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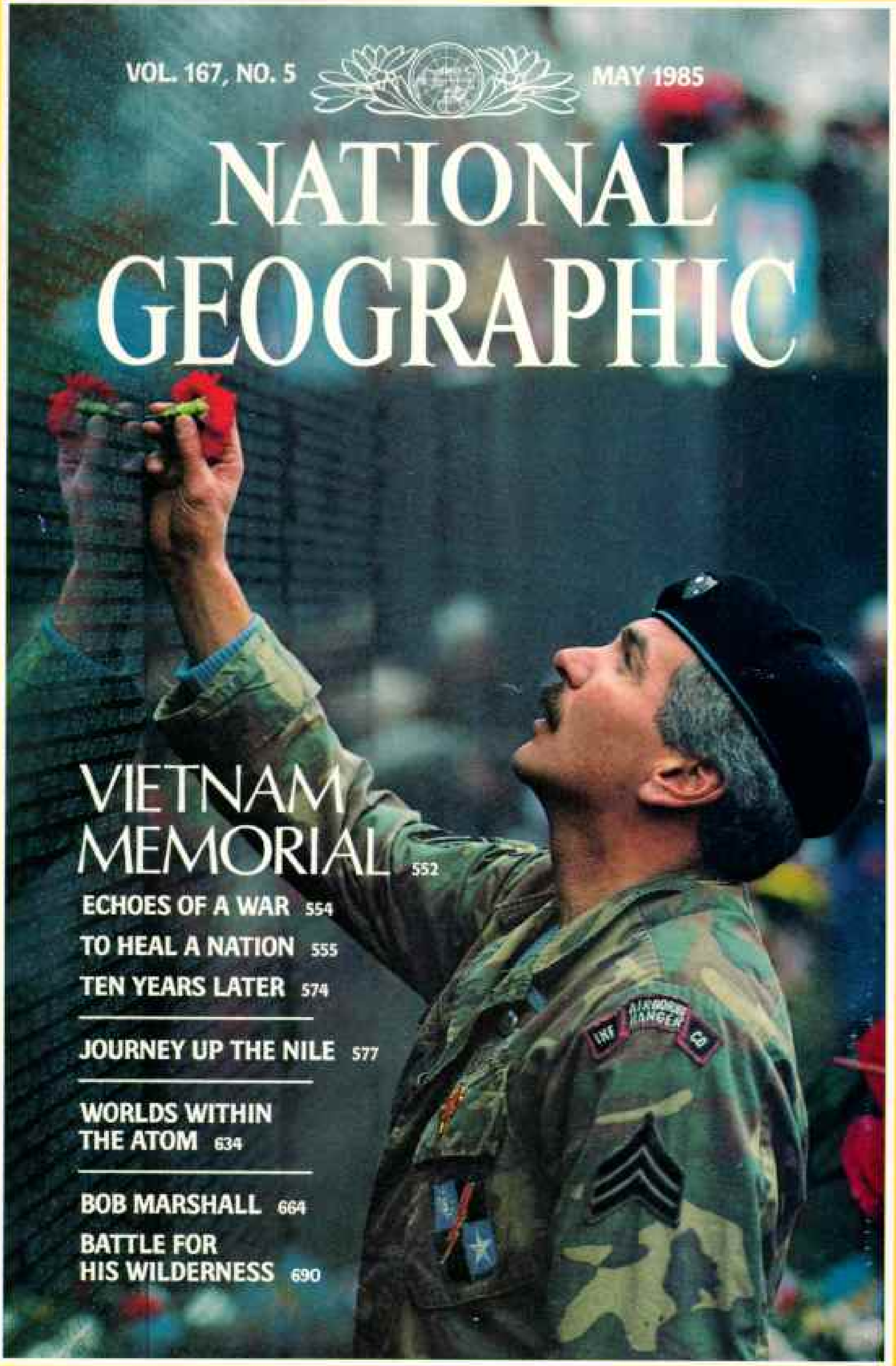
NATIONAL GEOGRAPHIC



VIETNAM MEMORIAL 552

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NATIONAL GEOGRAPHIC

May 1985

COVER: *Former Ranger Michael Kentes of Alexandria, Virginia, finds names of lost comrades at the Vietnam Memorial. Photo by Nick Sebastian, WorldWide Images.*

WHEN JAN SCRUGGS started his single-handed drive to build a Vietnam veterans memorial, he wrote to Senator John W. Warner, flatly asking for $5,000.

It's not that the Virginia senator's a soft touch, but Scruggs's naive bluntness touched a nerve. Recently I asked the senator—who gets thousands of letters each month—why he responded with the $5,000 personally and helped raise another $50,000 within weeks.

"As Secretary of the Navy, I had signed the

NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR

papers that sent a lot of those men out there." And then he told the story of a particular friend whose name is etched on that black granite wall. In Scruggs's determination to memorialize by name all 58,000 who died or remain missing lies the amazing attraction of this much visited Washington monument.

Like the senator and most others who go there, I too looked for a particular name. And there it was—third row down on the first panel. Army Maj. Walter H. Moon had been the 15th U. S. military man to die. I was with him the day he was wounded and captured—March 29, 1961—but I was lucky enough to get out. He died in prison four months later.

I was sympathetic to picture editor Kent Kobersteen's suggestion that we publish all the names in this issue. We soon found that, in our normal type size, it would require 230 pages. We backed off, but the publishers Harper & Row did not. This May 1 they will issue a book on the monument, *To Heal a Nation*, by Jan C. Scruggs and Joel L. Swerdlow (shown above holding one end of our 230-page mock-up). It will contain all the names—names that hold a very special meaning for all Americans.

Wilbur E. Garrett

EDITOR

Vietnam Veterans Memorial

AMERICA REMEMBERS

VETERANS DAY WEEKEND, 1984. MICHAEL S. WILSON, NATIONAL GEOGRAPHIC STAFF

Taps sounds a farewell for comrades lost in America's longest war. Often ignored, sometimes maligned, Vietnam veterans themselves sponsored this newest monument in the nation's capital, its simple black granite surface inscribed as a lasting tribute with the name of every one of those who made the ultimate sacrifice.

Echoes of a War

By TIMOTHY S. KOLLY

IN 1968 I was assigned to a funeral honor guard in Texas, detailed to bury the Vietnam dead. One morning, while acting as a pallbearer for a black infantry corporal, I moved forward to steady his grieving mother near the open grave. In furious disconsolation, she pulled her arm away, wheeled, and shouted, "Why couldn't it have been you, white boy?"

Everything stopped. Sound, movement, everything. I moved away, stunned. The weeping father later approached me to offer an unnecessary apology.

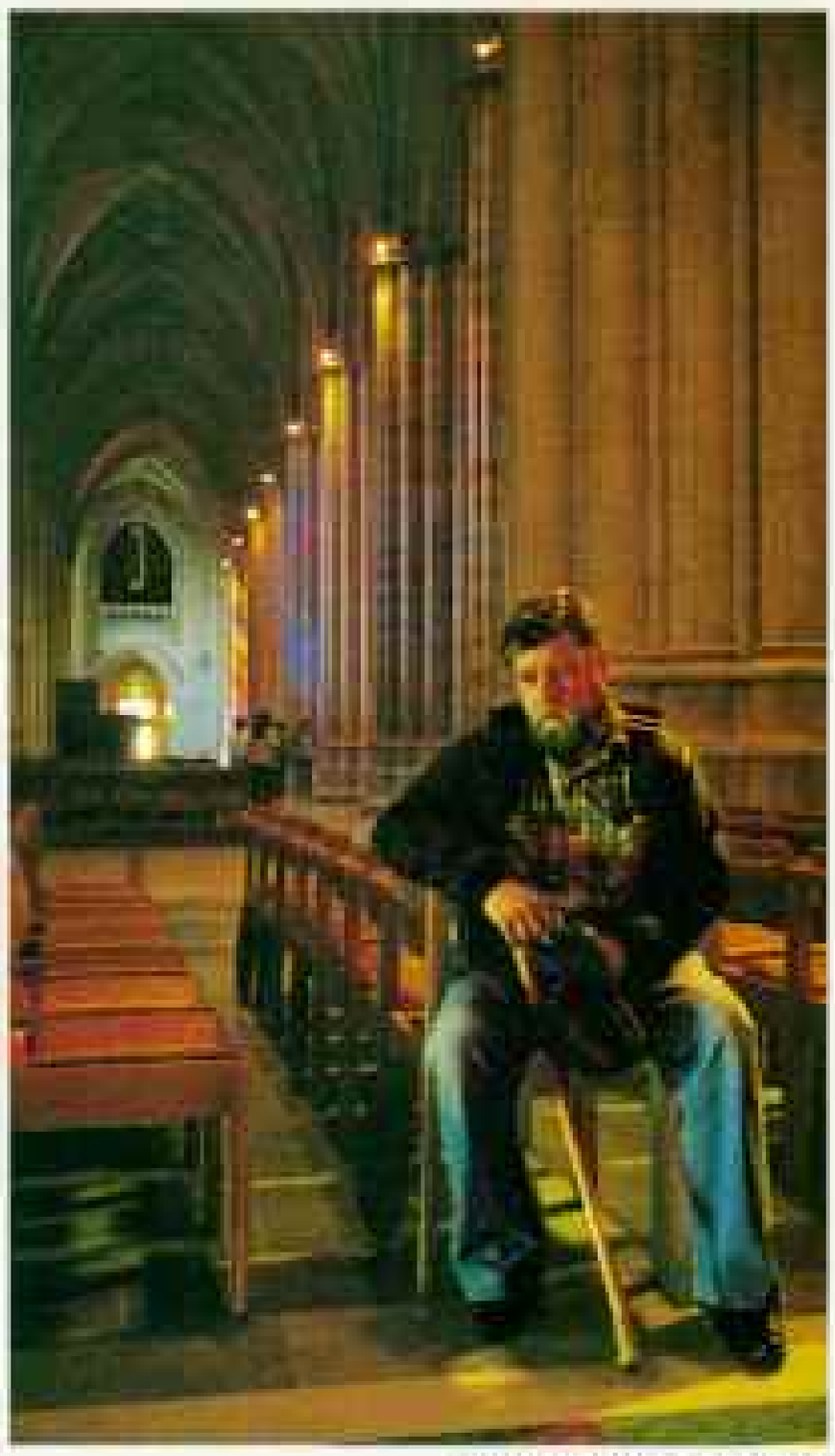
I still have no answer to the mother's question, and I have asked it myself many times. But I have always known, since that day, that some catharsis would be necessary, not only for the veterans who had served but also for the loved ones left behind.

More than a decade later, on a raw November afternoon in 1982, Vietnam veterans, thousands of them, were drawn to Washington for what was ostensibly the dedication of a memorial to their sacrifice and the final sacrifice of 58,000 United States men and women. In reality, the vets were coming to collect a debt. They were coming to pay to each other the tribute denied to them elsewhere.

At the National Cathedral, subdued golden light washed Bethlehem Chapel. Every chair was filled; listeners stood along the walls. At the altar two veterans knelt, one in camouflage fatigues. A middle-aged man recited an alphabetical litany of names of those who had perished, including the name that gave purpose to his presence. A son. Twenty years of age.

He haltingly delivered a homage that had been written in his heart years ago, so profoundly filled with love and remorse that when at last his voice broke, not an individual present would have been able to continue for him.

One of the veterans rose and silently laid a hand on the father's shoulder. In that moment, and in the days that followed, was fulfilled a need of all Vietnam veterans to speak to the parents or relatives of those who had died, finally to express to them their grief and their gratitude, and to relieve some of the guilt of survival.



WALLY MCNAMEE, NEWSWEEK

On a solitary vigil, *a veteran meditates at the National Cathedral during the November 1982 Salute to Vietnam Veterans. At that time the memorial was dedicated on the Mall, and its 58,000 names were read aloud here during a 56-hour watch.*

TO HEAL A NATION

By JOEL L. SWERDLOW

ADAPTED FROM THE BOOK "TO HEAL A NATION" BY JAN C. SCRUGGS AND JOEL L. SWERDLOW

FOR THESE GIs, coming home had not been like John Wayne had promised. They had gone to Vietnam filled with images of John F. Kennedy and Hollywood movies, and they did their duty, even though few of these images matched the muck and the moral confusion they found in Indochina.

After 12 months they were put on an air-conditioned airplane with pretty stewardesses, and suddenly the war was over. "Wash up," one returning veteran's mother had said. "Your welcome-home dinner is ready." He looked down at his hands. Mud from Vietnam was still under his fingernails.

No one wanted to hear what the vets had been through. People who saw them in uniform might spit, shout "Murderer," or ask, "How come you were stupid enough to go?" Or, if you'd arrived home blind or missing an arm or a leg, someone might come up and say, "Served you right."

Thus, many vets carried powerful and disturbing feelings that were buried deeper and deeper as the war became old news to other Americans.

For Jan Scruggs—wounded and decorated for bravery when only 19 years old in 1969—the feelings surfaced in March 1979 after he saw *The Deer Hunter,* an emotional movie about combat in Vietnam. "I'm going to build a memorial to all the guys who served in Vietnam," Scruggs told his wife. "It'll have the names of everyone killed."

Scruggs soon afterward presented his dream to a meeting of Vietnam vets. "We'll accept no money from the government," the son of a milkman from rural Maryland said. "Dollars will come in from the American people." You're naive, they told him. The country will never go for it.

At a press conference Scruggs explained that the Vietnam veteran could be honored without taking a position on the war, that the warrior could be separated from the war. He was enthusiastic and not embarrassed to let his feelings show. "The only thing we're worried about," he concluded, "is raising too much money."

