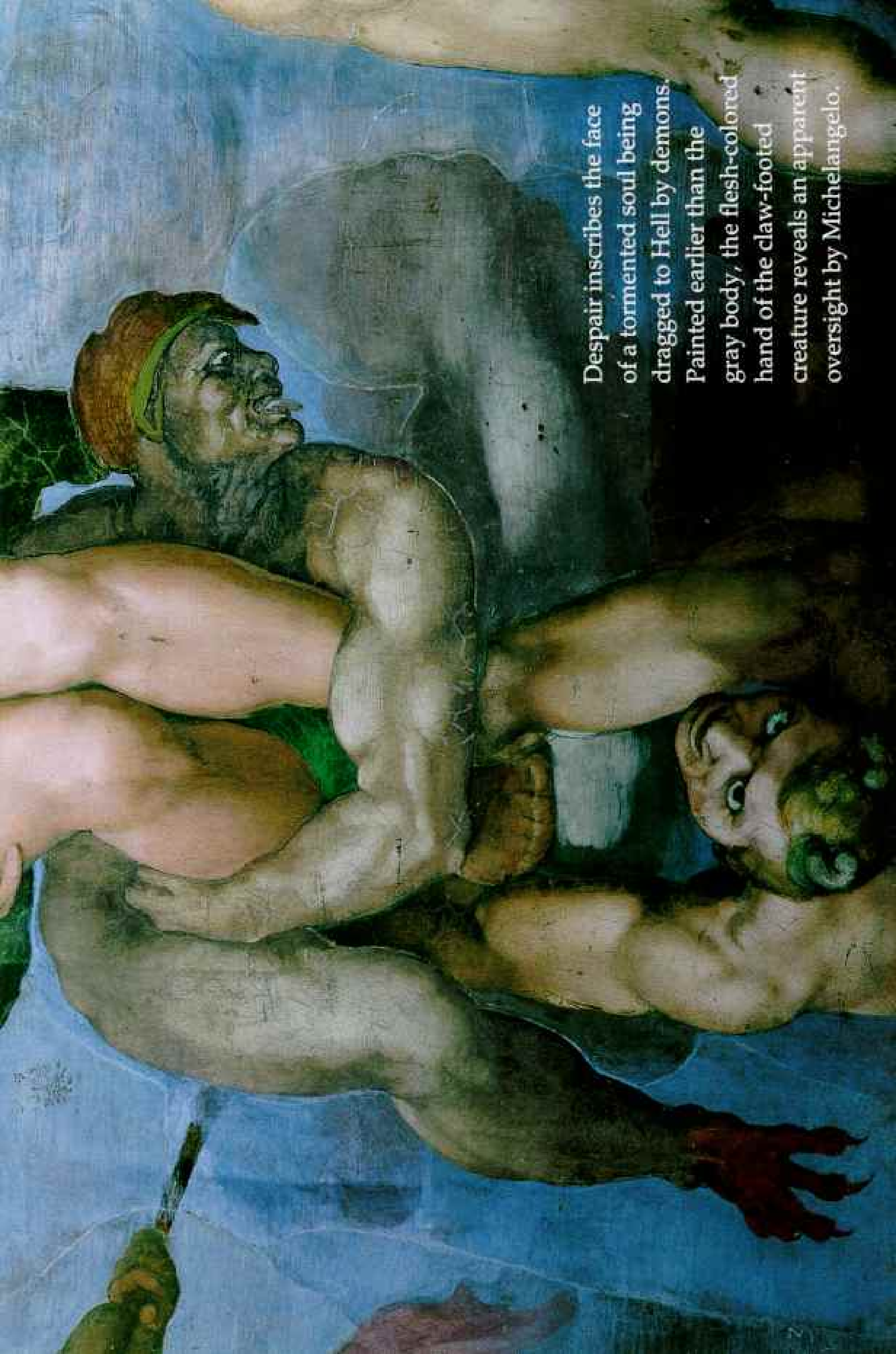


VATICAN MUSEUMS, COURTESY SOPRINTENDENZA B.A.S. DI NAPOLI (RIGHT)









Despair inscribes the face of a tormented soul being dragged to Hell by demons. Painted earlier than the gray body, the flesh-colored hand of the claw-footed creature reveals an apparent oversight by Michelangelo.



VATICAN MUSEUMS

In a hellish scene from Dante's *Inferno*, which Michelangelo could recite by heart, "stands Minos, horrible and snarling" (facing page). Entwined by a serpent—a symbol of lechery—the judge of the underworld bears the face of Biagio da Cesena, the

Pope's master of ceremonies. He had angered the artist by sneaking a look at the uncompleted fresco and criticizing the nudity. When Biagio begged the Pope to have the donkey-eared portrait removed, Paul III replied that his authority did not extend to

Hell, so the matter was out of his jurisdiction.

With catlike whiskers and glowering eyes, Dante's Charon (above left) ferries the dead across the River Acheron. Deep grooves outline his head where Michelangelo incised the design from his cartoon. When cleaning the blackened figure—now a sulfurous green—restorers discovered that his upraised oar was repainted in the mid-16th century by Domenico Carnevali, who also retouched the ceiling.

As terrifying as any monster of Hell is the anguish of a sinner (partly cleaned, above). An enigmatic self-portrait that went unrecognized until 1925 reveals Michelangelo's own torment. In the flayed skin of St. Bartholomew (left) emerge the broken nose and distorted features of the artist. Seemingly added on a whim, the image was painted without a cartoon.

Deeply religious, Michelangelo feared for his own salvation. He had devoted his life to achieving perfection in art, but as he grew older, his thoughts turned increasingly toward spiritual matters. At the age of 79 he wrote: "Painting and sculpture cannot any more / Quiet the soul that turns to God again. . . ." □





*Michelangelo's "Last Judgment"*

THE  
FADING CALL  
OF THE  
SIBERIAN CRANE





By GEORGE ARCHIBALD

Soaring on air currents high above Asia, Siberian cranes face deadly hazards during migration. Now endangered, the cranes have inspired international cooperation to help protect them from hunters' guns and habitat loss.



**S**hattering the calm of a sunlit marsh, a rare skirmish erupts as two male Siberian cranes spar over a choice feeding spot. Nearby, their mates squawk in support. One quick kick of a powerful leg decides the battle: The weaker bird walks away, slowly, as if feigning indifference to soothe his pride.

I've spent many quiet hours watching cranes here at Keoladeo

National Park near Bharatpur, India. Once the private hunting reserve of maharajas, this swampy patchwork of diked wetlands offers winter refuge to a remnant flock of Siberian cranes that breed far to the north on icy marshes.

Often called "snow wreaths," these magnificent birds—solid white but for black primary feathers and crimson faces—evoke superlatives. During marathon



JEAN-PAUL FERRERO, AUTOCAPTE

migrations Siberians travel as far as 3,000 miles. On wings spanning seven feet, they can cruise nearly three miles high as they cross the peaks of the Hindu Kush, conserving energy in the thin, frigid air by riding air currents for miles. Often I'll hear their musical calls drift to earth long before the cranes come into view.

Siberians are among the most threatened of the 15 species of

cranes. Just 30 years ago some 200 of the cranes wintered at Keoladeo. Two years ago five birds arrived, and this past winter none were spotted. Only ten Siberian cranes survive precariously in a wintering area in Iran. A large flock of 2,900 winters in eastern China. But all are imperiled by hunting and habitat loss.

An eleventh-hour fight to save the snow wreath has united a host

of former political enemies. I've slogged through mud—and paperwork—with scientists from Russia, Germany, India, Pakistan, Afghanistan, Iran, Japan, China, and Mongolia. We are tracking the cranes' migration routes, targeting rest stops for protection, and breeding birds in captivity for release in the wild. Our tools are a bit unorthodox: satellites, mosquito netting, puppets, and prayer.





GEORGE ARCHIBALD



I don't know which is more unnerving: The roar of an Aeroflot helicopter or the hum of relentless mosquitoes. This was our chorus in the summer of 1990, when I joined U. S. and Russian scientists in western Siberia to observe Siberian cranes and test satellite-tracking devices on abundant common, or Eurasian, cranes.

There was nothing common about Katya (above), one of three Eurasians we tracked. To capture this molting—and therefore flightless—crane, we zoomed overhead in a helicopter, shooting nets from a shotgun. We missed. Since a helicopter can't land on these slushy marshes, it hovered as we

jumped out to chase Katya down.

Having hooded her eyes with a cloth to calm her, David Ellis of the U. S. National Biological Survey (in netting) and Yuri Markin of the Oka Nature Reserve in Russia help fit Katya with a satellite transmitter—courtesy of the National Aeronautics and Space Administration. We were the first to test the device on wild cranes in Asia.

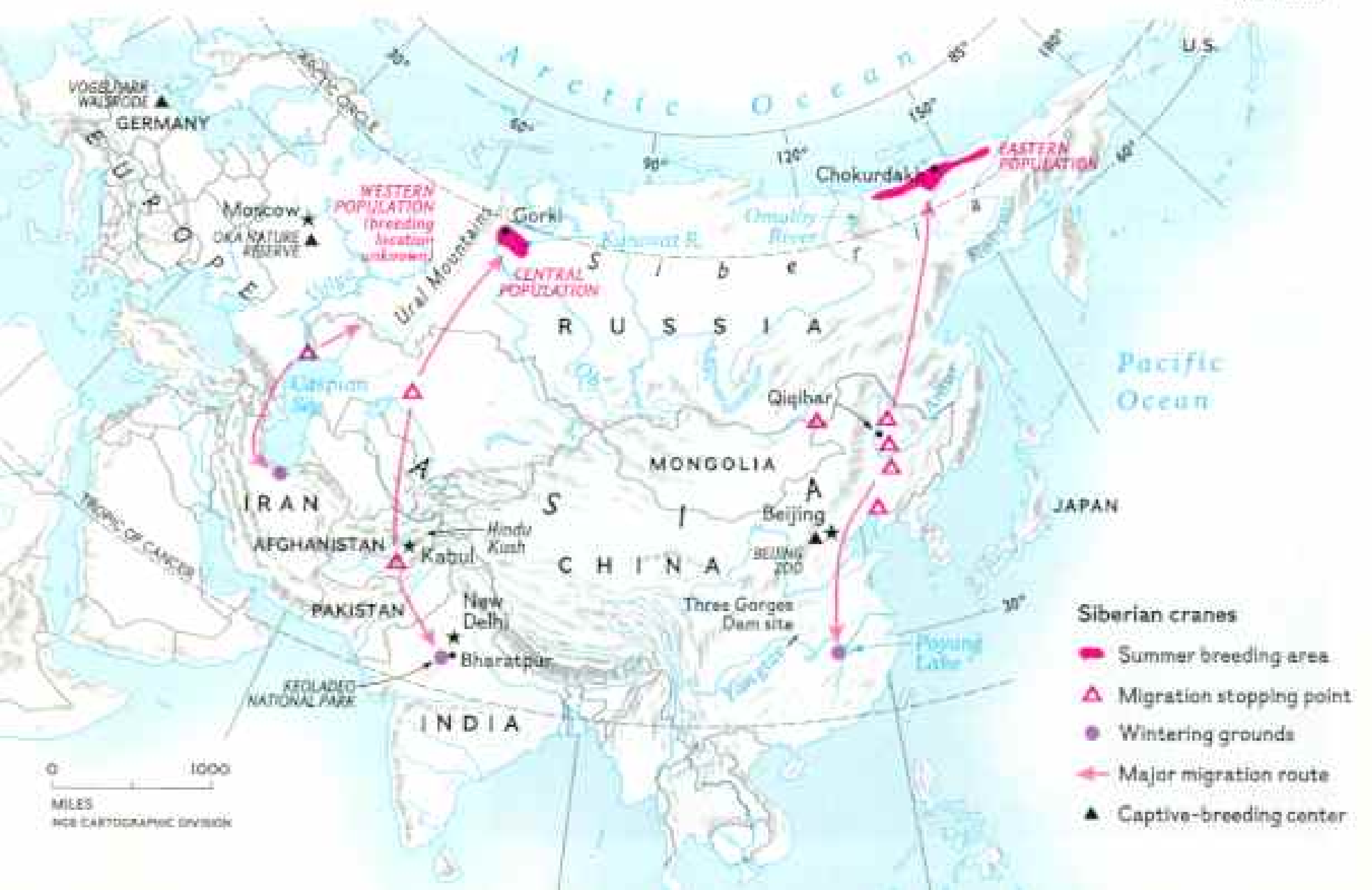
Katya transmitted all the way to her wintering grounds on the Afghan-Iranian border, 2,094 miles away. We were thrilled that the extra load didn't seem to hamper her. That discovery led my colleagues to capture and track Siberian chicks caught later

in eastern Siberia (above right).

Data from these experiments are helping us piece together the migration routes of the three distinct flocks of Siberian cranes. The most populous breeds in eastern Siberia and winters primarily at Poyang Lake in China. A western group of ten cranes that winter on the Caspian Sea in Iran breed in an unknown location farther north. And the tiny central flock of five seen at Keoladeo likely breeds along Siberia's Kunovat River, a branch of the Ob. Until stopping points along these flyways can be protected, we'll continue other—some say peculiar—methods to preserve these birds in the wild.



DAVID H. ELLIS



**I**t's a bird! It's a crane! Well, it's a close second. Humans in crane costumes are the best makeshift parents for captive-bred Siberian chicks—and the expansive wetlands along the Kur-ovat River are an ideal nursery. An international team of scientists led by Russian ornithologist Alexander Sorokin is raising chicks here, where wild pairs breed, in hopes that the young will join wild families on migration—a key to restocking endangered flocks.

Crane hatchlings become attached to, or imprint on, their first caregivers, whether human or crane. Ersatz parents—disguised with sheets, hand puppets, and tape-recorded crane calls—can successfully raise chicks to imprint on their own species.

Costumed rearing is tough. Because chicks can grow an inch a day, parents must walk them for hours to strengthen their joints. “Mother” Mini Nagendran uses a hand puppet to teach a cinnamon-colored chick to forage for snails, roots, and insects (below). As the cranes grow, their white feathers emerge. Flapping sheeted “wings,” another parent sparks a chick’s



natural instinct to fly (above).

No uncostumed human may go near the chicks, so caregivers walk to a secluded camp to bond with their own kind. The camp I shared in 1990 was a ramshackle haven. I can still hear the gravelly

voice of Russian ornithologist Vladimir Flint, discussing notes with colleagues by the fire (right). Soaked boots hang overhead to dry, and a humbled husky—brought to keep brown bears at bay—lies singed from dozing too close to the flame.

Summer in Siberia is unpredictable, wild, pure. Uncomfortable. Temperatures top 100°F or freeze the cranberry bogs. Mosquitoes are so thick they pepper my soup. Wet sphagnum moss is the only toilet paper. Yet I've never been happier. My hope now: that a hand-reared chick is accepted by a wild family and completes the migration to Keoladeo—joyful reward for the trying work here.







EDWARD BAZAROV



DAVID W. ELLIS; GEORGE ARCHIBALD (RIGHT)

I saw my first Siberian crane in 1966. In a zoo. She stood alone, and peeped one soft, single note.

Today's captive Siberians—about 115 worldwide—are a pampered, far livelier bunch that dance and duet as they do in the wild. The International Crane Foundation in Baraboo, Wisconsin—which I founded with my late friend Ron Sauey in 1973—has 29 Siberians. Used for breeding, they produce offspring that enrich the gene pool of other captive flocks.

Tanya (right) is my girlfriend. Or thinks she is. Imprinted on humans at birth, she spurns male cranes and will only enter laying condition if I spend each day of March and April being an attentive mate. She carefully preens her neck with mud—her makeup—a sexual cue that says, "Let's dance." We dance, we coo, we lay straw on "our" nest. And by artificially inseminating Tanya with semen from a male crane, we can get a fertile egg.

Fortunately ICF has several normally bonded pairs, which mate for life and share nest building, foraging, even incubating their eggs. Highly territorial, cranes puff out their feathers and bugle a piercing unison call to repel intruders (above left). The alternating duet of *UH-oh! UH-oh! UH-oh!* rivals a European police siren.

Chicks soon learn the tricks of survival. To waterproof feathers, a chick uses oil taken from a gland on its back (left). Since cranes generally lay two eggs but raise only the dominant hatchling, scientists can take one egg for captive breeding without harming flocks.





Unmistakable flute tones fill the air. From a bluff in China's Jiangxi Province, I peer out at Poyang Lake (above), winter home to the world's largest flock of Siberian cranes. Squinting as the morning mist burns away, I see a brilliant line on the horizon—hundreds of white birds, gleaming like candles in the sun.

I counted 1,350 Siberian cranes on that unforgettable morning in 1985—my first visit to Poyang. This past December nearly 2,900 birds were spotted there. Though robust in number, the flock is dangerously fragile.

Poyang Lake is fed by several monsoon-flooded Yangtze tributaries and the river itself. As floodwaters ebb, Poyang becomes a quilt of mudflats and shallows. In winter Siberian cranes feed almost exclusively on aquatic roots and



GEORGE ARCHIBALD

sedge tubers found in such wetlands. The cranes could perish if the wetlands drain.

They are being drained—at an alarming rate. I've watched thousands of workers with baskets and hoes turn area wetlands into diked agricultural land (above).

Though 55,000 acres around Poyang Lake are designated as a reserve, thousands of peasants still live within its borders, periodically draining the shallows to catch fish. Up the Yangtze, work has begun on the massive Three Gorges Dam, which could alter the way



STORY: BARLESON-TRAVELING

floodwaters replenish Poyang.

For other flocks, hunting is the main threat. Drooping like mournful puppets, a dead Eurasian crane and a string of songbirds hang in a Kabul market (right). Cranes migrating through war-torn Afghanistan are shot for food, and rare Siberians flying with other cranes can get caught in the cross fire.

In Pakistan hunters practice the ancient sport of tossing *saiias*—weighted cords—to ensnare low-flying cranes near migratory stops. The captives, kept as pets, are status symbols and effective “watch-birds” that shriek at strangers. Education programs developed by U. S. conservationist Steven Landfried and Pakistani officials now urge hunters to limit their take and to tag and release additional cranes—especially any hapless Siberians yanked from the sky.



RON SAUET





STANLEY BRADSHAW

Ethereal as ice crystals, Siberian cranes and their brown-plumed chick feed beside greylag geese at India's Keoladeo National Park. The scene transports me back to a cabin by a marsh near Baraboo, Wisconsin, where naturalist Aldo Leopold wrote: "The sadness discernible in some marshes arises, perhaps, from their once having harbored cranes. Now they stand humbled, adrift in history."

Leopold's words will become a final epitaph unless nations act fast. Cranes won't survive without ample wetlands. People, too, need wetlands as filters for groundwater and as nurseries for animals, plants, and insects. If the wetlands go, so do the cranes. I hope each will be the salvation of the other.

There is reason for hope. In a heartening show of international cooperation, nine nations are drafting a pact designed to save

the cranes that cross their borders. A huge wetland reserve is planned where Russia, China, and Mongolia meet—a favorite summer area for eastern nonbreeding juveniles.

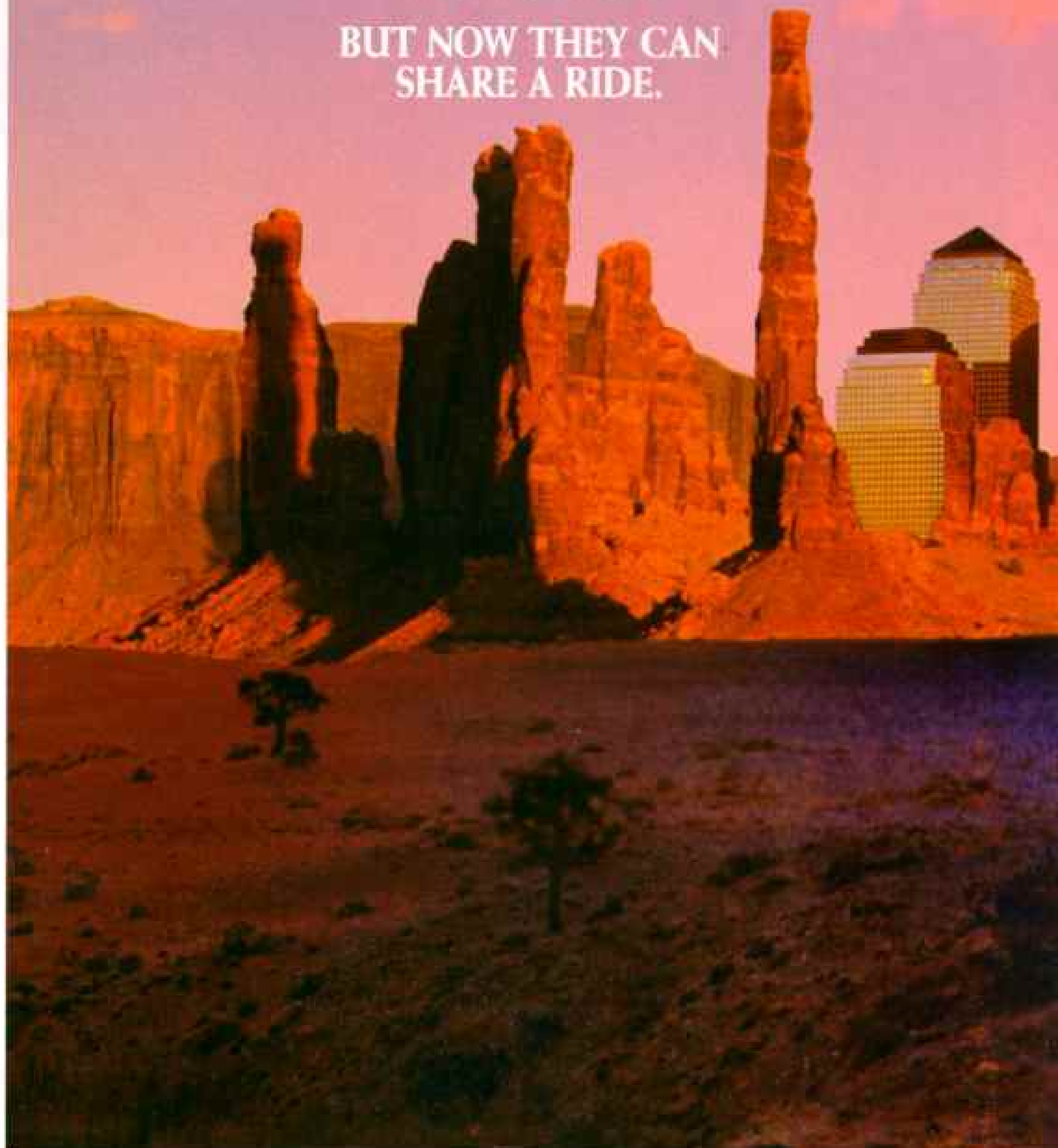
Some scientists believe that the small central flock has dwindled past the point of survival. They may be right. Yet dedicated teams of biologists will continue to release hand-reared young in the cranes' breeding and wintering grounds. Somewhere along the hazardous miles between Keoladeo and the Kunovat River, I imagine a banded chick learning the ancient migration route from its adopted wild family.

Leopold treasured the joyful noise of cranes in flight. "When we hear his call we hear no mere bird. We hear the trumpet in the orchestra of evolution." I pray that the jubilant Siberian trumpet will resound in the skies forever. □

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50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74

A Thousand Fables of Whales  
1. What did Yukio see on the shore before he saw the whale?  
2. How did Yukio feel about his father hunting whales?  
3. Why did Yukio cry on the sand?  
4. What did Yukio's father do to the whale?