Money did start coming in. Five dollars from an unemployed vet. Ten dollars from a young girl in memory of her father. One check came with only a torn piece of paper carrying the name of a dead GI. "All we want is for people to recognize the sacrifices and contributions they made because the country they love told them it was right," one man wrote.

On the CBS Evening News, Roger Mudd reported that the veterans organization whose only concern had been about raising too much money had gathered the grand sum of $144.50.

Later, a comedian on a network program made fun of Scruggs. It was a good joke, and the audience laughed.

TWO OTHER VIETNAM VETS were not laughing. Robert Doubek and John Wheeler, both attorneys in Washington, D. C., had begun working with Scruggs. Calls went out, and Bob Doubek and Jack Wheeler had no difficulty recruiting a group, organized into the nonprofit Vietnam Veterans Memorial Fund, willing to volunteer thousands of hours at no pay. The VVMF agreed upon a timetable:

1980—obtain land for the memorial.

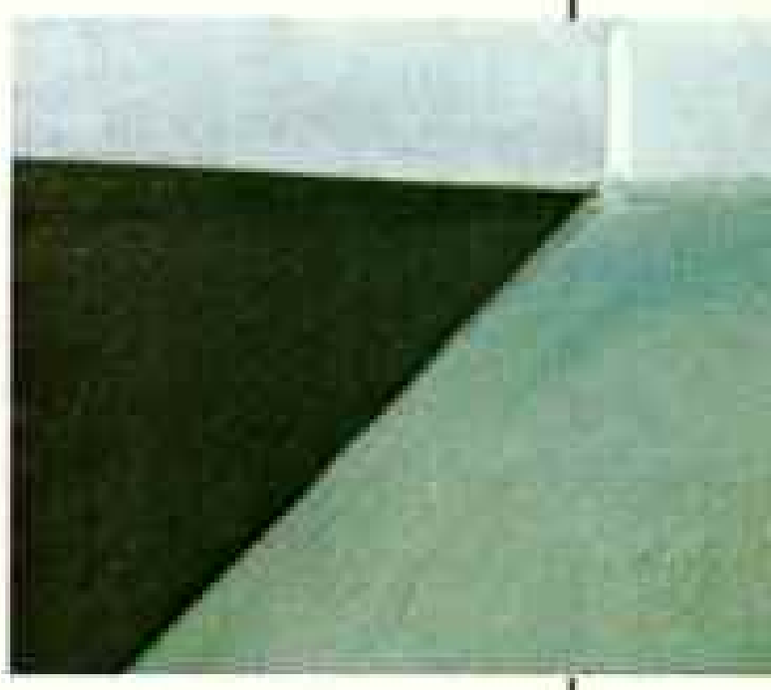
1981—select a design and finish fund-raising.

1982—complete construction; conduct dedication ceremonies on Veterans Day.

"THE FIRST TIME I saw the granite panels, the place was frighteningly close to what I thought it should be," recalls designer Maya Lin. "It terrified me to have an idea that was solely mine be no longer a part of my mind, but totally public.

"I had designed the memorial for a seminar on funerary architecture my senior year at Yale, after our class read about an open competition for the design. We had already been questioning what a war memorial is, its purpose, its responsibility. Many earlier war memorials were propagandized statements about the victor, the issues, the politics, and not about the people who served and died. I felt a memorial should be honest about the reality of war and be for the people who gave their lives. For a strong and sobering feeling, it should carry their names. I didn't want a static object that people would just look at, but something they could relate to as on a journey, or passage, that would bring each to his own conclusions. I was mulling these ideas, but I had no form. Then I went to the site.

"I had been home for Thanksgiving in Athens, Ohio, and decided to stop in Washington. I walked around this beautiful park, surrounded by trees. People were tossing a Frisbee. I wanted to work with the land and not dominate it. I had an impulse to cut open the earth . . . an initial violence that in time would heal. The grass would grow back, but the cut would remain, a pure, flat surface, like a geode when you cut into it and polish the edge. I didn't visualize heavy physical objects implanted in the earth; instead it was as if the black-brown earth were polished and made into an interface between the sunny world and the quiet, dark world beyond, that we can't enter.



"At Yale I sketched the idea and worked it up in clay. It seemed almost too simple. Then I reread details about the competition requirements: All names of those killed and missing must be part of the memorial; the design must be apolitical and harmonious with the site. It was perfect. The names would become the memorial. There was no need to embellish.

"I chose black granite to make the surface reflective and peaceful. The angle was formed solely in relation to the Lincoln Memorial and Washington Monument to create a unity between the nation's past and present.

"My professor thought the design was too strong but wanted me to enter anyway. I didn't consider that it might win.

"Later, when I visited, I searched out the name of a friend's father. I touched it and I cried. I was another visitor, and I was reacting to it as I had designed it."

NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR (LEFT); PASTEL BY MAYA LIN FOR THE DESIGN COMPETITION, COURTESY LIBRARY OF CONGRESS

A *Washington Post* article by Scruggs placed the VVMF's motives clearly on the public record: "If the war was unpopular at home, it was probably liked even less by those whose fate it was to serve in Vietnam. It was a year-long nightmare. Half the men in my company were killed or wounded. . . . A few months before leaving Vietnam I spent four hours of my life 50 feet from a North Vietnamese machine-gun emplacement. A dozen American youths were pinned down; several were wounded. . . . One fellow exposed himself to the enemy gunners and drew their fire. . . . Then came his screams. . . . We knew we were watching the man who had given his life for us die. . . .

"The bitterness I feel when I remember carrying the lifeless bodies of close friends through the mire of Vietnam will probably never subside. I still wonder if anything can be found to bring any purpose to all the suffering and death."

In September, Doubek, Wheeler, and Scruggs met with Senator Charles McC. Mathias, Jr. (R-Md.), whom Scruggs had recruited to their cause, and a National Park Service official, who spread out a map of the Washington metropolitan area.

Mathias put his thumb on the map. "How about this?" he said.

The Park Service official gulped. "Sure is a good site, Senator."

Wheeler and Doubek looked down. Mathias's thumb was on the Mall, right next to the Lincoln Memorial.

MONEY was the overwhelming problem. Professional fund-raisers warned that Vietnam would not sell. The vets, however, formed a National Sponsoring Committee—which included First Lady Rosalynn Carter, former President Gerald Ford, Gen. William Westmoreland, and Senator George McGovern—and mailed out a fund-raising appeal signed by Bob Hope.

Tens of thousands of dollars came back, but response to the Hope letter mostly showed how much the memorial was needed:

"My son was killed, and I can't bring it up during a party."

"I did not expect a ticker tape parade, but I served my country faithfully."

"I hope the monument will be built in my lifetime."

"For my son, so he can ask the questions I'll never be able to answer."

"Look at the sheer whimsy of it all. They are dead. I am not."

"Anyone who died in that fiasco is a hero in my eyes."

"Our son did not come home to us."

"Those boys, God bless, were given a *rotten* deal."

Not everyone loved the idea. "To me you are a bunch of crying babies," a man wrote. At the meeting of one government agency, a military officer had even asked, in effect, "Why build a memorial to losers?"

The chief source of potential opposition seemed to be the antiwar movement. "Let's not perpetuate the memory of such dishonorable events by erecting monuments to them," one person wrote. A reporter telephoned Scruggs, and from his questions made clear his antiwar views. "You're real egomaniacs," the reporter finally said. "You're building a memorial to yourselves."

America may have forgotten its Vietnam vets, but it had not forgotten its longest war. Frustration, finger pointing, and contradictory lessons—fueled by a decade of television images—were embedded in the nation's psyche. Sensitive to the

***Veterans** spearheaded the campaign for a memorial after Jan C. Scruggs, left, conceived the idea in 1979. With Robert W. Doubek, center, he founded the Vietnam Veterans Memorial Fund, which, joined by John Wheeler, raised nine million dollars from the American people.*

JAMES P. BLAIR

emotional minefield they were entering, Jack Wheeler warned his colleagues to take no political position and to express no opinions on Vietnam-related subjects. The stakes were far greater than simply building a memorial. "We have become," he said, "trustees of a portion of the national heart."

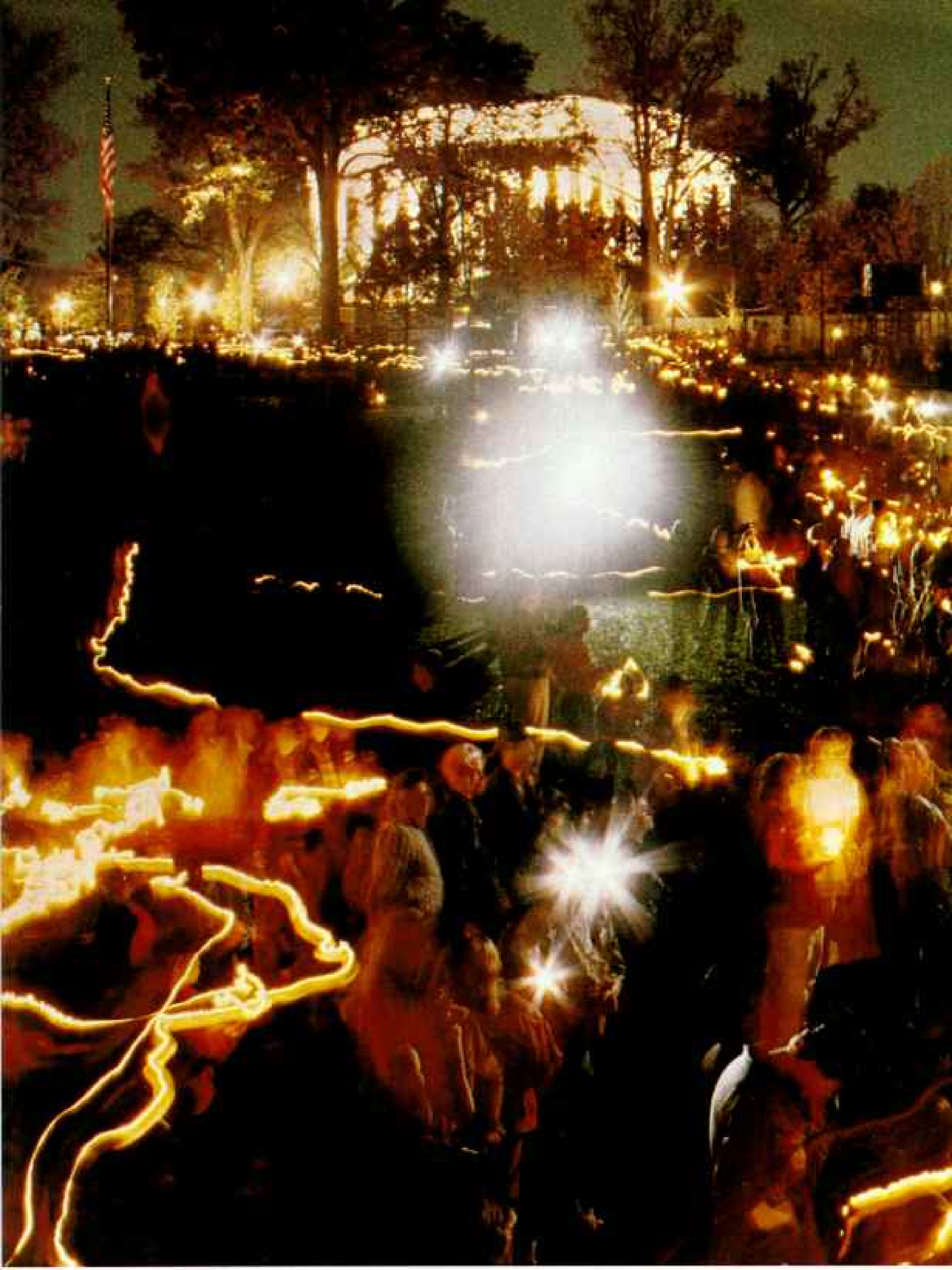
The site next to Lincoln was perfect. To leave site selection in the hands of an official such as the Secretary of the Interior, however, could mean an out-of-the-way location. The only way to get their land near Lincoln was to get Congress to give it directly to them. If the Vietnam Veterans Memorial was to help bind the nation's wounds, what better place could there be?

Hearings before a Senate subcommittee were scheduled for March 12, 1980. Jan Scruggs with a suitcase full of documents justifying the site on the Mall was in his car, and he couldn't find a parking place. He pulled into a parking lot reserved for senators.

"Listen," Scruggs told the guard, "I've got to testify for the Vietnam memorial. Hearings start in seven minutes."

"Third Marines. Two tours," the guard said, motioning Scruggs into a senator's parking slot.

Congress was doing little for Vietnam vets, yet many senators supported the VVMF because it was asking for land and not tax dollars. The VVMF, with little public attention, soon had 95 Senate cosponsors. Scruggs called the remaining five.



Lighting candles, *families and friends of prisoners of war and the missing in action gather during Veterans Day weekend ceremonies last November to say they*

RICK SEBASTIAN, WORLDWIDE IMAGES

have not forgotten. The names of more than 1,300 missing and unaccounted for are marked by a small cross that will be circled if a man returns alive.

Vietnam Veterans Memorial

***Joyous reunion** and heartrending grief mark dedication day on November 13, 1982. Crowds waiting to draw nearer the chevron-shaped wall form a cordon near the Constitution Gardens pool and the Washington Monument.*

MEDFORD TAYLOR, BLACK STAR (ABOVE); CHARLES A. PEREIRA, U. S. PARK POLICE

"We have 99 cosponsors," he told each. "The Associated Press wants to know who the holdout is." Within hours 100 Senators, the entire U. S. Senate, had signed up.