It's been two years since her classroom received its first Macintosh® computers. And in that time, Sandra Oby



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has noticed a remarkable transformation. Learning is more fun, students are more motivated,

teaching is more creative. Yet

when Macintosh computers were introduced to E. Morris Cox

Elementary School, Sandra remembers being more

concerned than confident about this new technology. "The Mac motivates these kids to write, like nothing I've ever seen. Revisions are easier, and they write more than they would otherwise." Sandra also discovered the advantages of teaching reading with a Macintosh. "Because books on CD-ROM come with interactive graphics, animation and sound," she says, "reading lessons are more interesting, and the kids seem to pick up spelling and vocabulary a lot quicker." While Sandra put togeth-

# How Sandra Oby quickly overcame her fear of mice.

er her own Macintosh teaching materials, Apple now offers educators a comprehensive literature-based package for teaching language arts. Called Early Language Connections, it includes Macintosh computers and programs, books on CD-ROM, portfolio assessment tools, lesson plans — even on-site training. All of which makes it even easier to discover the most important power any teacher can have. The power of Macintosh. The power to be your best.™

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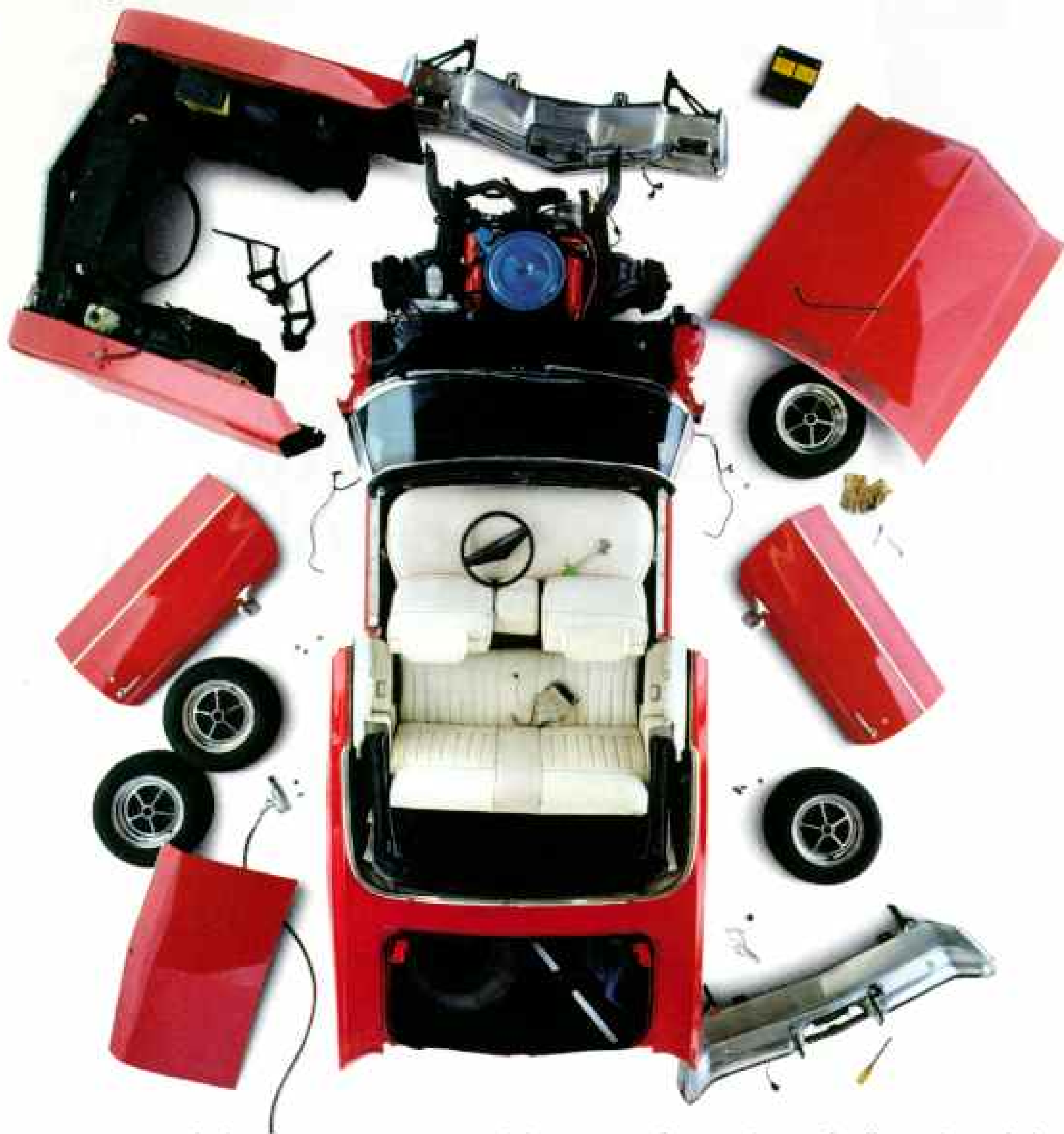
*Using Early Language Connections, teachers can easily make their lessons art, paper puppets, and the books. And their students can create colorful stories like these.*

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# Geographica



BY BROOKS WALKER

## Restoring a Miniature St. Peter's

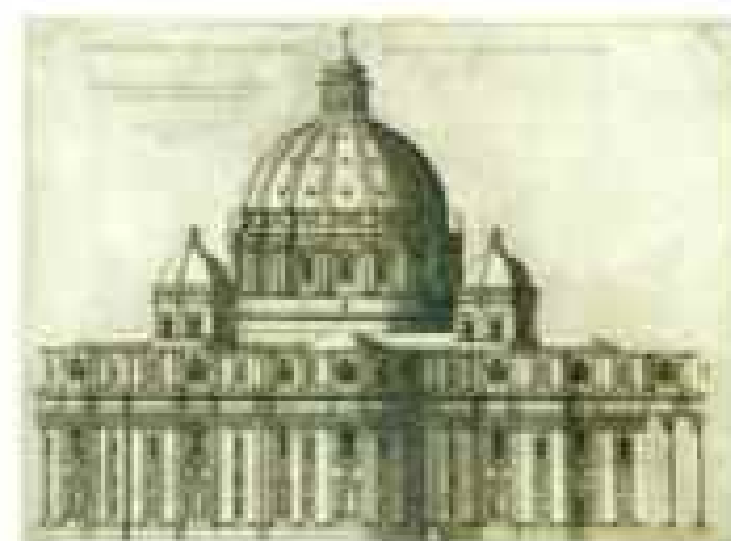
Putting together the final pieces of a 450-year-old puzzle, Italian restorers reassemble a lilliputian version of St. Peter's Basilica in Rome—the largest architectural model to survive from the Renaissance.

Construction of the mother church of Roman Catholics began in 1506 (NATIONAL GEOGRAPHIC, December 1971). In 1539 its fifth architect, Antonio da Sangallo, began to build this walk-in representation (above), at a scale of 1 to 30, to show Vatican officials and

construction workers his concept (right, top). The model—15 feet high, 26 feet wide, 19 feet deep—was unfinished at his death in 1546.

His successor, Michelangelo, complained that the plan had too many nooks and crannies—hiding places for scoundrels who might ravish praying nuns. He won approval for changes seen in a 1569 engraving (right, bottom). Michelangelo also prepared four small models of the basilica; only one survives.

Stored in St. Peter's, the Sangallo model had been slowly disintegrating, under attack from woodworms and dry rot. "Pieces fell off as glue dried or were lost whenever



METROPOLITAN MUSEUM OF ART (CROTHI)

something was moved," says Henry A. Millon of the National Gallery of Art in Washington, D. C. The idea for restoration came as he and the director of Venice's Palazzo Grassi planned an exhibition there on Renaissance architecture. Italian craftsmen sought to match the remaining wood, primarily fir and limewood. They found it by haunting 16th-century churches undergoing repair, Millon reports.

## The Whale That Walked

Until about 55 million years ago, ancestors of whales and their kind, the cetaceans, were four-legged landlubbers. Gradually they evolved to take advantage of ocean resources and became the sea-dwelling mammals we know today. Now with the discovery of a skeleton in Pakistan, scientists are beginning to understand how those animals maneuvered during the time of transition.

J.G.M. Thewissen, an anatomist at the Northeastern Ohio Universities College of Medicine, found the bones in a former inland sea in Punjab Province. He and his team uncovered much of the skeleton, including a skull that identifies the animal as a cetacean.

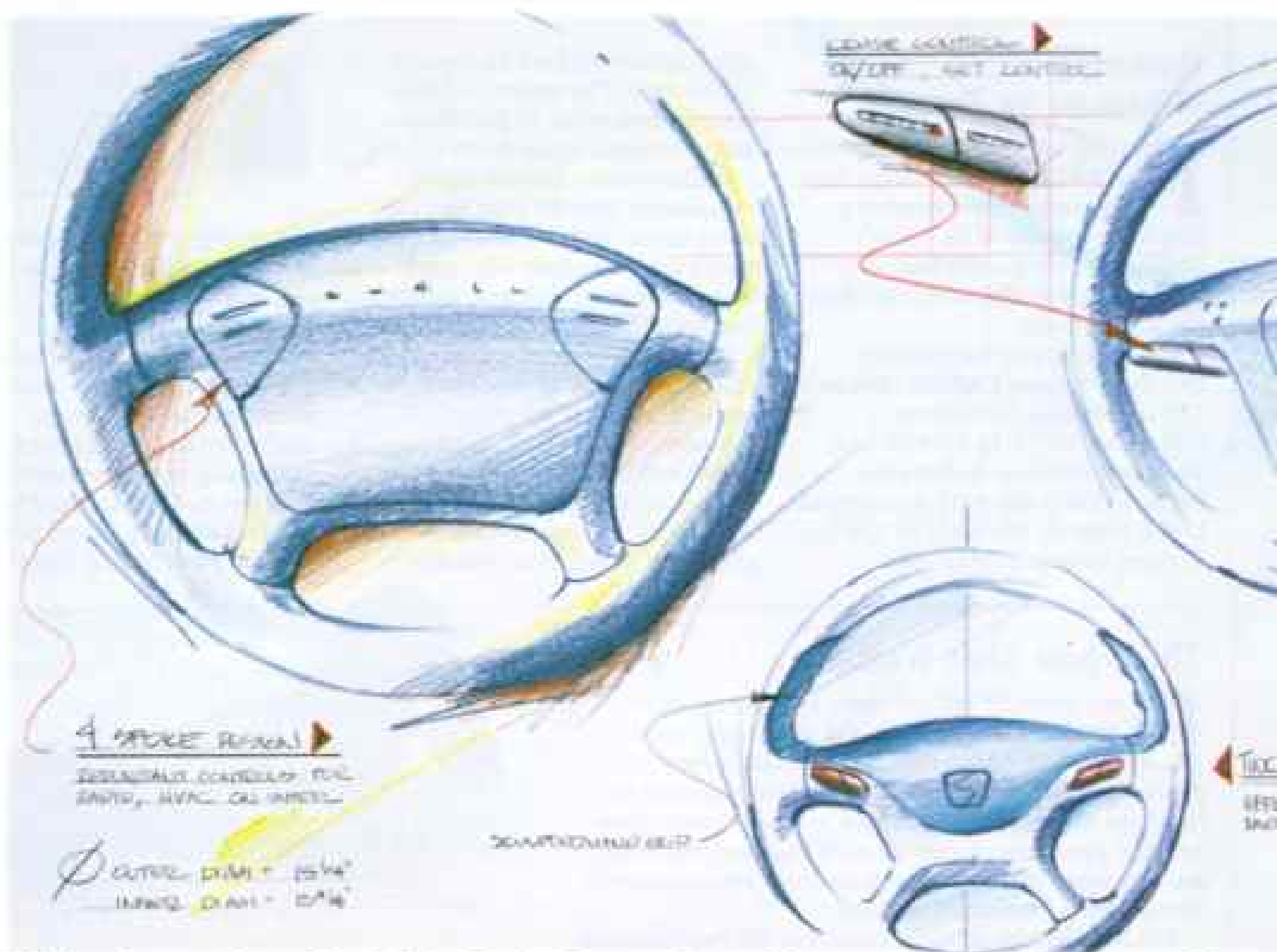
The spine indicates that it swam by moving its lower back up and down as modern whales do and swinging its huge hind feet for propulsion. Stubby forelimbs



NATIONAL GEOGRAPHIC ARTIST CHRISTOPHER A. ELLIOT

probably helped in steering. On land the animal lumbered like a sea lion. "It would look clumsy, but it could still get around," says Thewissen, whose research was funded in part by the National Geographic Society. He gave the discovery an appropriate name, *Ambulocetus natans*, "swimming, walking whale."