The bill, giving the vets two acres at the foot of Abraham Lincoln, passed the Senate in just seven minutes on April 30, 1980, but procedural difficulties in the House of Representatives delayed final action until after Memorial Day.

The VVMF, however, still held services at the site. About 400 people attended. Couples held hands or hugged children, and former GIs wearing jungle fatigues or ribbons pinned on business suits stood in tight clusters, as though sheer body proximity helped them share their emotions. Jack Wheeler stepped to the microphone. "There's no more sacred part of a person than his or her name," he said. "We have to start remembering real, individual names."

Members of the audience came up, one by one, to say the name of someone they had lost. My son. My husband. My father. My fiancé. My buddy. My brother. My childhood friend. My classmate. We still love them. We remember.

ON JULY 1, 1980, President Jimmy Carter signed the bill into law. The vets had their land. George Washington, Thomas Jefferson, and Abraham Lincoln would have new neighbors: every GI who served in America's most hated war.

The vets spent considerable time arguing about how best to get their design. Jan Scruggs found the whole issue boring. "Let's put the names on the Mall and call it a day," he said. Finally the VVMF decided to recruit a world-class jury that would, in turn, prompt the nation's best designers to submit entries. Any U. S. citizen 18 or older would be eligible to compete. Bob Doubek wrote out the basic philosophy behind the competition: "Because of inequities in the draft system, the brunt of dangerous service fell upon the young, often the socially and economically disadvantaged. [However] the memorial will make no political statement regarding the war or its conduct. It will transcend those issues. The hope is that the creation of the memorial will begin a healing process."

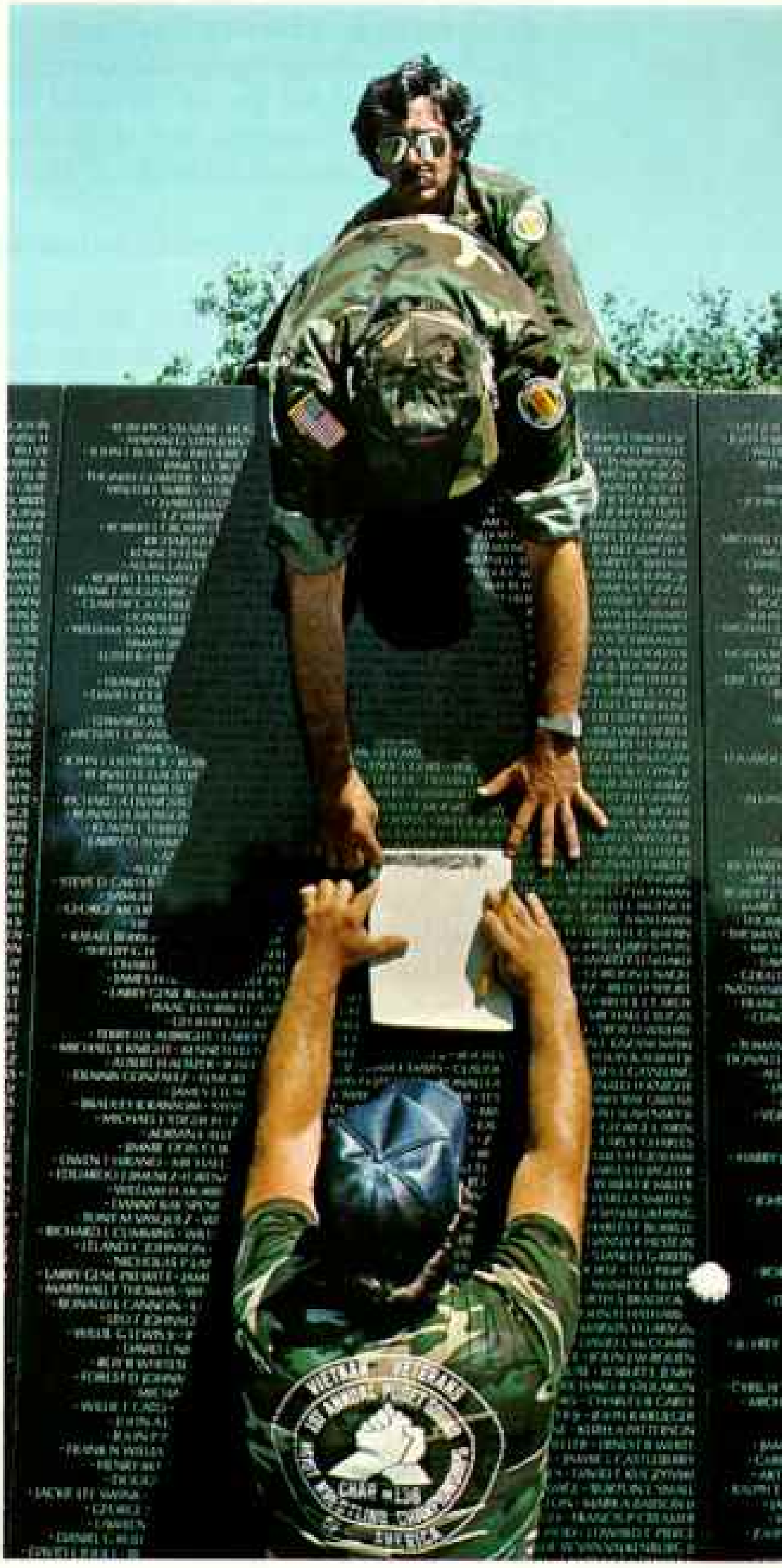
Not everyone agreed with this theme. For example, Peter Braestrup—a combat veteran of the Korean War and an award-winning war correspondent—asked what sort of memorial could possibly emerge from the reconciliation theme. "What

• ERIC A LORD • JOHNNIE LEE WILLIAMS
• CLINTON E MILLER • JAMES I YATES • ROWLA
THOMAS E CARUSO • JUAN A DIAZ-DOMENECH • JOH
• SHERBERT L COX • STEPHEN J CHANEY • GALE

MEDFORD TAYLOR (ABOVE); SAL LOPES (RIGHT); CAROLOU MARQUET

Reflecting faces, *the polished granite draws beholders into a special union with loved ones* ***(above)****. From the day of dedication, visitors have reached out to touch the names they know. And without invitation, many have left behind personal offerings* ***(left)****, from formal wreaths to garden blooms, war medals and unit patches, dog tags and discharge papers, photographs, loving notes, even toys. Volunteers and rangers of the National Park Service, which maintains the memorial, collect them for storage.*

Taking home *more than a memory, veterans find a friend's name and make a rubbing on a panel recording losses during 1969, the height of the conflict. Chronological arrangement of names by the day a serviceman or woman was lost gives visiting veterans the chance to find comrades' names by looking up their own years of service. Space was left for those inadvertently omitted.*



are you going to do?" Braestrup asked. "Show a hippie hugging a marine?"

When the March 31, 1981, deadline arrived, the VVMF had received 1,421 entries. One came from a Yale student who had been given a classroom assignment to design a Vietnam veterans memorial (pages 556-7). In late November she and three classmates had driven to Washington to examine the site. It was a cold, clear day, and the only other people nearby were a few Frisbee players.

After several minutes she decided that the earth should be cut open, with stone exposed in the wound as part of the healing process. She also thought about death. To her, it was an abstract concept. She was 20 years old, and no one close to her had ever died.

Back at school it took less than three weeks to complete her design, which she saw as "visual poetry."

To help draw attention to the memorial, a former infantryman and a former paratrooper walked 818 miles from Jacksonville, Illinois, to Washington. At the Ohio-Indiana border they were joined by a man who said, "My wife and I want to see our son's name on the monument."

On April 26, about 150 people, including vets on crutches and in wheelchairs, joined the walkers as they crossed the Potomac River. "It would have been nice to have a bigger reception for those guys," Scruggs told reporters waiting at the memorial site. "Well, maybe the Americans killed in Vietnam don't mean that much to a lot of people."

The next day the design jury began four days of closed-door deliberations. The proposed memorials came in all shapes, including hovering helicopters, miniature Lincoln Memorials, peace signs, and Army helmets.

After the first day a juror bumped into a friend in a hotel lobby.

"How's it going?" the friend asked.

"Very strange. One design keeps haunting me."

By noon the next day 1,189 submissions had been eliminated. The remaining 232 were placed together for further examination. That evening the juror once again saw his friend. The juror shook his head. "It's still haunting me," he said.

On the third day the jury was down to 39 entries. Number 1,026 generated the most comments: "There's no escape from its power." "A confused age needs a simple solution." "Totally eloquent." "No other place in the world like that." "Looks back to death and forward to life." "Note the reflectiveness." "Presents both solitude and a challenge." "It's easy to love it."

After 1,026 won unanimously, the jurors voted again just to make sure. 1,026. The next day Doubek looked up number 1,026. They had expected that the winner would be a prominent professional. "Maya Ying Lin." A woman. An Oriental name. Jack Wheeler recognized her address. An undergraduate residence at Yale.

PRESS REACTION to the design was enthusiastic. The *New York Times* said: "[It] honors these veterans with more poignancy, surely, than most more conventional monuments. . . . This design seems able to capture all of the feelings of ambiguity and anguish that the Vietnam War evoked in this nation."

The Commission of Fine Arts and other government agencies approved Maya Lin's design, and within weeks the American people started to register their

opinion. Fund-raising flourished under the direction of Sandie Fauriol, daughter of a professional Army officer. Veterans organizations were particularly responsive, and another Bob Hope letter—which read, "It is our duty now to show these veterans (who have yet to receive public recognition) that you and I personally care"—brought in daily sacks of mail.

A radiothon at a shopping center was quickly mobbed. Vets and their families stopped by to tell their stories. Former POWs came to plead for funds. Fathers brought in their children to give small change. People signed over Social Security and disability checks. Nonvets came in with grocery bags filled with cash they'd collected at parties. Radiothon organizers had said at 3 p.m. Friday that they'd be happy with $35,000; by 6 p.m. Sunday, they had $250,000. "What *is* going on out there?" a reporter asked Scruggs. He could only answer, "Hooray, America."

THEN, on October 13, a Vietnam vet appeared before the Commission of Fine Arts and called Maya Lin's design a "black gash of shame." He had hit a nerve. The design *was* hard to understand, and journalists propelled anti-memorial accusations—most notably that it was unheroic, unpatriotic, below ground, and death-oriented—into a civil war among vets. VVMF reassurances that the memorial would be exposed to sunlight all day, and that the names as displayed in Maya Lin's design would speak eloquently of sacrifice, commitment, and patriotism, never attracted as much attention as the attacks.

On January 4, 1982, even though more than 650,000 people had contributed more than five million dollars to build Maya Lin's design, a letter from Secretary of the Interior James Watt arrived. The memorial would not get a construction permit and was on hold until further notice.

That night Scruggs went to the site, and walked over to the Lincoln Memorial.

They were losing their memorial. How did it happen? The competition had been fair. No one had complained. The jury had done a good job. After the negative publicity, art critics had gone back and examined all 1,421 entries. They had concluded that Maya Lin's was by far the most brilliant.

Scruggs looked up at Lincoln. Was the dream about to die? The Civil War had been America's bloodiest conflict, and yet the memorial carried no sense of violence. It was nonpolitical. Nothing favored the North or the South. Nothing said that slavery was morally wrong. Or that the Civil War was right. Like Maya Lin's design, it provided a sense of history, it was simple, and it relied on words. People would read Lincoln's Gettysburg Address and Second Inaugural Address, think about the words, stand quietly, and let the feelings flow. They could come away different than when they arrived.

Maya Lin's design would do the same thing. Its words were the names. Even those who wanted glory had only to pick a name at random. Who could deny the glory in a young man willing to risk—and give—his life for his country?

The memorial would be built. Let the American people come with their children. Let the children ask tough questions. Who are these names? What did they do? Why did they die? Did you know them? What does it mean to me?

After several lengthy, emotional meetings, a compromise was reached: A flag and a representational statue would be added, and opponents would withdraw

The power of a familiar name turns the memorial into a place to mourn

WALLY MCNAMEE

and to reflect and, for many, to find the solace of final reconciliation.

Uncanny realism *invests the bronze statue of three servicemen placed near the wall as if they are scanning for their own names there. The work by Washington, D. C., sculptor Frederick Hart depicts the ethnicity, comradeship, apparel, and youth of Vietnam fighting men.*

JAMES P. BLAIR

their objections. The sculptor eventually selected, 38-year-old Washingtonian Frederick Hart, had been the highest placing sculptor in the original competition.

Hart's selection symbolized how the country was pulling together. The wall and statue would come from a woman too young to have experienced the war and a man who never served in the military and said he had been gassed in an antiwar demonstration.

At 11 a.m. on Monday, March 15, Secretary Watt authorized a permit. As concrete pilings were driven 35 feet into the ground, workmen in Barre, Vermont, used massive, high-speed, diamond-tipped saws to cut 3,000 cubic feet of granite into slices that were polished first by a series of bricks and then by a felt buffer covered with tin oxide, which is finer than talc.

Guided by computer-generated drawings, workers then fabricated the stone, cutting it into about 150 panels, each of them three inches thick, 40 inches wide, and varying in height from ten feet nine inches to 18 inches.