"Finding out what the  
Doing something about it,



Liz Wetzel, a member of the Cadillac Design Team at General Motors, spends a fair amount of time listening to customers react to her ideas. This is not always fun. Human nature being what it is, most people instinctively want to discount views that don't square with their own. Sometimes



customer wants is easy.

That's the hard part."



responding to customer input means scrapping a beloved notion. It can mean a costly retooling or a delay in production. So be it. These days at General Motors, the customer isn't just somebody with an opinion. The customer is a colleague with a whole lot of clout.

# DOROTHY HAMILL

Gardener, Olympic Gold Medalist



I remember helping my mother in her garden when I was little. I was so proud.

Now, when my daughter, Alexandra, helps me in our garden,  
I get that same wonderful feeling, like remembering a dream.

My mother let me feed her plants with Miracle-Gro, a cupful at a time.

Today, I wouldn't use anything else. Like mother used to say,  
"There's nothing like Miracle-Gro."

*Dorothy Hamill*

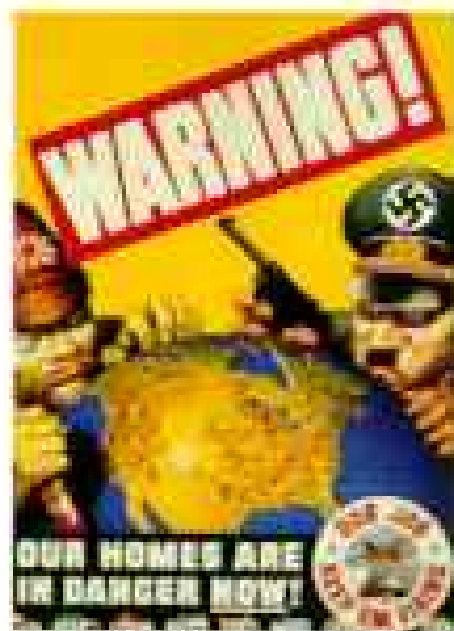


MIRACLE-GRO

## Posters With a Message: Artful Weapons

**W**e recall the atomic bomb, the B-29, and the tank as weapons of World War II. But words, art, and symbols also were tools in the battle to win hearts and minds at home.

The psychological armament appeared in posters that hung in shop windows and on factory walls as ever present reminders of the national war effort. A National Archives exhibit, "Powers of Persuasion," will display 70 World War II posters from its collection of



NATIONAL ARCHIVES (20TH)

5,000 through February 1995 in Washington, D. C. "Many portray a confident, optimistic America," says curator Stacey Bredhoff—cheerful workingwomen, determined men, brightly colored displays of Uncle Sam or other symbols of patriotism. But others picture "the flip side, America at risk" from careless talk, foreign spies, and evil enemies.

Some images cause cringing 50 years later, especially the stereotypical caricatures of the Japanese. "When artists attacked Germany, they pictured Hitler," Bredhoff says. "When they went after Japan, they indicted a whole nation."

## Elephant Flyswatters: The Right Tool for the Job

**H**uman beings use swatters to get rid of pesky flies. Some elephants do too.

A study of 15 Asian elephants that carry tourists to visit wildlife



VERTICAL SCALE ENLARGED IN THIS COMPUTER IMAGE BY CHRIS CARTER. CRATER APPEARS RED.

in Nepal found that the pachyderms had good reason to grasp a leafy branch in their trunks and swish it around their bodies: When they did, the number of biting flies dropped by about 40 percent.

"It really worked," says Benjamin Hart of the University of California at Davis. Hart and his wife, Lynette, both animal behaviorists, conducted the study.

Swatter use increased as rising temperatures brought more flies. In addition at least 7 of the 15 elephants altered their flyswatters, shortening them or breaking off side branches. To date such tool modification has been seen mainly among primates.

The pachyderms also saved tools for up to half an hour for repeated use, another sign that the elephants know exactly what they are doing. The Harts hope to study wild elephants in India to see if they use tools as their captive cousins do.



BENJAMIN HART

## Did a Meteorite Strike the Middle of Nebraska?

**W**akefield Dort would love to find "the smoking gun—a nice ten-ton meteorite" that he believes crashed and exploded in what is now mid-Nebraska some 2,800 years ago. But even without the enormous object the University of Kansas geologist believes he has sufficient evidence to determine the cause of a round depression a mile in diameter near Merna.

Dort spotted the crater while poring over Nebraska topographic maps. He eliminated other possible causes—a volcanic eruption (there is no volcanic debris), the melting of glacial ice, wind erosion, or subsurface collapse.

On site he found magnetic pellets, glass particles, and mineral fragments with elements not found in the underlying rock, suggesting an extraterrestrial origin. Lightly eroded gullies in the 70-foot-high walls of the crater hint at a geologically young age. Other scientists are not yet convinced, however; they await definitive geophysical evidence.

Local Indians, the Skidi Pawnee of eastern Nebraska, built part of their cosmology around a "big black meteoric star." Dort thinks those beliefs have their origin in the meteorite that created the Merna crater.



I can't believe  
they gave my promotion  
to Kaminsky.



Let him have it, I don't  
want all that  
responsibility anyway.



He could use the  
extra money, a good hair weave  
isn't cheap.



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he'll have to watch  
the rest of us leave at five.



Besides, everyone in management develops a nervous tick eventually.



And with a reserved parking space, the boss always knows when you're late.



I can't believe they gave my promotion to Kaminsky.

**THIS IS REFRESHMENT** 

## The Battle to Preserve China's Buddhist Caves

Sometimes simple solutions work best. Case in point: the Mogao Grottoes at Dunhuang, once China's gateway to the West along the Silk Road.

In nearly 500 man-made caves on a mile-long cliff face, wall paintings and monumental sculptures like this 108-foot-tall Buddha depict daily life and Buddhist religious themes, an amazing record from the 4th to the 14th centuries.

But blowing desert sand threatens the grottoes' survival, eroding the cliff, piling up at cave entrances, and coating paintings and sculptures. In response, specialists from the Getty Conservation Institute of California have teamed with their Chinese counterparts to install a knitted-textile fence, two and a half miles long. The fence has cut the amount of sand removed from cave entrances by 60 percent. Experts are now planting a permanent wind-break of desert-adapted trees and putting fabric screens on cave entrances, where grates encourage visitors to scrape their shoes.

Not all threats yield easily. The area is seismically active, and an earthquake could bring down the cliff face, burying the art forever.



SEIJO OZURA, NHK BROADCASTING CENTRE (BOTH)

## A Bronze Age Boat Beneath Dover Streets

Boats ferried passengers and cargo across the English Channel before the opening of the new tunnel (page 37). Long before, it turns out.

In September 1992 workers in Dover building a pedestrian underpass beneath a road leading to the tunnel entrance discovered remains of a 50-foot boat dating from at least 1300 B.C. It was made of oak planks, each weighing more than a ton. The lengths were fastened together with twisted yew branches and chinked with packed moss.

"Bronze tools and weapons of continental design have been found in the Dover area, but we had no idea what kind of boat could have brought them across—until now," says nautical archaeologist Valerie Fenwick. The seagoing vessel was abandoned in a creek and later buried under Dover.

Skilled woodworkers in a rich, well-organized trading community must have built the boat. Their carpentry and woodworking skills hint at much more sophisticated houses, furniture, and wagons than we have yet discovered from the Bronze Age, Fenwick believes.

## Los Angeles Yields on Mono Lake

Scenic, saline, and teeming with brine shrimp, Mono Lake, at the foot of California's Sierra Nevada, is a major bird habitat. It is also known for its ghostly towers of tufa, a porous form of calcium carbonate. For years this picturesque wonder has been a battleground pitting environmentalists against Los Angeles, which since 1941 has diverted four feeder streams to the city, 275 miles away (*GEOGRAPHIC*, October 1981). The lake level has dropped more than 40 feet, endangering nesting and feeding birds.

Los Angeles withdrew an average of 68,000 acre-feet of water a year, between 10 and 20 percent of its water supply, until 1989. Then a court order temporarily halted the diversion. A state agency will set a permanent lake level this year.

Now, for the first time, Los Angeles will be giving up rights to some imported water. In a 1993 pact joined by the Mono Lake Committee and the National Audubon Society, the city agreed to use state funds to substitute 35,000 acre-feet of reclaimed water from the Los

Angeles area's East Valley project for Mono Lake water. "For the lake, it's long-term protection; for the city, it's reassurance that replacement water will be available," says Martha Davis of the Mono Lake Committee.

—BORIS WEINTRAUB



ART WOLFE, ALLSTOCK



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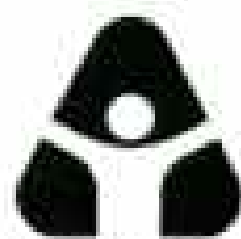
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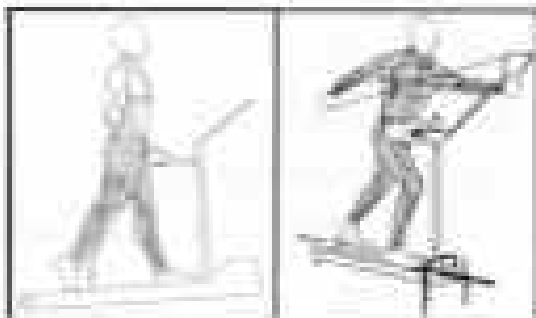


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Treadmills neglect your upper body.

NordicTrack works your entire body!

## 2. You'll Burn Up To 1,100 Calories Per Hour.

Your jog on a treadmill burns about 600 calories an hour, according to research. But NordicTrack uses all your major muscle groups to burn up to 1,100 calories an hour. You'll drive your body to lose weight quickly.

## 3. You'll Melt More Fat Than With Treadmills.

You'll burn not only more calories with NordicTrack. You'll burn stored fat in as little as 30 minutes, three times a week. Indeed, studies show you'll burn more fat than with treadmills. Trim the fat and you'll lose the pounds. In fact, of those who used a NordicTrack for weight control, studies show that 7 in 10 people lost an average of 17 pounds. And 80% of them kept the weight off for at least a year!