Shipped on specially air-cushioned trucks to Memphis, Tennessee, the stone was cleaned, painted with chemicals, and allowed to dry overnight. It was covered with a photo negative that was an exact stencil of the names in the order in which they would appear on the wall; then it was exposed to light, left for a short time, washed, and gritblasted. Experiment revealed that cutting letters into the stone one-fiftieth of an inch deep made them cast too heavy a shadow. Even a small error could spoil the memorial.

Architect Kent Cooper, hired by the VVMF to develop Maya Lin's design, made the final decisions: To maximize legibility, use very fine grit, do the blasting straight in front, and stand about 18 inches away so the letters will have maximum depth with uniform shadow. The letters would be .53 inches high and .015 inches deep.

Bob Doubek supervised compilation of the names. Many cases were heartbreaking. Veterans had been slowly dying from war-related causes for years. Some of them were in comas. Some had died in training or while on their way to Indochina. At least one former POW had committed suicide shortly after he returned home.

Who should go on the wall? The VVMF could only rely on the Department of Defense: If the Pentagon, acting in accordance with presidential directives specifying Vietnam, Laos, Cambodia, and coastal areas as combat zones, listed an individual

as a fatality or as missing in action, his name would be included. Heartbreak notwithstanding, nothing could be done about the rest.

The names were also at the center of a dispute between Maya Lin and the vets. Her design called for names to be listed in the order of the day they died. She argued that this was essential to her design. The wall, she said, would read like an epic Greek poem. Vets could find their story told, and their friends remembered, in the panel that corresponded to their tour of duty. Locating specific names, with the aid of a directory, would be like finding bodies on a battlefield.

Some vets initially disagreed. If nearly 60,000 names were scattered along the wall, anyone looking for a specific name would wander around for hours and leave in frustration. One solution seemed obvious: List everyone in alphabetical order.

But when the vets examined a two-inch-thick Defense Department listing of Vietnam fatalities, their thinking changed. There were over 600 Smiths; 16 people named James Jones had died in Vietnam. Alphabetical listing would make the memorial look like a telephone book engraved in granite, destroying the sense of profound, unique loss each name carried.

The vets admitted Maya Lin was right.

ON SEPTEMBER 20, 1982, sculptor Frederick Hart pulled back a tarpaulin covering a 14-inch-high model of his statue. "One senses the figures as passing by the tree line and, caught in the presence of the wall, turning to gaze upon it almost as a vision," he told reporters. "There is about them the physical contact and sense of unity that bespeaks the bonds of love and sacrifice that is the nature of men at war. And yet they are each alone."

To the vets, the statue looked true. Boonie hat. Facial expressions. Fatigues. Helmet. Dog tags in a boot. Way of holding weapons. The men were strong, yet vulnerable. Committed, yet confused. Wheeler told reporters that the sons and daughters of men killed in Vietnam would look at the statue and say, "This is my father. I never saw him alive. But he wore those clothes. He carried that weapon. He was young. I see now, and know him better."

As construction of the wall was rushed to meet the deadline set by the upcoming Veterans Day weekend ceremonies, many people simply stood outside the eight-foot construction fence waiting for a glimpse. Construction workers usually let family members and vets inside. An older man found his son's name, and stood there, clear-eyed and staring. But when he recognized nearby names, people his son had mentioned in letters, the man started to sob.

Most people did something unexpected. They touched the stone. Even young children reached up to fathers and uncles they had never known. The touches were gentle, filled with feeling, as if the stone were alive.

A Navy pilot in uniform brought with him a Purple Heart. "It belonged to my brother," he explained. "He and I flew together. I'd like to put it with the concrete that's being poured."

The pilot saluted as the medal disappeared into the wall.

October brought government approval of the statue, as vets and their families from all over the country began streaming into Washington for dedication of the memorial. One vet walked 3,000 miles. Another sold his household appliances for

***Focused** on the memorial, a spectator among the 150,000 at the 1982 dedication symbolizes the sense of union and of renewed patriotism that the wall has evoked, one reason it has become one of Washington's most visited memorials.*

NATIONAL GEOGRAPHIC PHOTOGRAPHER OTIS IMBODEN

airfare. Groups checked out of VA hospitals. And in the Midwest a couple heard about the upcoming ceremony on TV, finished dinner, cleared the table, got in the car, and started driving.

"It was," reported a newspaper in Beaumont, Texas, "as if they were all drawn by the same ghostly bugle."

For weeks, volunteers had been practicing reading names for a 56-hour vigil during which every name on the wall would be read in a chapel at the National Cathedral in Washington.

The hardest part was preparing not to cry. Pronunciation was also a problem, and a Polish priest, a Spanish teacher, and a rabbi supplied expert advice.

"Rhythmic Spanish names. Tongue-twisting Polish names, guttural German, exotic African, homely Anglo-Saxon names," wrote *Newsweek* editor-in-chief William Broyles, Jr., who served in Vietnam as a Marine infantry lieutenant. "The war was about names, each name a special human being who never came home."

When you lost a son in Vietnam, you did everything you could to never forget anything about him. You made yourself remember conversations and scenes over and over again. You studied family photographs. You climbed to the attic and opened the cedar chest in which he'd stored his things. You touched the American flag that had come home with him.

So much had been taken from you, so you clung to the one thing they could never take away, something that had been with you since the joy of his birth: his name.

The names were read in alphabetical order, from Gerald L. Aadland of Sisseton, South Dakota, to David L. Zywicke of Manitowoc, Wisconsin. Each name was like a bell tolling. As it was read aloud in the chapel, each ripped into the heart, into old wounds that could heal only after they had been reopened.

Time slots when names would be read were announced, so their sound could reach across America to people who loved them.

In Oklahoma, for example, at the exact moment her son's name was being said out loud, a woman stopped feeding her chickens and whispered a prayer.

A Congressional Medal of Honor winner who had volunteered to read names lasted five minutes before he broke down. He read the rest of the names on his knees.

WITH MORE THAN 150,000 people in town for the dedication, Washington's hotels, restaurants, and streets filled with vets. It was, said one happy ex-GI, "one helluva party."

After many beers, a vet said he had won the Medal of Honor but was afraid of how people would react. To the cheers of a crowded bar, he opened his suitcase, took out the medal with its blue ribbon, and put it on for the first time.

A man in a wheelchair slowly pushed through another bar that was filled to capacity. At first no one noticed him. Slowly, the noise faded, and then people reached out to touch him.

A former medic sat in a corner, crying. He pushed away all who tried to console him. "I should have saved more," he kept saying. "I should have saved more."

Another ex-medic was walking down the sidewalk when a man grabbed him.

"You remember me?" the man said.

"No," the medic replied.

"Well, I was shot up pretty bad. Take a close look."

"Sorry, brother, I still don't know you."

"Well, I remember *you*, man. You saved my ass. Thanks."

THE VETS, along with the American public, discovered the wall.

At night, they used matches, cigarette lighters, and torches made from rolled newspapers to find names. Volunteers stayed until dawn passing out flashlights. One father struck match after match, and then said to his wife, in a hushed voice, "There's Billy."

On Saturday, November 13, Vietnam vets marched down Constitution Avenue to the memorial in one of the largest processions the nation's capital had seen since John F. Kennedy's funeral.

Following speeches by dignitaries, the crowd sang "God Bless America," and paused for a moment of silence. "Ladies and gentlemen," Jan Scruggs said, "the Vietnam Veterans Memorial is now dedicated."

The tightly packed mass surged forward, crushing fences erected for crowd control. As thousands of hands strained to touch names, a lone GI climbed to the top of the wall, put a bugle to his lips, and played taps, slowly. Between each note people seemed frozen, stunned by emotion. Nearby, another vet thrust a sign into the ground. "Honor the dead, fight like hell for the living," it said.

All afternoon, all night, the next day and the next and the next for an unbroken stream of months and years, millions of Americans have come and experienced that frozen moment.

The names have a power, a life, all their own. Even on the coldest days, sunlight makes them warm to the touch. Young men put into the earth, rising out of the earth. You can feel their blood flowing again.

Everyone, including those who knew no one who served in Vietnam, seems to touch the stone. Lips say a name over and over, and then stretch up to kiss it. Fingertips trace letters.

Perhaps by touching, people renew their faith in love and in life; or perhaps they better understand sacrifice and sorrow.

"We're with you," they say. "We will never forget." * * *

EDITOR'S POSTSCRIPT

Southeast Asia Ten Years Later

By W. E. GARRETT

HALF A WORLD AWAY from our Vietnam Veterans Memorial stands a macabre monument to the same Southeast Asian war, a wall of 9,000 nameless skulls—all removed from one mass grave—all from people murdered long after the United States pulled out—all victims of a war that began in the dim past and continues to this day.

Ten years ago this April 30, the victorious North Vietnamese Army poured into Saigon. In the decade since, a million Vietnamese and ethnic Chinese have fled afoot and by boat. Some 15,000 children fathered by American GIs have endured a decade of torment and rejection. As many as 10,000 of our former allies—considered criminals by the present government—remain in prison.

In that same month a decade ago in Cambodia, Pol Pot's Khmer Rouge (Red Cambodian) Army occupied the capital, Phnom Penh, and began a brutal regime that resulted in the death of from one to three million people. No one knows, or will say, how many. The world averted its eyes for five years while the Khmer Rouge tortured and killed. Not until the Vietnamese invaded Cambodia in 1978 and drove their former allies out of power and into sanctuaries along the Thai border did the genocide stop. And not until the photographs of the horribly emaciated and diseased Cambodians began appearing did the world collectively shiver in horror at what had happened.

I was among those who met and photographed Cambodian survivors as they came like the walking dead into Thailand in October 1979. The world responded with massive aid, but for millions it came too late.

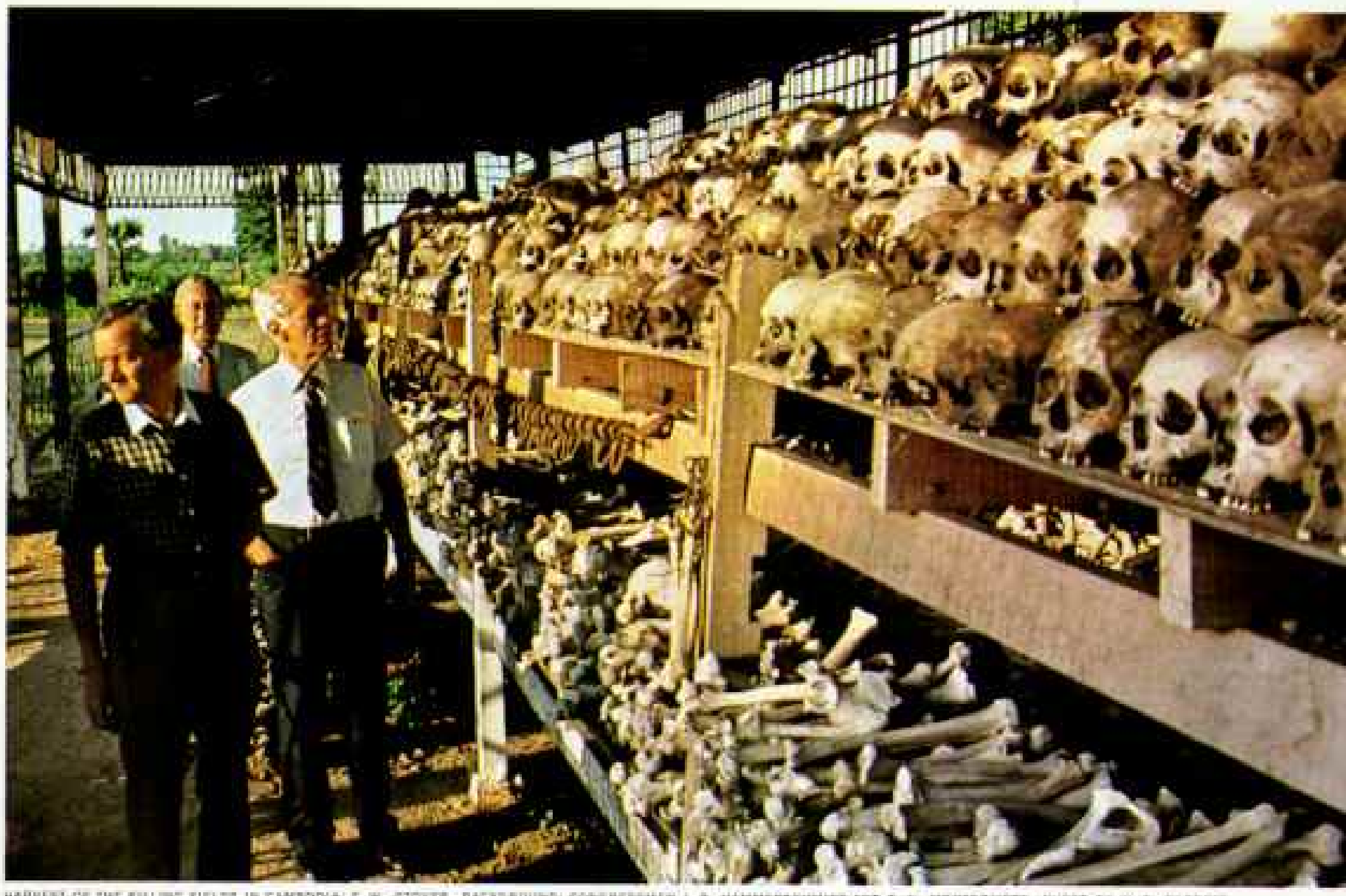
For 25 years I have been covering Southeast Asia for NATIONAL GEOGRAPHIC—drawn back there as so many others have been, like moths swarming to a flame. It was a region in ferment: Years of Western domination were being painfully peeled away. But amid the horror there was always beauty and charm and an incomprehensible patience and resilience. Some misread the latter and rationalized that Asians don't value life as Westerners do. What a tragic misconception.

Six years ago the first outside scholars to reach Phnom Penh after the holocaust found that—like Hitler—Pol Pot had kept detailed files and photographs of the 16,000 prisoners tortured and executed in the Tuol Sleng prison. We helped buy a duplicating machine so copies of the files could be made and stored safely outside Cambodia. As a result we were invited to visit Cambodia again three years ago. Writer Peter White, photographer Dave Harvey, and I witnessed the opening of a mass grave near Phnom Penh. In mute shock we walked among 6,000 decaying bodies—some with skulls still blindfolded, arm bones still bound by wire.

THIS PAST DECEMBER Congressman G. V. "Sonny" Montgomery of Mississippi invited me to join a six-member congressional delegation going to Hanoi, Saigon (now Ho Chi Minh City), Phnom Penh, and Vientiane, Laos, to discuss MIAs, Amerasian children, former Saigon officials still in prison, and the effects of Agent Orange spraying.

Hanoi—like a massive set for a 1940s movie—seems locked in the past. Traffic moves in a lethargic hush on bicycles or the antique electric streetcar system. The few cars and trucks flow politely to the cyclists' pace. Though most of these people weren't born when I first went to Vietnam, Hanoi was to me like a sad old aristocrat in a tattered coat. The stoic charm is tempered by the aura of poverty.

Ho Chi Minh City seems prosperous by comparison. The black market flourishes like an open-air supermarket. Bars have reopened along Tudo Street. The sense of living in a rerun of the '60s was heightened by my American companions in the Kangaroo Bar—another correspondent, three former GIs, a doctor, and Congressman David E.



HARVEST OF THE KILLING FIELDS IN CAMBODIA: F. W. STOVER. BACKGROUND: CONGRESSMEN J. P. HAMMERSCHMIDT AND G. V. MONTGOMERY. PHOTO BY W. E. GARRETT

Bonior of Michigan. The veterans and the doctor were studying the effects of Agent Orange on the land and people of Vietnam.

Phnom Penh, like a boxer awakening from a knockout punch, was still a little shaky. We were lectured for two hours by Hun Sen, the tough 33-year-old Cambodian foreign minister, since promoted to prime minister. Considering he had been wounded five times as a guerrilla—before he defected from the Khmer Rouge—he was quite hospitable. There were only 70 people in the capital, he said, when he returned to it in 1979. Pol Pot's forces had forcibly evacuated the city in April 1975 as the first step in a demented policy aimed at driving Cambodia back to the Stone Age and rebuilding it to his concept of the "perfect" society. Not long before we arrived, his guerrillas had stopped the daily train outside Phnom Penh and coldly killed some 200 passengers—apparently to let people know he was still around. As Hun Sen told us, their war isn't over yet. Today as in the past, foreign powers provide the guns and often the ideologies. Now the U.S.S.R. supplies one side and China the other, but—as usual over the past century—most of the dead are Southeast Asians.

Until the movie *The Killing Fields* focused on Cambodia, few Americans were aware of the extent of the tragedy there. This spring media attention again focuses on Vietnam, ten years after the Communist victory. As our new Vietnam Veterans Memorial attests, the past decade has seen a healing of the wounds within the United States. May the next decade see a healing of far deeper wounds among Southeast Asian nations, as well as between the United States and all of Southeast Asia. □

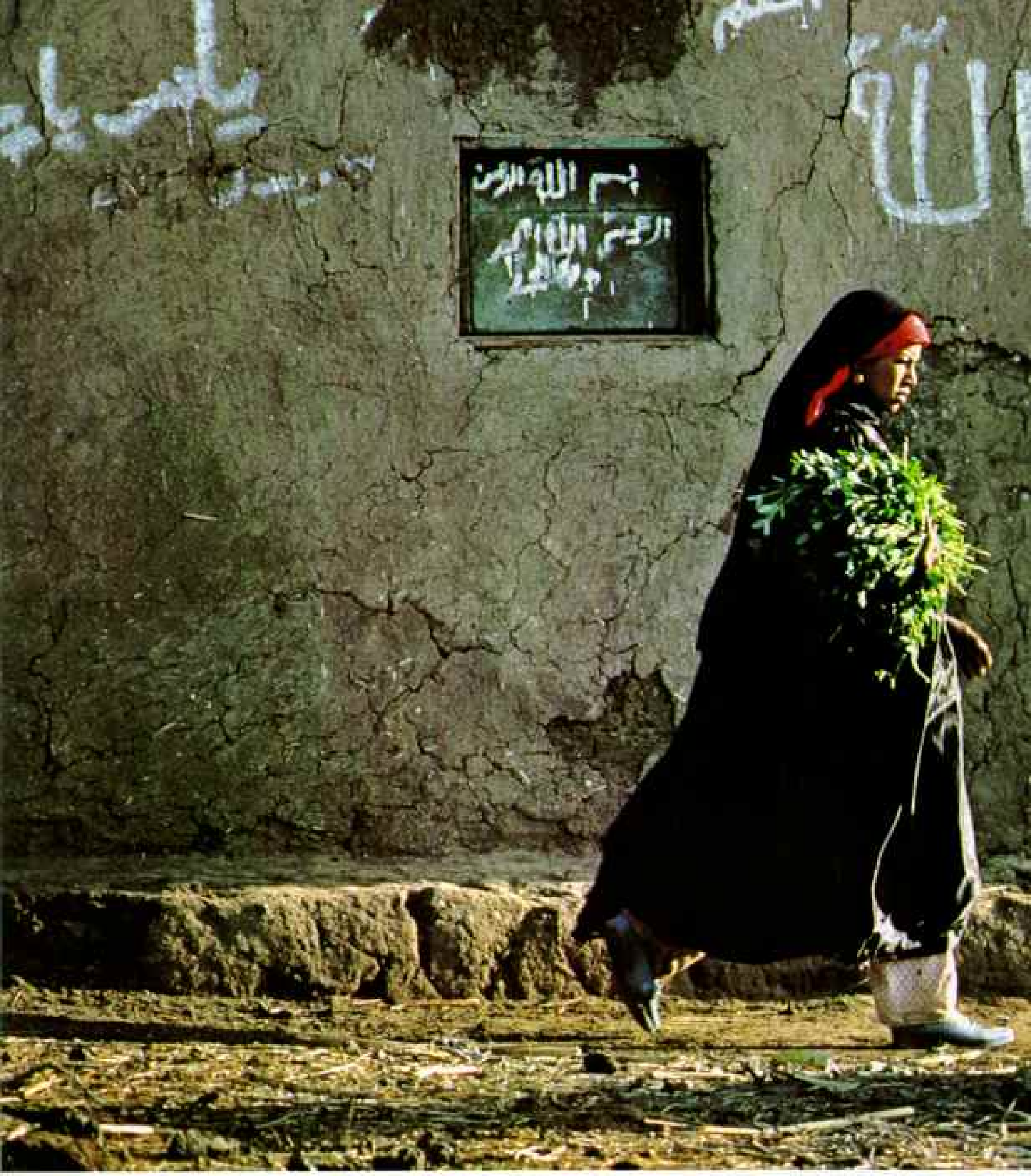
JOURNEY UP THE NILE

ARTICLE AND PHOTOGRAPHS BY
ROBERT CAPUTO

GREAT CHEOPS, the most breathtaking structure on earth, rose 40 stories above the desert between the sun and the Nile. Standing in its enormous shadow, smelling the dust of Egypt and listening to her ancient sounds, I felt the pulse of history. Here, in the ever renewing mud of the greatest and most mysterious river on earth, a civilization took seed and grew, raising the Pyramids of Giza (**left**) and, nearly five millennia later, sending spaceships to the moon. Like every person of the West, I was in a sense a descendant of the Nile.

And in that sense, the journey I was about to undertake was a long homecoming. My destination was the source of the Nile. To reach it, I would travel through lands and peoples, legend and history stitched together by the gleaming thread of the great river, which begins as a tiny trickle of water issuing from the earth more than 4,000 miles

UNFINISHED OFFICE BUILDINGS NEAR CAIRO TOWER SIX MILES FROM GIZA'S MYCERINUS PYRAMID.



away, deep in the heart of Africa.

I knew, before I began, this fact that had eluded pharaoh, Greek, and Roman, and even the most determined scientists until the middle of the 19th century.

Egypt, wrote the Greek historian Hecataeus, is the gift of the Nile. No other country is so dependent on a single lifeline. Egypt's very soil was born in the Nile's annual flood; with the flood came the life-giving mud that made Egypt the granary of the ancient world. And as rain fell in the Ethiopian highlands and the snows melted in the Mountains

of the Moon, the river was everlastingly renewed.

"This is the best place on earth," said Ahmed, an Egyptian *fellah,* or farmer, I encountered in the Nile Delta, that incredibly fertile 8,500-square-mile triangle between Cairo and the Mediterranean coast. The

Gifts of the Nile, *this mud-built house and the Egyptian clover a woman will feed her livestock speak of the river's part in the life along its banks. Since ancient times men have offered thanks for the Nile's blessings—some with mighty monuments, others with simple prayers. The name of Allah adorns this house.*

delta and the narrow Nile Valley to the south make up only 3 percent of Egypt's land but are home to 96 percent of her population. Here nearly 48 million people live in an area only slightly larger than Maryland. The rest of Egypt is desert.

"Truly Allah has blessed us," Ahmed exclaimed piously. "Soil, water, sun—we can grow anything!"

In the gathering dusk Ahmed and his five companions had invited me to join them. Their *galabias* and turbans stained by the sweat and dirt of a long day's work, they sat in front of a wayside shop, enjoying

three of the best things in life along the Nile—tea, conversation, and the water pipe. At the edge of a nearby canal, donkeys laden with freshly harvested alfalfa waited for their masters to lead them home, braying a fretful counterpoint to the steady thud of an irrigation pump.

***Gravity brings water** to sugarcane near the giant Kenana processing plant in arid Sudan. Siphon tubes draw water from a canal that taps the White Nile on its long sluggish journey through Africa's largest nation. The plant opened in 1980 as part of Sudan's struggle to exploit the river's enormous agricultural potential.*

All this suggested ancient harmonies. Yet the Nile has been changed by modern man in ways not yet fully understood. In 1971 engineers and workers completed the Aswan High Dam, nearly 600 miles upriver from Cairo toward the Sudanese frontier. It is the greatest public work to be undertaken in Egypt since the Pyramids. The devastating floods and droughts that imposed a recurrent tax of suffering on the fellahin no longer occur. Egyptian agriculture has been transformed, and industry is benefiting from power generated by the dam.

Biting sand, *driven from the desert, blasts a felucca, the river's traditional cargo boat, and a new cruise ship, the* Nile Beauty, *as it steams between Aswan and Luxor. Scores of such passenger boats now ply the waterway for voyages of a few days or longer, stopping at the sites of ancient Egyptian temples.*

But there have been negative effects also. Standing on a sandy beach at the mouth of the Rosetta branch of the Nile, I was puzzled by what seemed a ghost town—a sad vista of crumbling buildings, smashed windows, and broken wires dangling from utility poles.

One house teetered drunkenly, half in, half out of the sea.

"Last summer, people stayed in those rooms—this was a summer resort," said a voice behind me. The speaker was a young Egyptian named Muhammad, member of a team from Alexandria that had come to this abandoned village to study coastal erosion. "Now the sea is moving in," Muhammad said. He pointed to a lighthouse perched on a tiny island a couple of miles offshore: "That lighthouse used to be on land. About six years ago it became an island. Day by day the sea is eating the land—the dam has stopped the sediment of the Nile from replenishing the shoreline."

As we chatted, a brightly painted sardine boat dropped anchor. The captain came ashore and joined our conversation. "Before they started the High Dam 25 years ago," he said, "the Nile mud had a lot of food in it, and so the sardines gathered near the mouth of the river to feed. Now there is no mud, and no food for the fish—they've left us."

"If all this can happen in 25 years, what will happen after 50 years, or 100 or 200?" asked Muhammad.

From the nearby town of Rashid, where Napoleon's troops discovered the Rosetta stone in 1799, I drove south through the delta, through villages where veiled women passed among walls on which the name of God had been written over and over by the pious. I stopped often to watch the fellahin at work in their fields. Modern equipment driven by diesel or electric motors is a common sight. But so are ancient irrigation devices—Archimedes' screw, the weight-pivoted *shaduf*, and the *saqia*, an ox- or buffalo-driven waterwheel.

CAIRO, abuzz with the commerce and the rollicking street life of its ten million people, lies astride the Nile where Lower and Upper Egypt—the delta and the valley—meet. Blaring horns. Stalled traffic. Diabolical drivers. Overflowing buses. Darting pedestrians, some in traditional Arab dress, others in Western clothes. By Egyptian standards Cairo is a newcomer among cities. Invading Arabs established a military settlement on the site in A.D. 642. Three centuries later the Fatimid Dynasty built the newer part of the city, naming it El Qahira, "the victorious." Then came the Syrians under Saladin, the Mamluks, the Ottoman Turks, the French, the Turks again, and finally the British. Col. Gamal Abdel Nasser overthrew the monarchy in 1952 and reestablished Egyptian sovereignty after 2,300 years of foreign domination.

I climbed to the Citadel, a 12th-century fortress on the eastern edge of the city, just below the Muqattam Hills. From there Cairo spreads out across the Nile to the Great Pyramids, faintly visible in the Western Desert through the polluted air. Hundreds of mosques thrust their thin, ornate minarets into the sky, over rooftops crowded with people hanging out laundry or cooking meals in the open air above the hubbub of the metropolis. Egypt is growing by 100,000 people a month. Some are forced to live on rooftops; others find a wretched home in one of the city's cemeteries.