## 4. NordicTrack Provides A Better Cardiovascular Workout Than Treadmills.

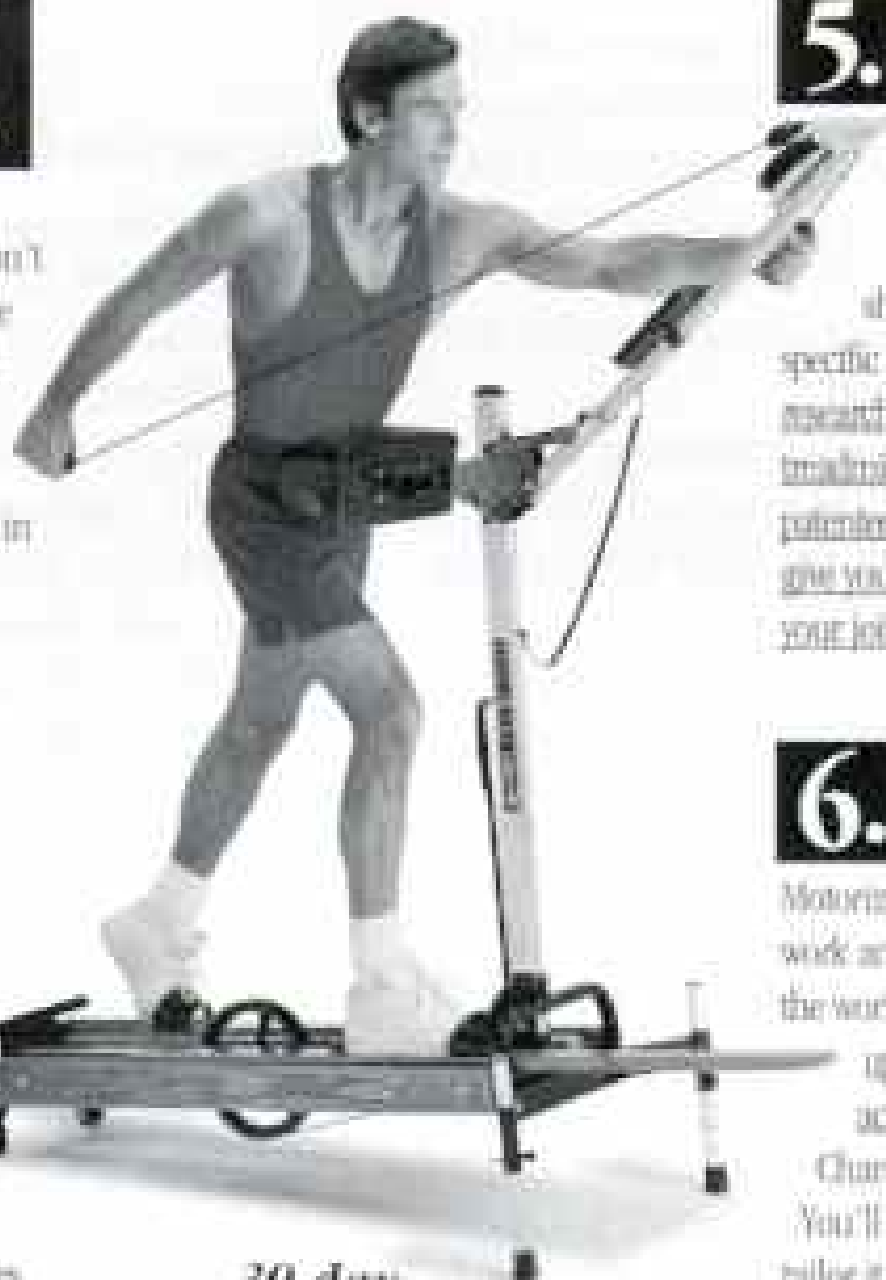
Clinical studies show a total-body workout with NordicTrack more effectively improves the performance of your heart and lungs than ordinary treadmills. You'll get the energy, vigor and stamina you need to enjoy life.

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There are two reasons why NordicTrack is easier on your body: First, it makes all major muscle groups share the workload, without straining any specific muscle. In fact, people tell independent researchers that NordicTrack feels less tiring than treadmills. Finally, only NordicTrack has a patented flywheel and one-way clutch system to give you smooth, jarless action that's easy on all your joints. Treadmills just can't match it.

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# Forum

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## Glass

I was impressed with the way you addressed the diversity of glass (December 1993) but disappointed that you left out the discipline of scientific glassblowing. It is at the foundation of many scientific discoveries. Everything from thermometers to semiconductors was developed employing the services of a laboratory glass shop.

The next time you sit at your computer or send a fax over fiber-optic lines, remember the men and women who helped make the high technology possible.

WAINÉ ARCHER  
*Albuquerque, New Mexico*

Your excellent article did not mention the use of glass fiber optics for lighting. It furnishes energy-saving illumination without the infrared and ultraviolet rays so destructive to buildings and their contents. The Gutenberg Bible in the British Library, the Raffles Hotel in Singapore, and all McDonald's in Britain are lit by glass fiber. It has been employed for scientific, ambient, architectural, and emergency lighting everywhere but in the United States for more than ten years. It is truly the lighting of the future.

GERSIL N. KAY, Chairman  
*Building Conservation International  
Philadelphia, Pennsylvania*

Regarding your description of how information is sent down a glass fiber, it is not described as an electronic signal but is called a photonic signal. Electronic signals move electrons, but light energy is based on the movement of photons, hence the name photonic. The electronic signals are the input and output of the transmission after it has been multiplexed through high-speed digital circuits and light diodes. Working with photonic transmissions, I need to keep the naming of the technologies consistent to avoid confusion.

CARY KYHL  
*Grapevine, Texas*

Toledo, Ohio, played an essential role in the growth and development of the glass industry in the United States and is headquarters of three major glass companies. Dominick Labino, creator of the art glass on your cover, lived and worked here most of his professional life and, more than anyone else, reintroduced the tools and the art of glassblowing. Founded and endowed by Edward

Drummond Libbey, the Toledo Museum of Art has one of the finest glass collections in the world.

ROBERT J. LAUER  
*Toledo, Ohio*

Take a look at your car windshield. If it has the LOF logo, it was manufactured by Libbey Owens Ford here in Rossford, the real "glass capital," right across the river from Toledo. I ought to know. My great-aunt Mary was secretary for Edward Ford for 43 years.

JOAN SCHROEDER  
*Rossford, Ohio*

## Himalayan Caravan

As a former park warden of Shey Phoksundo National Park in Dolpo, Nepal, I have mixed feelings about the article by Eric Valli and Diane Summers. Tourism and organized trekking are not benefiting the local economy. The traditional lifestyle and trading practices of the Dolpo people will continue despite these activities. I only hope visitors will respect and not influence or harm the traditional culture and fragile environment. The Nepal Department of National Parks and the World Wildlife Fund-U. S. are working to preserve the trans-Himalayan flora and fauna, including the endangered snow leopard.

NIMA WANGCHU SHERPA  
*Bozeman, Montana*

## Macaws

Charles A. Munn's "Macaws: Winged Rainbows" (January 1994) was the GEOGRAPHIC article I've been waiting for. I am an urban parrot breeder whose best success is with red-and-green macaws. A loose network of us across the U. S. devote our lives to breeding parrots. We incubate the eggs and hand-feed the babies every two hours from the day they hatch, producing sweet, smart, tame babies, suited to be pets. The hope is that making them available to the pet trade will wake up the public to the realization that it's not necessary to buy wild-caught birds, which make lousy pets, to be able to live with a parrot.

NANCY CHAMBERS  
*New York, New York*

As a Peruvian and a fanatic about the untapped wonders of my country, I felt proud of the article, especially since I explored Manu National Park just a few months ago. However, I am worried that articles like this encourage visitors. There is little control in the heart of the park. Park keepers have almost no economic support to do their jobs. They live in deteriorated shacks and don't have basic medicines or enough fuel to run rusty boats. Every year we see more tourists going to Manu and Tambopata parks; if an elemental infrastructure is not prepared, we will not see any macaws a few years from now.

OSCAR A. RIZO-PATRON  
*Lima, Peru*

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### **Kyushu: Japan's Southern Gateway**

I am a former resident of two regions in Kyushu. I take exception to a caption in your article saying that "naturalized Koreans" in the 1600s produced porcelain for export. Many Korean artisans were brought as prisoners to Japan for their ceramics skills. They were severely isolated and regarded as slaves. Their work was for the personal use of the ruler. European demand occurred much later.

The author opens with an admission of hitchhiking in the mountains. Hitchhiking is not looked upon as a proper activity in Japan, where even remote villages are well served by inexpensive transportation. Some of us make diligent efforts to conform to Japan's unique social codes; for example, open urination by a roadway is acceptable in a number of regions, but hitchhiking—never!

ROBERT E. DEBOLD  
*Trinidad, Colorado*

### **Eyes on the Universe**

I have spent many years as an actuary extrapolating into the future, and I know what a chancy operation that is. So many answers depend on the initial assumptions you make, and this would seem to apply equally to the present views on the big bang theory. Scientists are extrapolating backwards, and it is difficult to produce convincing evidence that the present theories are the end of the matter.

I would challenge the sentence on page 34 that COBE had a major question to resolve "Why are we here?" Surely we are no closer to any idea about why the universe exists or why there is conscious life than any of our predecessors.

CLIFFORD SHARP  
*Gillingham, Dorset, England*

Bradford Smith and Roger Ressmeyer's tour of the universe was a real eye-opener. Even as an employee of NASA's Goddard Space Flight Center familiar with imaging technology, I was impressed with the research at NASA centers and elsewhere that shed light on the seemingly incomprehensible scope of the cosmos. To realize there are events now unfolding that our distant offspring will witness hundreds of years hence with unimaginable technology is humbling.

SCOTT GOETZ  
*Hyattsville, Maryland*

The universe's first second is also noted in a biblical discussion of faith as "evidence of things not seen" (Hebrews 11:1). Concerning those unseen things, how was the one-trillion-K temperature at  $10^{-5}$  second sampled and verified? If the initial expansion of the universe occurred between  $10^{-36}$  and  $10^{-32}$  seconds, what clock monitored and confirmed the event? The conjecture devised to explain a non-recurring, unrepeated, and non-measurable origin of the universe proves that religion has no monopoly on faith.

F. E. NORTHAM  
*Hays, Kansas*



**Western Swamp Tortoise** Genus: *Pseudemys* Species: *unbina* Adult size: Length, 11-15 cm; Adult weight: 250-450 g Habitat: Shallow seasonal swamps northeast of Perth, Western Australia Surviving number: Estimated at 30 in the wild Photographed by Jim Lochman

# WILDLIFE AS CANON SEES IT

A western swamp tortoise emerges cautiously from its watery ochre world. In the heat of summer, when the swamps dry up, these tortoises aestivate in burrows until the rains return and rejuvenate life. Clay mining, ever increasing demand for land from developers and predation by introduced fox have reduced western swamp tortoises to some 30 survivors in one

tiny reserve. To save endangered species, it is vital to protect their habitats and understand the role of each species within the earth's ecosystems. As a global corporation committed to social and environmental concerns, we hope to foster a greater awareness of our common obligation to ensure that the earth's life-sustaining ecology survives intact for future generations.

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### Floods of '93

Everything I saw and read about the floods in the U. S. showed citizens helping fellow citizens. When Europe had floods last December, and cities like 2,000-year-old Cologne disappeared under a layer of water and mud, I saw mostly pictures of uniforms (civil defense, army, etc.) and thousands of gapers with their hands in their pockets or on their video cameras, blocking streets, even entering flooded homes. German authorities are discussing a law that would fine people who harass helpers by gawking and loitering.

REINHARD J. GROSS  
*Elville, Germany*

Saying the Mississippi River exhibits "a mean streak" anthropomorphizes and trivializes a phenomenon that is natural and without malice. Humans, like those portrayed sympathetically and emotionally, have exploited, polluted, diverted, and hemmed in the river for centuries. I do feel for those affected, but, please, let's have less of this "nature as bad guy" imagery. It encourages the adversarial attitude humans have taken toward nature for centuries. We must find ways to work with the forces of nature not against them.

TERRY BURNS  
*Toronto, Ontario*

The Mississippi flood could have been worse. Take a scenario of frozen ground and a sudden thaw of deep snows, combined with heavy spring rains. The total quantity of water runoff could not be eliminated. The river channels could only handle a limited amount, and dikes would cause concentrations resulting in even higher river levels. The solution is to allow more natural floodplains to act as temporary reservoirs, reducing the river flows. The loss of these areas to infrequent floods can be weighed against economic loss that could result from flooding. Levees should protect critical community centers and facilities such as power plants, not small farm communities within floodplains.