Returning through the teeming streets, I entered the mosque of Muayyad Shaykh, an island of coolness and peace. High walls decorated with calligraphy enclosed a spacious courtyard. A fountain softly gurgled, while little groups of men prayed quietly in the shade of leafy trees. After a few moments of serenity there, I felt able once again to face the chaos outside.

TOMBS and temples of ancient Egypt follow the Nile well into Sudan. Driving southward from Cairo into the valley, I entered a landscape that owed little to the present era. For the next 1,800 miles the thin blue ribbon of the Nile, flowing slowly north, unwound over brown soil and green fields, some only a few yards wide, others as broad as an Iowa cornfield. At the edge of the fields, rising in dramatic hills or stretching flat to the horizon, lay the brown barren deserts.

I had the illusion that I was driving through one immensely long, narrow farm. The villages and towns were usually perched on the edge, so as not to waste arable soil and because there was a need, before the High Dam tamed the Nile, to live beyond the reach of the annual floods. The road followed the course of the Nile, now passing through the fields, now drawing a black line *(Continued on page 598)*

Foldout Map of the Nile

Africa's River of Legend

"THAT GIGANTIC SERPENT that winds so fabulously, so ungraspably, back through history," wrote Dame Rose Macaulay of the waterway that for centuries obsessed those who sought its origins. In 1937 a German explorer discovered a mountain spring now marked by a small pyramid with the inscription *Caput Nili*—"Source of the Nile." Actually the river feeds not from one source but from many rivers and lakes, with two main parent branches: the 2,285-mile White Nile and the 1,080-mile Blue Nile, which merge at Khartoum.

Stretching northward to the Nile Delta, the fertile valley traces a green serpentine line against the brown desert. Here early civilizations took root, beholden to the floodwaters that between June and October sometimes left devastation along with the rich soil that nourished the granaries of the pharaohs. Even today, 96 percent of Egypt's 48 million people crowd the Nile Delta and Valley. But only part of the story of the Nile is told in Egypt; four-fifths of the river lies south of the Sudanese border.

In 1964 the Aswan High Dam began harnessing the Nile (see page 595). The cycle of flood and drought was broken, radically altering the rhythm of agriculture and soon generating enormous stores of hydroelectric power. Rising Lake Nasser endangered archaeological wonders as the face of the Nile changed forever.

Mediterranean Sea

NILE DELTA
(LOWER EGYPT)

Rosetta Mouth

Damietta Mouth

Matruh

Rashid (Rosetta)

Lake Idku

Damietta

Port Said

Alexandria

Damanhur

El Alamein

El Mansura

El Mahalla el Kubra

Ismailiya

Zagazig

Suez Canal

Giza

Cairo

① PYRAMIDS OF GIZA

MEMPHIS ②

Suez

QATTARA DEPRESSION

El Faiyum

Beni Suef

Maghagha

Bawiti

El Minya

WESTERN DESERT

EASTERN DESERT

Mallawi

BENI HASAN

Dairut

TELL EL AMARNA

SAHARA

Asyut

Nile

UPPER EGYPT

Sohag

Akhmim

Girga

Dishna

El Balyana

Qena

DEIR EL BAHRI

KARNAK

VALLEY OF THE KINGS

Luxor ③

Isna

NEKHEN

HIERAKONPOLIS ④

Idfu

EGYPT

The

WEST BANK
(Occupied by Israel)

Jerusalem

GAZA STRIP
(Occupied by Israel)

ISRAEL

SINAI

Elat

Aqaba

Gulf of Suez

Gulf of Aqaba

LURE OF THE ANCIENT WORLD

① *Near the Pyramids of Giza lies the Sphinx, subject of controversial plans to save it from erosion.*

② *Called the White Wall, Memphis served as Egypt's capital for a thousand years.*

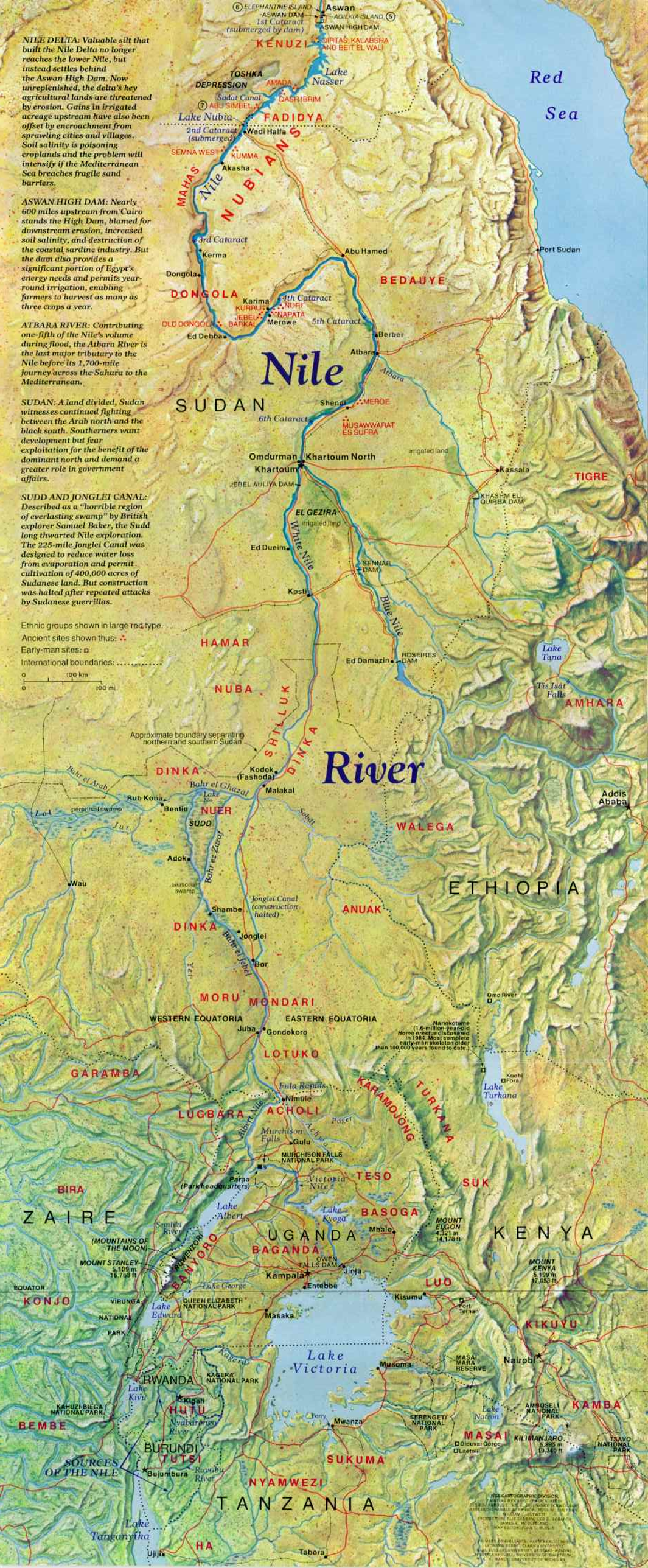
③ *Site of ancient Thebes encompasses Luxor and the temples of Karnak. The grand terraced temple of Deir el Bahri, built by the female pharaoh Hatshepsut, stands on the west bank, where the Egyptians buried their elite in the Valley of the Kings, Valley of the Queens, and Tombs of the Nobles.*

④ *The legendary first pharaoh, Menes, ruled upper Egypt from Nekhen before he conquered lower Egypt about 3100 B.C. and moved his capital to Memphis.*

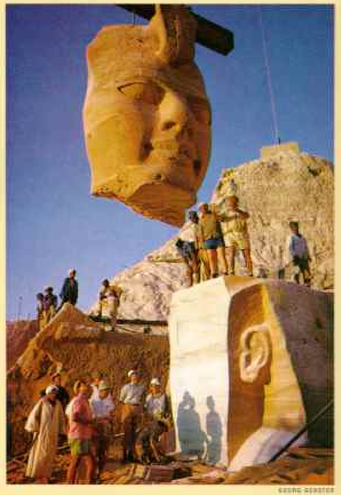
⑤ *Temple of Isis and other monuments were moved from Philae to Agilkia Island.*

⑥ *Excursion boats from Aswan sail by Elephantine Island's "nilometer": Markings on walls of ancient stone record the level of Nile floods.*

⑦ *Carved into sandstone cliffs in the 13th century B.C., the Great Temple of Abu Simbel celebrates the great Ramses II, who ruled Egypt for 67 years.*


NILE DELTA: Valuable silt that built the Nile Delta no longer reaches the lower Nile, but instead settles behind the Aswan High Dam. Now unreplenished, the delta's key agricultural lands are threatened by erosion. Gains in irrigated acreage upstream have also been offset by encroachment from sprawling cities and villages. Soil salinity is poisoning croplands and the problem will intensify if the Mediterranean Sea breaches fragile sand barriers.
ASWAN HIGH DAM: Nearly 600 miles upstream from Cairo stands the High Dam, blamed for downstream erosion, increased soil salinity, and destruction of the coastal sardine industry. But the dam also provides a significant portion of Egypt's energy needs and permits year-round irrigation, enabling farmers to harvest as many as three crops a year.
ATBARA RIVER: Contributing one-fifth of the Nile's volume during flood, the Atbara River is the last major tributary to the Nile before its 1,700-mile journey across the Sahara to the Mediterranean.
SUDAN: A land divided, Sudan witnesses continued fighting between the Arab north and the black south. Southerners want development but fear exploitation for the benefit of the dominant north and demand a greater role in government affairs.
SUDD AND JONGLEI CANAL: Described as a "horrible region of everlasting swamp" by British explorer Samuel Baker, the Sudd long thwarted Nile exploration. The 225-mile Jonglei Canal was designed to reduce water loss from evaporation and permit cultivation of 400,000 acres of Sudanese land. But construction was halted after repeated attacks by Sudanese guerrillas.
Ethnic groups shown in large red type.
Ancient sites shown thus: ∴
Early-man sites: □
International boundaries:
0 100 km
0 100 mi
Nile
River
SUDAN
ETHIOPIA
ZAIRE
UGANDA
KENYA
RWANDA
BURUNDI
TANZANIA
Red Sea
Lake Nasser
Lake Nubia
Lake Victoria
Lake Albert
Lake Turkana
Lake Tana
Lake Tanganyika
Lake Kivu
Lake Edward
Lake George
Lake Kyoga
Lake Natron
Aswan
ELEPHANTINE ISLAND
ASWAN DAM
1st Cataract (submerged by dam)
AGILKIA ISLAND
ASWAN HIGH DAM
KENUZI
QIRTAS, KALABSHA AND BEIT EL WALI
TOSHKA DEPRESSION
AMADA
Sadat Canal
ABU SIMBEL
DASH IBRIM
FADIJA
2nd Cataract (submerged)
Wadi Halfa
SEMNA WEST
KUMMA
Akasha
MAHAS NUBIANS
3rd Cataract
Kerma
Dongola
DONGOLA
Karima
KURRU
NURI
NAPATA
JEBEL BARKAL
OLD DONGOLA
Merowe
4th Cataract
5th Cataract
Ed Debba
Abu Hamed
BEDAUYE
Port Sudan
Berber
Atbara
Athara
Shendi
MEROE
6th Cataract
MUSAWWARAT ES SUFRA
Omdurman
Khartoum North
Khartoum
irrigated land
Kassala
TIGRE
JEBEL AULIYA DAM
KHASHM EL QUIRBA DAM
EL GEZIRA
irrigated land
White Nile
Ed Dueim
SENNAR DAM
Kosti
Blue Nile
HAMAR
NUBA
SHILLUK
DINKA
Ed Damazin
ROSEIRES DAM
Lake Tana
Tis Isat Falls
AMHARA
Approximate boundary separating northern and southern Sudan
Kodok (Fashoda)
Malakal
Bahr el Arab
Bahr el Ghazal
Rub Kona
Bentiu
NUER
SUDD
perennial swamp
Lol
Jur
Sobat
Addis Ababa
WALEGA
Adok
Bahr el Zaraf
Wau
seasonal swamp
Jonglei Canal (construction halted)
Shambe
ANUAK
DINKA
Jonglei
Bahr el Jebel
Bor
MORU
MONDARI
Omo River
WESTERN EQUATORIA
EASTERN EQUATORIA
Juba
Gondokoro
Nariokotome (1.6-million-year-old Homo erectus discovered in 1984. Most complete early-man skeleton older than 100,000 years found to date.)
LOTUKO
GARAMBA
Koobi Fora
Lula Rapids
Nimule
KARAMOJONG
TURKANA
LUGBARA
ACHOLI
Albert Nile
Murchison Falls
Gulu
MURCHISON FALLS NATIONAL PARK
Victoria Nile
Parra (Park headquarters)
TESO
SUK
BIRA
BASOGA
Mbale
MOUNT ELGON 4,321 m 14,178 ft
Semliki River
(MOUNTAINS OF THE MOON)
MOUNT STANLEY 5,109 m 16,795 ft
BUNYORO
BAGANDA
Kampala
Entebbe
OWEN FALLS DAM
Jinja
LUO
Kisumu
Fort Ternan
MOUNT KENYA 5,199 m 17,058 ft
EQUATOR
KONJO
VIRUNGA NATIONAL PARK
QUEEN ELIZABETH NATIONAL PARK
Masaka
KIKUYU
Nairobi
MASAI MARA RESERVE
Musoma
KAGERA NATIONAL PARK
Kigali
HUTU
KAHUZI-BIEGA NATIONAL PARK
BEMBE
Kagera River
Ferry
Mwanza
SERENGETI NATIONAL PARK
MASAI
Oldoinyo Lengai
Laetoli
KILIMANJARO 5,895 m 19,340 ft
AMBOSELI NATIONAL PARK
KAMBA
TSAVO NATIONAL PARK
SOURCES OF THE NILE
Bujumbura
Ruvubu River
TUTSI
SUKUMA
NYAMWEZI
Ujiji
Tabora
HA
NGS CARTOGRAPHIC DIVISION

Race against time and tide



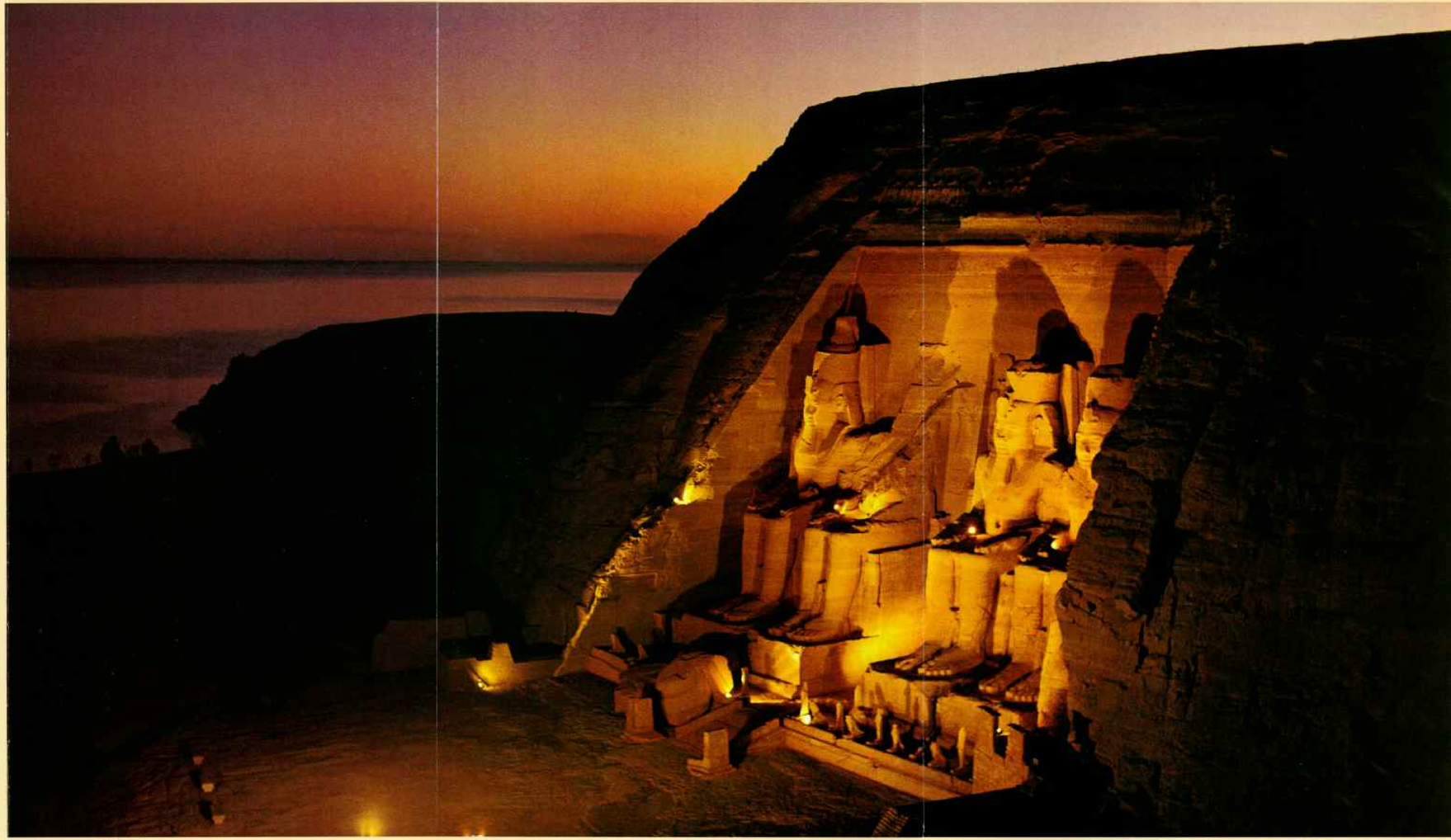
GEORG GERSTER

THE LIFE-GIVING NILE *threatened ancient monuments in 1964, when water began rising behind the Aswan High Dam.*

Two massive monuments stood at Abu Simbel—the Great Temple, built about 1270 B.C. by Pharaoh Ramses II in his own honor, and the Small Temple, dedicated to his queen, Nefertari. These magnificent structures rose in the southern reaches of Ramses' empire, possibly to discourage Nubian uprisings. Engulfed by invading sand over the centuries, the temples lay hidden until they were discovered by a Swiss traveler in 1813.

*To prevent the monuments' disappearing again, this time underwater, UNESCO launched a worldwide campaign to dismantle them and move them to a higher site. During the four-year, 40-million-dollar project, the temples were cut into 1,050 sections. Here the pharaoh's 21-ton visage (**left**) is lifted by crane from the head of one of the 67-foot-high figures that guarded the Great Temple. Today the reassembled colossi gaze across Lake Nasser (**right**) from a reconstructed hill similar to the original.*

*Egyptians revered Philae Island as the "pearl of Egypt." There stood the temple of the goddess Isis, dating from the third century B.C. When the Aswan Dam was completed early in this century, rising waters began to swallow the island, and the problem worsened with the High Dam. Finally, in 1972, a 30-million-dollar salvage program was begun, half of it funded through UNESCO. Some 40,000 original blocks were removed and reassembled to crown the loftier Agilkia Island (**below**), now also called Philae for the celebrated island that has vanished beneath Lake Nasser.*



A dam against famine

IN A DREAM, Pharaoh saw seven ears of grain, fat and healthy, followed by another seven, shriveled and thin and blasted by the east wind. A young slave, Joseph, interpreted Pharaoh's dream as seven years of plenty followed by seven years of famine.

This biblical cycle of fat years followed by lean years appears to have come true again in the terrible drought and famine that now grip Ethiopia and other countries south of the High Dam on the Nile at Aswan.

Alone among neighbors with whom it suffered through millennia of drought, Egypt has been spared famine. The reason is El Sadd el-Aali, the High Dam.

In February of this year Egyptian authorities reported that the level of water in Lake Nasser, the 500-kilometer-long reservoir behind the dam, had dropped to 30 meters below capacity. Because of the drought, the flow of the Nile—84 billion cubic meters in a year of normal rainfall—was too feeble to fill the lake.

Yet water aplenty flowed through the dam for Egypt's farmers. At top level, Lake Nasser stores nearly 170 billion cubic meters of water, enough to satisfy Egypt's needs for about three years.

The dam, initiated in 1960, has already saved Egypt from two cycles of dangerous floods in 1964 and 1975 and two threatening periods of drought in 1972-73 and 1983-84.

As recently as 1978, engineers feared that the water in Lake Nasser would rise beyond 183 meters above sea level, the maximum the dam can safely hold. But soon the level of the lake started dropping. During the next few years rain clouds failed to reach the edges of the African monsoon envelope, which lies roughly between 15 degrees north and south of the Equator and includes the drought-stricken areas of Ethiopia in the north and Mozambique in the south.

Recent aerial photographs of Lake Nasser reveal bathtub rings of old water levels on wadis and escarpments above a dark deposit of silt, like a landlocked mini-delta, green with new vegetation, between Egypt and Sudan (***following pages***). Fractures in the rock have been exposed, allowing study of the cause and effect of earthquakes recorded south of Aswan since the filling of the lake.

HIGH-RESOLUTION photographs of the Lake Nasser region taken from NASA's space shuttle *Challenger* in 1984, and their comparison with Landsat images made from space in previous years, will help us study the changes of lake boundaries and how they relate to cycles of floods and droughts in the interior of Africa.

Before the High Dam was built, 50 percent of the Nile's flow drained into the sea. Advocates of the dam argue that it conserves this water, prevents floods, is capable of producing 2,100 megawatts of electrical power, and will increase the agricultural area of Egypt by 1.2 million hectares (2.9 million acres).

Critics charge that it has blocked fertile silt of the yearly floods, increased the incidence of the parasitical ailment schistosomiasis among farmers, and caused a rise in groundwater levels in the Nile Valley down to Cairo.

On one point, there can be little argument: The High Dam has preserved Egypt from the famine that grips its neighbors to the south. As Joseph stored grain against the lean years in Pharaoh's day, modern Egypt stores the life-giving Nile water itself behind the dam.

—FAROUK EL-BAZ
FORMER SCIENCE ADVISER TO THE PRESIDENT OF EGYPT

Africa's withering drought *leaves a workboat marooned high above Lake Nasser's receding shoreline near Abu Simbel; fishermen maneuver through a shrunken inlet* ***(left)****. Nubian farmers* ***(above)*** *from a nearby lakeside village now tend irrigated crops on land once submerged more than four miles from shore. This photograph* ***(below)*** *taken by the space shuttle Challenger in April 1984 reveals rings of silt deposits around the lake, which has now dropped almost 100 feet.*

JAMES NACHTWEY (LEFT AND TOP); NASA

(Continued from page 584) separating them from the desert.

At El Awamia, just south of Luxor, I watched farmers harvest sugarcane. A village elder, Amin Ibrahim, invited me into his house and gave me a cheerier view of the effects of the Aswan High Dam than I had heard before. "Before the dam we were obsessed with the flood—would it be too high or too low?" said Amin. "Like all the generations of my family back to the pharaohs, I used to plant my crops and never know if I would harvest. Now there is no fear; we know there will be water, and how much there will be. And we can get three crops a year instead of one. There is electricity in our houses and to run pumps, so we do not have to work the saqia and the shaduf. We used to go to the house of a rich man to hear the radio. Now, since we grow crops all year, we buy our own radios and even televisions."

Judiciously, Amin conceded that there was another, less happy, side to the story: "The land is poorer, because the mud that used to come with the Nile flood has stopped. We must use fertilizers that cost a lot of money. Even so, the crops are less."

He led me through fields near his house. The ground was encrusted with salt. "The flood does not carry away the salt as before," Amin explained. The annual flood of the Nile used to deposit as much as 20 million tons of silt on the fields along the river. As the flood receded, the water draining through the soil leached out the salts and carried them off to the Mediterranean. It was a natural system of replenishment and cleansing. Today this treasury of silt is trapped behind the dam, and there is no effective drainage system.

It was only a short drive from Amin's serene village to Luxor, the center of tourism in Upper Egypt, but it seemed like a leap of centuries. Cruise ships lined the waterfront. The broad avenue along the river was crowded with gleaming tour buses. Horse carts, awaiting the tourists, were self-consciously picturesque. The market sold souvenirs, not the simple necessities and the simpler luxuries of the fellahin.

At the beginning of the New Kingdom (1570 B.C.), Thebes, which encompassed the site known today as Luxor, was the chief city of Egypt, destined to be one of the capitals of the ancient world. Time obliterated the fame of Thebes, and its grand tombs and temples were lost as if beneath the sands for hundreds of years, until the beginning of the 19th century, when French scholars attached to Napoleon's conquering army rescued them from obscurity. It was in the hot, arid Valley of the Kings, across the river from Luxor, that the tomb of Tutankhamun was discovered in 1922.

JUST NORTH of Luxor lies Ipet-esut—"most esteemed of places" to the ancients, Karnak to our own age. This great complex of temples covers an area of 60 acres and took almost 2,000 years to build as a succession of kings added their own embellishments. Dwarfed as these dead monarchs had intended, I walked through the ancient complex by night, through the great Hypostyle Hall, among giant columns capped by papyrus buds like a forest of that feathery plant. From a distance the temple glowed in the faint light of a half-moon. It might have been some great ship from the past, reflected in the still waters of a sacred lake. Never had I felt so small, so mortal.

When Ipet-esut was built, and long before, the eastern bank of the Nile was considered the land of the living. The west bank was the land of the dead. On the barren desert between the Nile and the setting sun were built the funerary temples. Tombs of kings were hidden in desolate gorges.

The Colossi of Memnon, two enormous statues of Amenhotep III that once guarded the entrance to his vanished temple, now stand in fields worked by the fellahin. At Medinet Habu, dominated by the funerary temple of Ramses III, I met conservators Richard and Helena Jaeschke of the University of Chicago's Oriental Institute, which has been studying the monuments of Thebes since 1924. The Jaeschkes were painstakingly removing an accumulation of soot, grease, and limestone dust from the walls of an XVIII Dynasty chapel. The accretion had resulted from cooking fires of Coptic Christians who had lived in the chapel from the second to the ninth centuries.

"Sometimes you peel away a layer of dirt and discover things that were completely unknown," said Richard with satisfaction.

"This chapel was a real surprise." In other parts of the temple I noticed dark stains in the lower portions of the walls. "Salt damage," Richard explained. "With the higher water table created by the Aswan High Dam, water migrates to the surface of the sandstone from which the monuments were built. The water evaporates, but the salts are left. They crystallize, blistering the surface and crumbling the stone."