A. JOHN MACCHI  
*Hartford, Connecticut*

The problem with using the natural floodplain as a barrier is that the floodplain does not stay put. Before the levees were constructed, it was not unusual for the river to move as much as 50 miles laterally in spots. On page 54 one can see examples of minor movements of this sort in the oxbow lakes marking the river course in earlier years. Those who oppose reconstruction of levees should read Mark Twain's *Life on the Mississippi*.

GEORGE R. PATTERSON III  
*Somerset, New Jersey*

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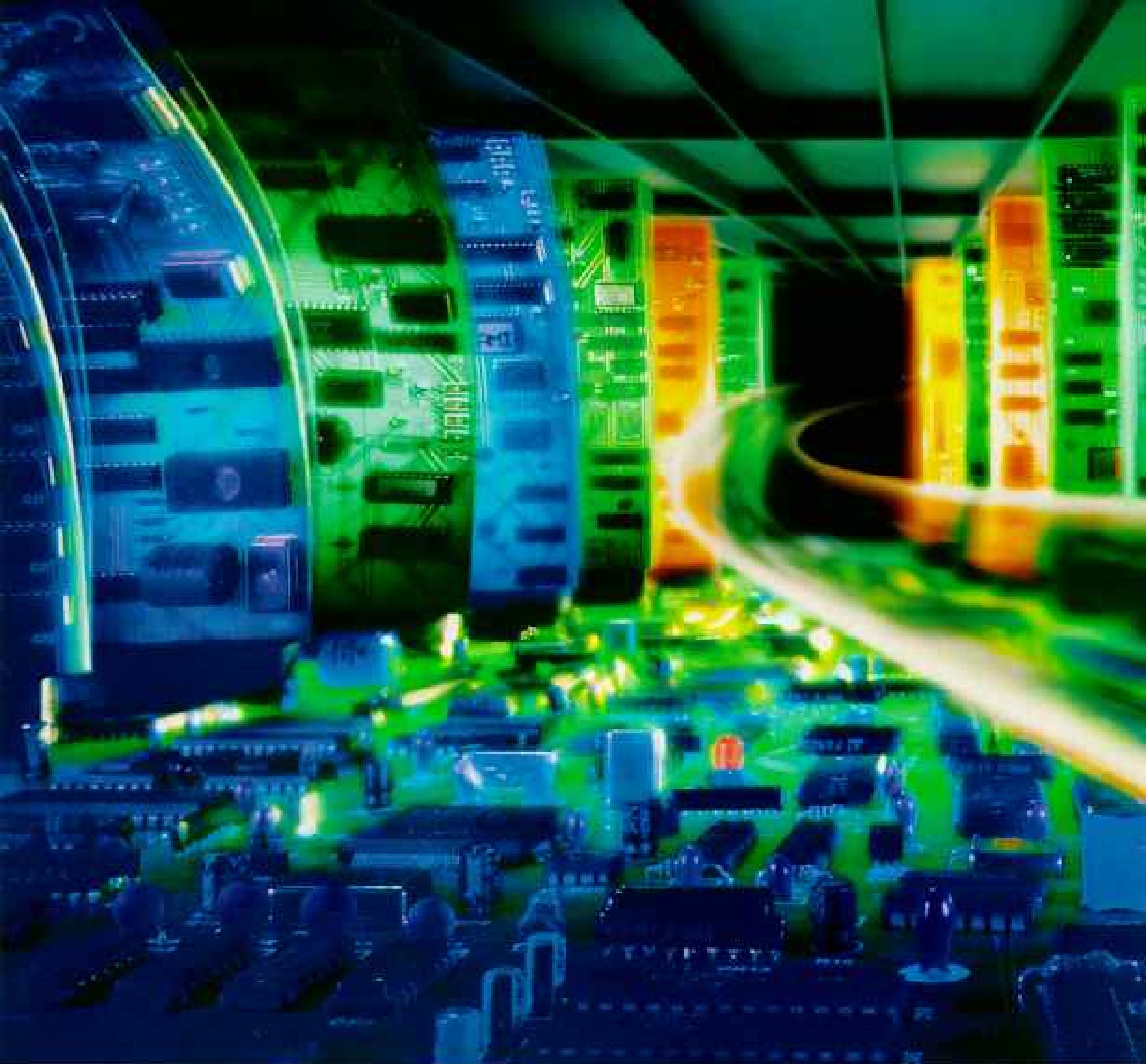
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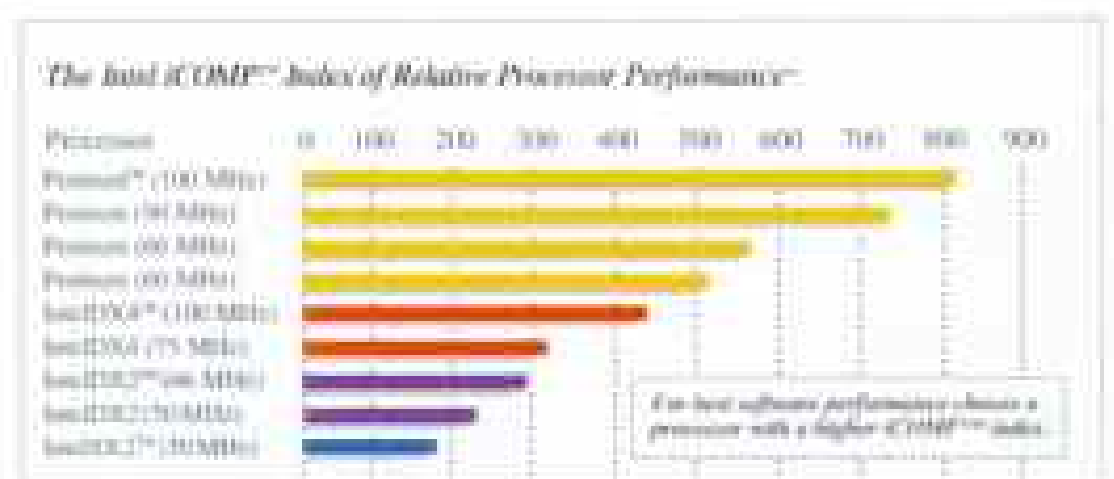
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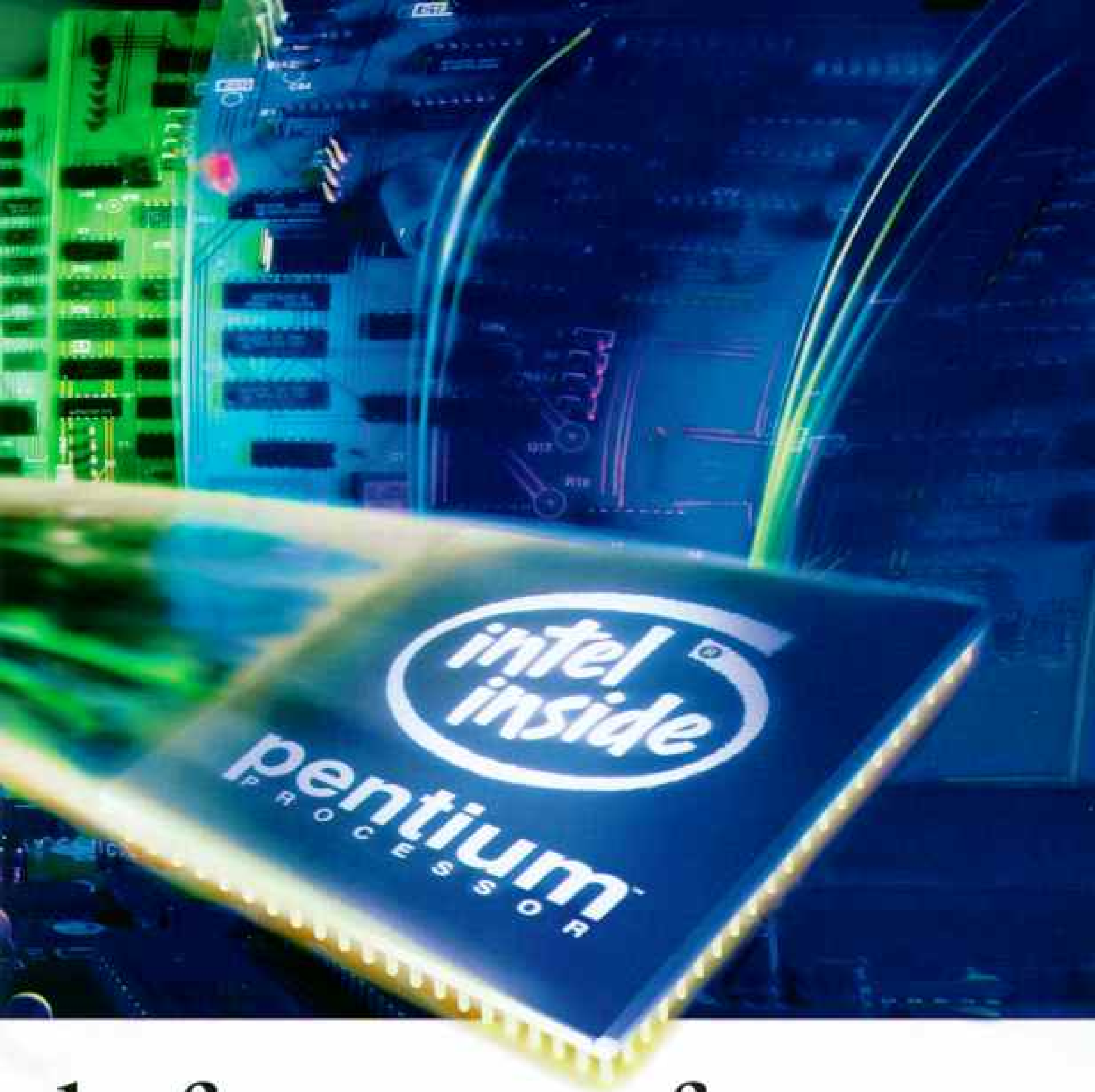
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## DOROTHY DOBSON HAS A NOVEL APPROACH TO TEACHING SOCIAL STUDIES.

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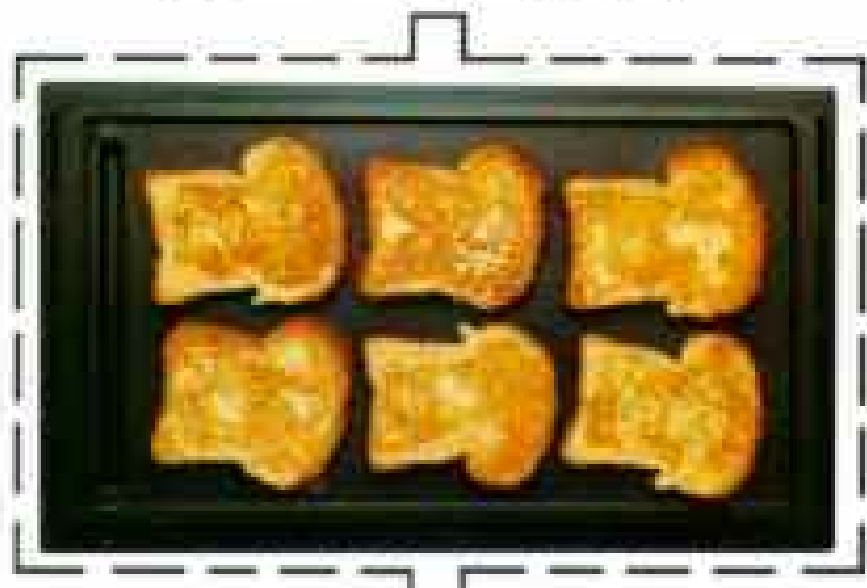
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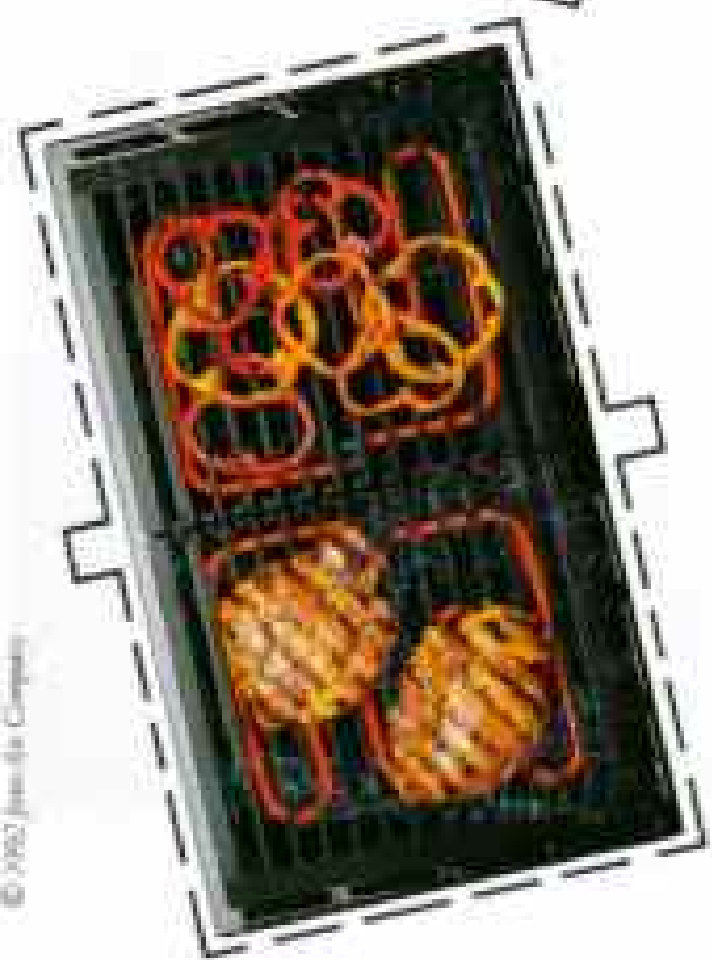
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# On Television



JOHN DANCALOSI, TOM STACE & ASSOCIATES

## Videos for Kids: Fun Yes. Facts Yes. Violence No.

**W**e are determined to provide parents with the opportunity to choose quality family viewing instead of the crime and gore that dominates so much of TV aimed at children," says Society President Gil Grosvenor.

"Our new Children's Television department dynamically fulfills that commitment." National Geographic's first home-video series for children—*Really Wild Animals*—is geared to youngsters between the ages of five and ten.

The series is hosted by Spin (below), a cartoon globe-on-the-go who introduces young viewers to the ways Earth's inhabitants live, use their environment, and care for one another. For instance, children see renowned scientist Jane Goodall studying the social structure of chimps and discover that these primates, just like humans, comfort their young.



*Really Wild Animals* begins with three video cassettes: "Swinging Safari," "Wonders Down Under," and "Deep Sea Dive." Six more are scheduled. The videos are entertaining, educational, and packed with animals—from African lions to Australia's spiny anteater.

Spin roams the world, speaking in the many voices of actor Dudley Moore. Using techniques familiar from other National Geographic TV programming, Spin presents a soap opera about colobus monkeys, a Western about sea horses, and a segment on lifestyles of the weird and little, about a fish called a mudskipper, a marsupial called a quoll, and a mammal that flies—the fruit bat. Each video includes mini-documentaries about animals. Original music accompanies the stories.

Andrew Wilk, executive producer and vice president for Children's Television, says: "We chose to start with a home-video series because we wanted involved viewers. When kids run VCRs themselves, they watch with concentration instead of zapping from channel to channel."

Children four and under will soon have their own home-video series in



STEPHEN L. KRASCHANN, DRK PHOTO (MOTM)

a format designed to appeal to that age. Called *GeoKids*, it will premier in the fall of 1994.

Says Gil Grosvenor: "With this major new commitment, we hope to give children a running start toward a future where they can connect with the exciting, living world in all its variety and fullness."

*Really Wild Animals* is available through the National Geographic Home Video Club and in video stores nationwide.

## Contestants Face Off in National Geography Bee

**A**nswering wide-ranging questions about the world is the skill that will lead ten smart kids to the finals in the sixth annual National Geography Bee, a PBS prime-time special. These finalists will emerge from six million fourth- through eighth-grade participants in school and state bees. They compete for three top prizes: college scholarships for \$25,000, \$15,000, and \$10,000.

Host Alex Trebek, of *Jeopardy!*, says, "The more young people know about the Earth, the more likely they are to protect it."

The National Geography Bee is sponsored by the National Geographic Society and Amtrak.

*The National Geography Bee* airs on PBS, May 25, 8 p.m. ET.



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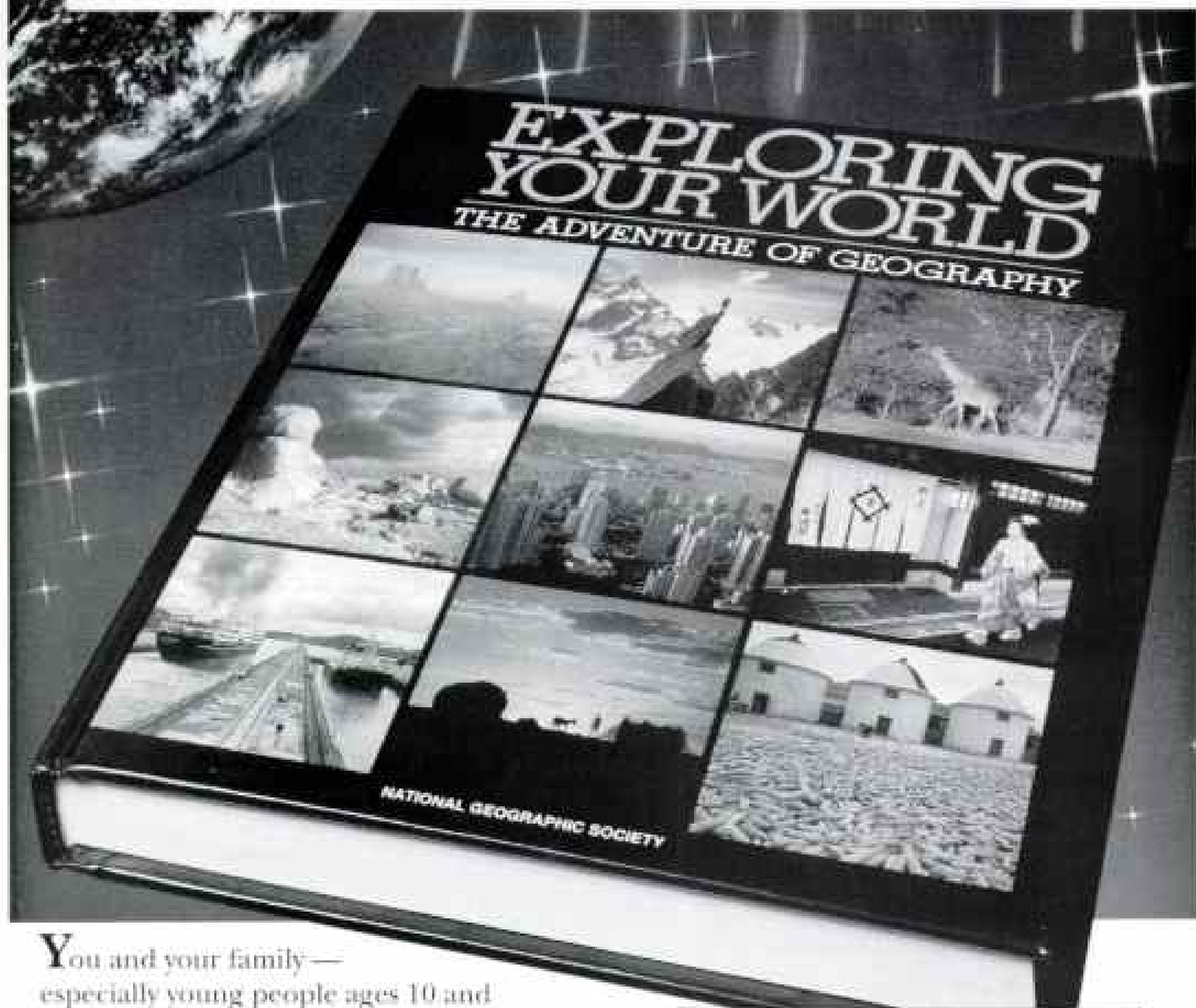


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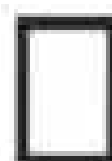
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# Earth Almanac



STUART FRANKLIN

## South America's Largest Lake: Awash in Pollution

**T**he waters of Venezuela's vast Lake Maracaibo have long been troubled. Larger than Connecticut, the lake covers more than 5,000 square miles. It suffers from equally large woes: oil pollution, agricultural runoff, and raw sewage. After decades of abuse, the sewage problem is being addressed. The others, however, drag on.

The most visible evidence is a forest of 10,000 wells that has grown since 1917 to tap a bonanza of oil and gas beneath the lake bed. "There are oil slicks around some rigs," says Stan Bolsenga, one of several consultants from the Great Lakes Environmental Research Laboratory in Michigan who is studying the lake. "But worse is the 9,600-mile underwater 'spaghetti network' of pipelines that are old and leaking." The pipelines were built by foreign oil companies. Venezuela's government nationalized the oil industry in 1976 but now says it has no money to fix the network. Meanwhile, phosphates and other agricultural pollutants flow into the lake from surrounding rivers.

But another scourge—sewage

pumped into the lake from Maracaibo city's 1.4 million residents—may soon be eased. "The Venezuelans are on the brink of completing excellent sewage-treatment facilities for Maracaibo and smaller communities," Bolsenga says. "These are badly needed, because in some parts of the lake formations of algae nourished by the sewage are as thick as pea soup." Bolsenga, who studied the history of Lake Erie's pollution for more than a decade, calls Lake Maracaibo's situation "much, much worse."

## Hot Stuff! Pepper Paint Foils Barnacles

**S**ailing in Florida, Ken Fischer figured there must be a better way of freeing boat hulls from barnacles than by scraping them or protecting them with copper-based antifouling paint, toxic to marine life. One day Fischer bit into a Tabasco-laced deviled egg—"and I wondered if barnacles would react the same way."

To test his theory, he coated floor tiles on one side with cayenne pepper and immersed them

in seawater. Eleven months later the coated sides bore no barnacles, but the uncoated sides did. Buoyed by his findings, Fischer went to the spice giant, McCormick & Co., which tested several peppers with encouraging results. He then patented a paint, called Barnacle Ban, that should fire up the market when released later this year.



DAVID CLARK



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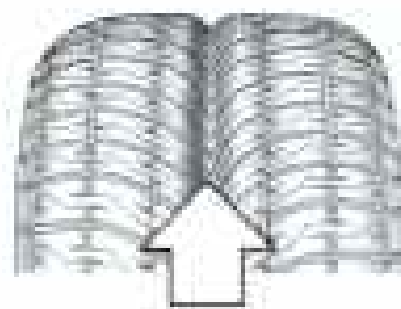
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# Earth Almanac

## Better Times for a Mediterranean Seal?

**T**heodoros, a Mediterranean monk seal, is the toly-poly symbol of conservation efforts for his species on the Greek island of Alonissos. In 1991 he was rescued by volunteers after being separated from his mother. Treated at an intensive care station, he responded well and was released back into the waters of the Aegean Sea.

Living only in the Mediterranean and off Africa's Atlantic coast, these seals have long been considered one of the world's most endangered mammals, thought to number no more than 500. Fewer than 1,500 of the related Hawaiian monk seals survive in the Pacific, and the Caribbean monk seal is likely extinct. So it was good news for Theodoros and his friends in 1992 when Greece declared their islands, the Northern Sporades, a national marine park, complete with patrol boats. Mixed tidings came the same year from Western Sahara's coast with the end of a long guerrilla war: The dangers posed by the fighting are gone, but fishermen can now return to compete with some 125 seals for food.



METTHIAS SCHNEELMANN

for China to be ground into medicinal potions.

The bones, representing the fate of at least 35 adult tigers, weighed more than a thousand pounds and could have fetched smugglers hundreds of thousands of dollars. Yet one man arrested in the raid told police that he could procure another 2,000 pounds of tiger bones within a month. These are chilling numbers in a country where between 500 and 1,000 tigers have been killed during the past three years. As few as 3,000 remain.

The world's tigers have dwindled to about 5,000, and pressure is growing on the 13 nations with tigers to crack down on poachers. The U. S. threatened economic sanctions against Taiwan and China last year—a Damoclean sword that has produced some results. Both countries banned the sale of medicines made from tiger bone and rhino horn, but some conservationists want all stocks of bone and horn destroyed.

## Tiny Spiders Commit “Insecticide” Neatly

**A**rtfully camouflaged, a female crab spider takes on the golden hue of her host flower to ambush a syrphid fly on which to dine. She can also match a white

flower with her strategy of deceit.

Numbering about 3,000 species worldwide, these wily spiders spin no webs to ensnare their victims. Instead they sit motionless and await flies, bees, or moths. They slowly embrace their prey with their legs, then suddenly lunge, stabbing their fangs into the prey's head and injecting venom directly into its brain.

But neatness counts. All spiders liquefy their victims' innards with enzymes before eating. Most crush and dismember the exoskeleton to



MOHIT AGGARWAL, WORLD WILDLIFE FUND PHOTOLIBRARY

## Poachers Rapidly Reduce Tigers to Skin and Bones

**L**ast summer's Operation Dragnet was spectacular—and horrifying. Indian agents netted two caches of illegal wildlife products in a Tibetan refugee camp in Delhi. The contraband, made up primarily of tiger bones, included this leopard skull. Most of the haul was destined



BEJUMENHOPE ASPERATON, U.S. DEPT. OF AGRICULTURE, DENVER PHOTO ASSOCIATES

get at the soft tissues, so the area looks like a miniature battle zone. But crab spiders make just two pairs of fang punctures—one in the head or neck, the other in the abdomen—and drain the corpse dry.

—JOHN L. ELLIOT

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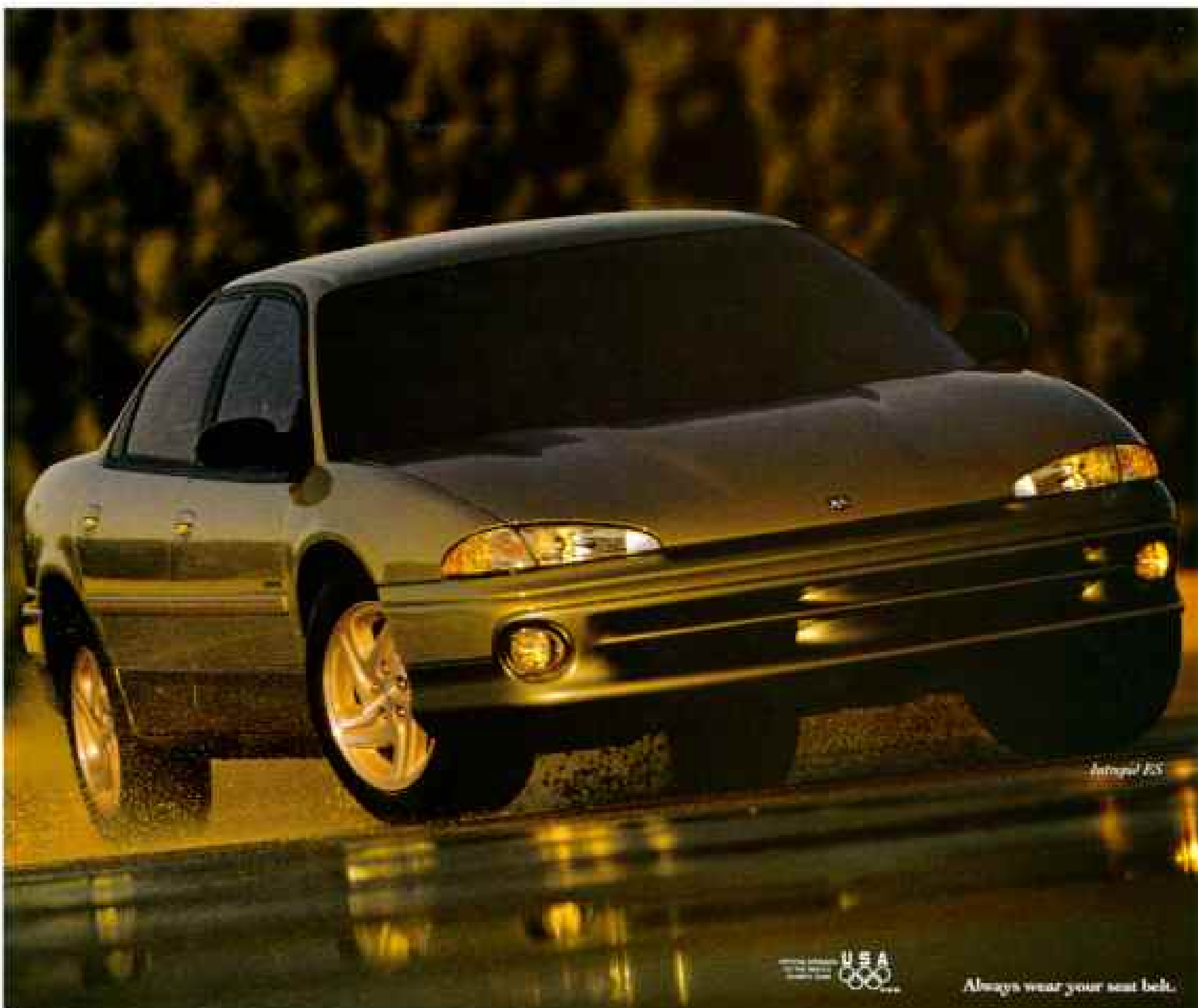
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# On Assignment

For as long as he can remember, ornithologist **GEORGE ARCHIBALD** has loved birds. For a Siberian crane named Ramsar, the feeling is mutual. "She thinks I'm her mate," says Archibald, who admits to leading the lady on. During breeding season the director of the International Crane Foundation in Baraboo, Wisconsin, moves his office to a hut near the crane's pen to provide round-the-clock attention. He regularly takes her dancing (right), following her lead in the wing-flapping cha-cha of crane courtship. The activity stimulates the crane's hormones in preparation for artificial insemination. It's all part of the foundation's effort to propagate dwindling crane populations.

"We have all 15 species of the world's cranes," reports Archibald, who encourages the public to visit. "It's the first time since Noah that they've all been together." Appropriately, the birdman has been



NEEL VESPA, MILWAUKEE JOURNAL

appointed to the Order of the Golden Ark by Prince Bernhard of the Netherlands. He has also been awarded a MacArthur Foundation fellowship and the World Wildlife Fund Gold Medal for his work.

Senior writer **NOEL GROVE** hasn't

stopped to rest often in his 25 years with the **GEOGRAPHIC**. A believer in writer participation, Noel has driven combines with wheat harvesters in Kansas and built a Mark Twain-style raft and ridden it down the Mississippi. He's hiked the Appalachian Trail and danced with Yemeni tribesmen. "Nothing beats putting a pack on your back and getting out there," he says.

"Out there" this time was Alaska's Wrangell-St. Elias National Park and Preserve, which he says "makes you sense what this country once was."

Noel was a schoolteacher in Kansas before becoming a newspaper reporter. He moved on to Cleveland, Ohio, then Washington, D. C., as a writer for Scripps Howard. The former Iowa farm boy has always been at home in the outdoors. "When I should have been doing chores as a kid, I was often wandering away into the woods," he remembers. Now he does it for a living.



GEORGE F. MODLEY

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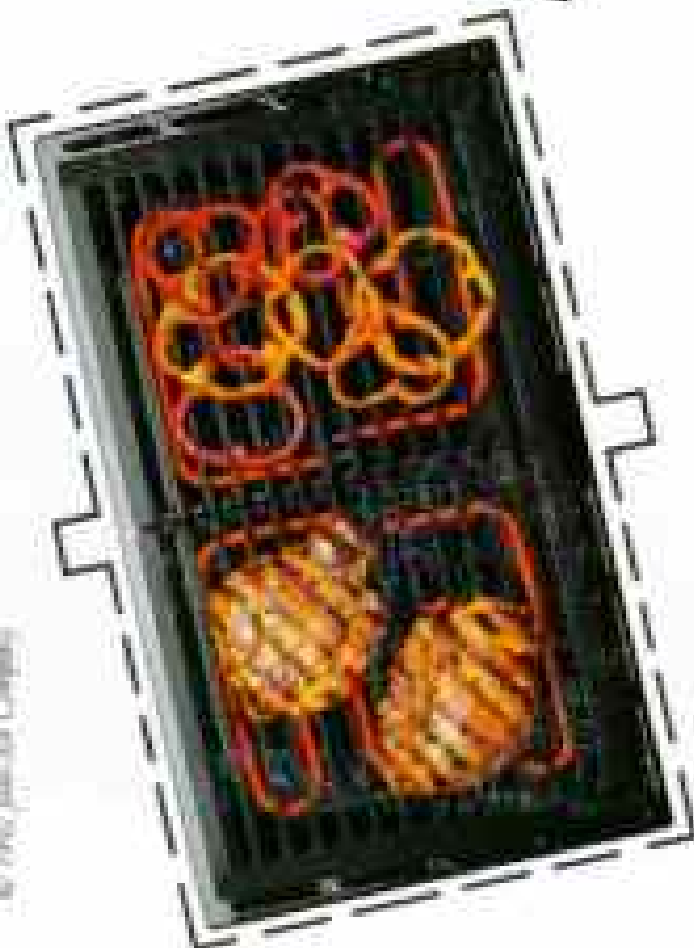
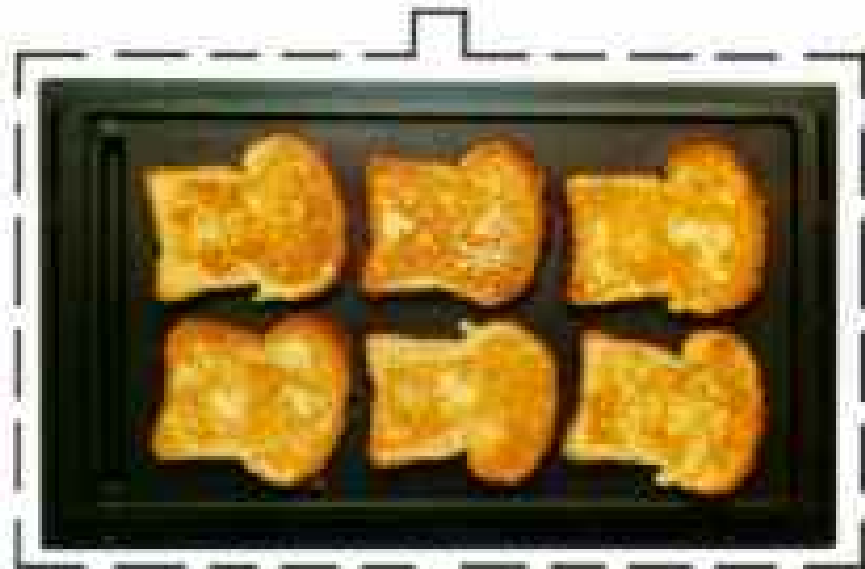
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