Richard takes the long view: "Egyptian monuments have always faced the depredations of man and nature. There have always been floods and grave robbers and kings who looted the temples of their predecessors to build their own monuments."

In the darkness before dawn I hiked up to a rocky perch at the top of the dry cliffs above the temple of Queen Hatshepsut. The sun rose over the Eastern Desert. The valley below was shrouded in mist, but I could make out the thin line, gleaming in the sunrise, that stretched far off to the north and south where the tawny desert met the bright green patchwork of the fields along the river. In the still air I could hear the crowing of roosters and the braying of donkeys. This new day would not be much different from those that had preceded it for thousands of years and not unlike those to come.

Behind me, sunk in the craggy bluffs, lay the Valley of the Kings, a place where the god-kings of ancient Egypt believed they would lie undisturbed during their voyage through eternity. Little did they suspect that the treasures they took with them to the grave would one day be scattered around the globe, or that their sacred valley would be invaded by hordes of tourists who would have to look up their names in guidebooks written in languages unborn in the age of the pharaohs.

NEAR the temple to the crocodile god Sobek, just south of Kom Ombo, I came upon the camps of some fishermen. Beating the water with the oars of their small rowboats, or *sambuks*, the men drove fish into the gill nets they laid in semicircles from the bank.

"Itfaddal," one of the men called out in welcome as I approached. His name was Naan. He and his two young sons were camped apart from the other fishermen, though I did not stop to wonder why as I accepted his invitation to eat. Naan gutted some small fish and threw them into a frying pan atop a kerosene burner. I sat down on the prow of the sambuk and inhaled the aroma of the sizzling fish.

Naan leaned toward me and pulled back the sleeve of his ragged sweater. On his arm was a small tattooed cross. "Christian," he said. "In Egypt we Christians are few. Our

Workday ends *for a fisherman toting his catch from brackish Lake Idku, in the Nile Delta. The fishing industry finds itself at cross-purposes with farmers in Egypt's drive to increase food production. As the runoff of chemicals and agricultural wastes from delta farms increases, fish takes drop dramatically.*

SHOPS AND STREET *are one in an old district of Cairo. Eager for a sale, tenacious vendors push their wares into the path of traffic streaming by on foot, on wheels, and sometimes on hooves.*

life is very difficult." In fact, some five million Coptic Christians live in Egypt, not always in harmony with the Muslim majority.

I spent a few days with the fishermen at their camp by the Nile. Naan and his sons worked like their Muslim fellows, from dawn to dusk, netting eight or nine pounds of fish a day, and, like the others, sold their catch at the market in Kom Ombo. With the profits they bought sugar, tea, salt, tobacco, and other simple "luxuries."

At the Kom Ombo market I met Abdel Kadir Muhammad Fadl, an elderly Nubian. His famous people—who still speak to one another in their own language, though they have adopted Islam and learned Arabic—had lived for thousands of years in the Nile Valley at the southern edge of Egypt. The goods of Africa—gold, ivory, incense, and slaves—passed into Egypt from Nubia.

The Nubians were relocated in the early 1960s when the Aswan High Dam created Lake Nasser, inundating their villages. The 60,000 Egyptian Nubians could not move to comparable land north of Aswan, as it had long been occupied. Instead, new settlements—rows of cinder-block houses with wall touching wall—were built in the desert away from the river. Irrigation canals were dug to help the Nubians farm the area.

Abdel Kadir and his family were resettled in one of the new villages, Korta Talit. "In the old days," Abdel Kadir said, "we lived in Korta, about halfway between Aswan and Abu Simbel. Ah, it was a pleasant place. We worked in the fields early and late, and in the middle of the day we sat in the shade of the palms. And dates! We grew rich from them. Our big, cool houses were made from Nile mud and the fronds of the palms. We left our fathers and grandfathers in the ground there, and they are lost. We lost our land, our houses, and our date palms."

The women of Abdel Kadir's house brought lunch: chicken, mutton, salad, green peppers stuffed with rice, and beautiful oranges, tangerines, and bananas. Not even a feast could dispel my host's sadness.

"And what about the children who have never seen Nubia?" another man, named Hassan, said. Abdel Kadir nodded. "Before, when a couple got married, people came from all over to celebrate, and there was a festival for seven days," he said. "Now a wedding lasts only one day—civilization! There is no time for festivals here."

FINALLY, at Aswan, I saw the High Dam itself—364 feet high, 12,565 feet long at the crest, completely shutting off the Nile. Lake Nasser stretches some 300 miles through virtually unpeopled country into Sudan.

The dam was the creation of Gamal Abdel Nasser. For centuries men had dreamed of damming the Nile. Nasser believed that it was a necessity if food production was to keep pace with Egypt's soaring population. He rejected schemes to build nearer to the headwaters of the Nile, arguing that Egypt's utter dependency on the Nile required that the dam should lie entirely within Egyptian territory. When the United States and the United Kingdom withdrew their support because of political differences, Nasser turned to the Soviet Union. Work started in 1960 and Lake Nasser, one of the world's largest man-made lakes, was filled by 1975. This reservoir holds 133 million acre-feet—the equivalent of two years of Nile water.

The Egyptian Nile became one very long irrigation ditch. A government expert on agricultural development projects described the positive result: "Before the dam was built, we were using all the traditional food-producing land and had reclaimed about a million *feddan* [1,038,000 acres]," he told me. "But whatever we gained was lost to urban sprawl. We were not even holding our own. Now we are planning to reclaim another 2.8 million feddan for agriculture. This is only possible because of the water and power guaranteed by the High Dam."

The Soviets built 12 turbines into the dam. Unfortunately, because of faulty design, the turbine blades quickly cracked, and the power plant has never produced at capacity. In 1982 the U. S. gave the Egyptian government 85 million dollars to replace the blades. By 1990 the generators should be fully operational.

There are other problems. Lake Nasser, lying in one of the hottest deserts on earth, loses 350 billion cubic feet of water annually through evaporation. This affects the ecology and climate of Nubia in ways still not fully understood, though it is known that it makes the water of the lake more saline.

adding to the salt problem in Egypt's fields downriver. Power from the dam means industrial development along the Nile, adding to the pollution of the river by the herbicides, pesticides, and chemical fertilizers that have come into use as a result of the modernization of agriculture.

The enormous weight of Lake Nasser may have produced another unexpected effect—earthquakes. A local quake in November 1981 measured 5.3 on the Richter scale, and less violent tremors occur often.

On the lake steamer to Wadi Halfa—the hull for first-class passengers and two barges lashed alongside for everyone else—I watched the stone wall of the High Dam recede as the ship, engines throbbing, headed for Sudan across the smooth blue waters of the captured Nile. That night, lying on the deck, I did not count the myriad stars so much as try to find space between them. The morning sun revealed rumpled heaps of cloth strewn about the barges. They stirred, yawned, faced toward Mecca, and said their morning prayers. Soon water for tea was boiling on little charcoal stoves.

And soon after that, embraced again by the unquenchable generosity and friendliness of the people of the Nile, I was sipping sweet tea in a circle of camel traders. "We drive camels from Darfur, in the west of Sudan, along the Trail of Forty Days to Egypt," explained one of them in Arabic slow enough for me to understand. "Camels are worth a lot in Egypt because the Egyptians like to eat them. In Egypt we buy goods to sell in Sudan—it's a good business."

As the slow day passed from chill of dawn to furnace of noon to cool of evening, my companions played cards, taking breaks for Islam's five daily prayers. This relaxed relationship with heaven and nature had another side, as I discovered when I checked on my car. My fellow passengers had spread their belongings on the hood, and they were brewing tea on several little cooking fires all around it. Explaining that the car carried more than a hundred gallons of fuel, I urged them to put out the fires or at least move them away from the vehicle. "*Malesh*," they replied, with friendly grins—"never mind." A couple of months later 300 people died when the steamer caught fire and sank. Sparks from a tea maker's fire had ignited drums of fuel.

In Sudan the reservoir, extending a hundred miles south of the frontier, is called Lake Nubia. At Wadi Halfa there is no dock. Gangplanks were lowered, and the passengers scampered off onto a rocky bit of

***Temples** of the new Cairo, high-rise buildings flank the Nile as it winds toward the southern apex of the delta en route to the Mediterranean Sea. Named El Qahira—"the victorious"—in A.D. 969, Cairo gained power from its position beside the mighty highway of the Nile.*

Today it is Africa's largest city and the largest Arab city in the world. Urban planners fear that Greater Cairo will reach 30 million by the early part of the next century, further straining services and facilities.

lakeshore at the end of a dusty track that led to the new town—what there was of it. Old Wadi Halfa and many smaller Sudanese Nubian villages had been swallowed by the lake. But Nubian hospitality, as might have been expected, had survived and was alive and well. Kamal Hassan Osman, the customs official, cleared my car and camera gear—and immediately invited me to his house. It was large and new and made of adobe that matched the color of the surrounding desert.

Mayor Muhammad Ahmed Deram joined us for dinner—goat stew and beans, and *kissra*, the thin bread with which to pick up the food. As we ate, Kamal's grandmother Hamida ("She is about 80—Nubians never keep track of their years") told us what her people had lost when they lost the Nile. Old and frail, nearly blinded by cataracts, she leaned against her daughter's legs and worried a string of beads as she talked in a strong storyteller's voice.

"When I was a girl, some of the young men thought I was beautiful and called me Shamandura, which is a light that shines on the river at night to guide the boats," said Hamida. "I was married at 15, and the wedding lasted 15 days. On the second night my husband and I went to the Nile at four o'clock in the morning and washed each other's face with the water from the river. The Nile was everything to us then. But if there is no river, how can there be Shamandura?"

AVOIDING the great loop of the Nile, 540 miles long, the main track out of Wadi Halfa follows the railway's straight line to Abu Hamed, 230 miles to the southeast. But I took the less traveled Nile route, skirting the southern end of Lake Nubia. My Mercedes, which had not really been tested in more developed Egypt, began to prove its worth as I ground along in four-wheel drive across

March of the desert *halts at irrigated fields stretching to the west bank of the Nile across from Luxor. With the threat of flooding checked by the Aswan High Dam, many of the people from the village, foreground, have moved to homes closer to the river.*

seemingly endless desert. Golden rivers of sand filled the valleys between camel humps of rock, while a tireless north wind peppered me with gritty dust. Following tracks left by occasional trucks that carry goods to villages farther south, I often wondered if *they* had really known where they were headed in this baffling landscape.

At nightfall, not wishing to risk getting lost in the dark, I stopped to camp. The wind had died; nothing stirred in all that vast expanse of brown and blue. I unfolded the roof tent and for the first time used my shower—a jerry can with a spout in the bottom lashed to the roof of the car. It was to be a lifesaver in the weeks ahead. I dined from tin cans and let the silence shush me to sleep.

The next afternoon, from the top of a ridge, the Nile—the natural, undammed, unfettered Nile—burst into view. The village of Akasha lay between me and the river, its green fields stretching to hundreds of swaying palm trees along the banks.

"By the will of Allah, this is where the lake stopped," said Akasha's schoolteacher, Hassan Muhammad Salih. "By the Nile we have always lived." As if to demonstrate the truth of the teacher's words, young women, pausing only to giggle as we strolled among them in the village fields, gathered bean stalks into windrows. Akasha's money crop is dates (one tree bears about 150 pounds, worth some $30), but villagers also grow wheat and vegetables in the ever renewing mud and keep goats and sheep. Here, too, songs are of lost lands, vanished loved ones, and the sorrowful end of an ancestral world.

Once again alone in the desert, a few miles south of Akasha, my maps brought me face to face with the sobering fact that I was truly a wanderer in the wilderness: To the east, 400 miles of desert lay between my campsite and the Red Sea. To the west, the nearest densely settled area was 3,000 miles away on the Atlantic. I understood, and not just in my mind, why people cling to the Nile.

In Nubian villages along the southward track, children streamed from the houses to welcome me, shrilling "stop, stop," the only word of English they knew. If I refused the tea they offered, as sometimes I had to do, they would scamper off, returning to present me with a bag of dried dates. Such generosity is moving in a land where people barely have enough for themselves.

At Dongola, 150 miles south of the lake, I passed out of Nubia and into the land of the Arabs. The eye does not immediately register the distinction. The many tribes in northern Sudan have intermarried with each other and invading Arabs over a long period of time, and they have been unified by Islam. White galabias and turbans are the common dress, and women wear long bright *tobes* to shield them from the eyes of strangers. Older people still display the facial scars that establish tribal identity.

Over a savory breakfast of bean stew and unleavened bread, I heard the surprising news that Dongola, like all of Sudan, is suffering from a brain drain—that dilemma of the Third World in which the best and the brightest prefer to work abroad.

"After they have been to school," an old man told me, "the young men are unhappy to stay on the farms. So they all go off to the gulf, where they can make a lot of money."

THE DESERT west of the Nile, a great sea of rolling sand dunes, presents challenges to the driver. In the early morning the sand, compressed by the cold, damp night air, is fairly firm. As it is heated by the sun, it becomes loose, and the car, heavily laden with fuel, spare parts, and water, was inclined to sink. When I got stuck, I dug trenches in front of the wheels for aluminum sand ladders, which provided enough traction to get going again. At day's end, I was glad of my jerry-can shower, heated by the sun.

The temperature reached 110 degrees, and of course it was even hotter inside the car. I had a cooler, but no ice. I was worried that my film would be spoiled. I had noticed that the camel nomads I encountered in the desert kept their water in porous goatskin bags; evaporation kept the water cool. I thought the same principle might work for me, so I wet a towel and wrapped it around the outside of the cooler. As any nomad could have told me, it worked.

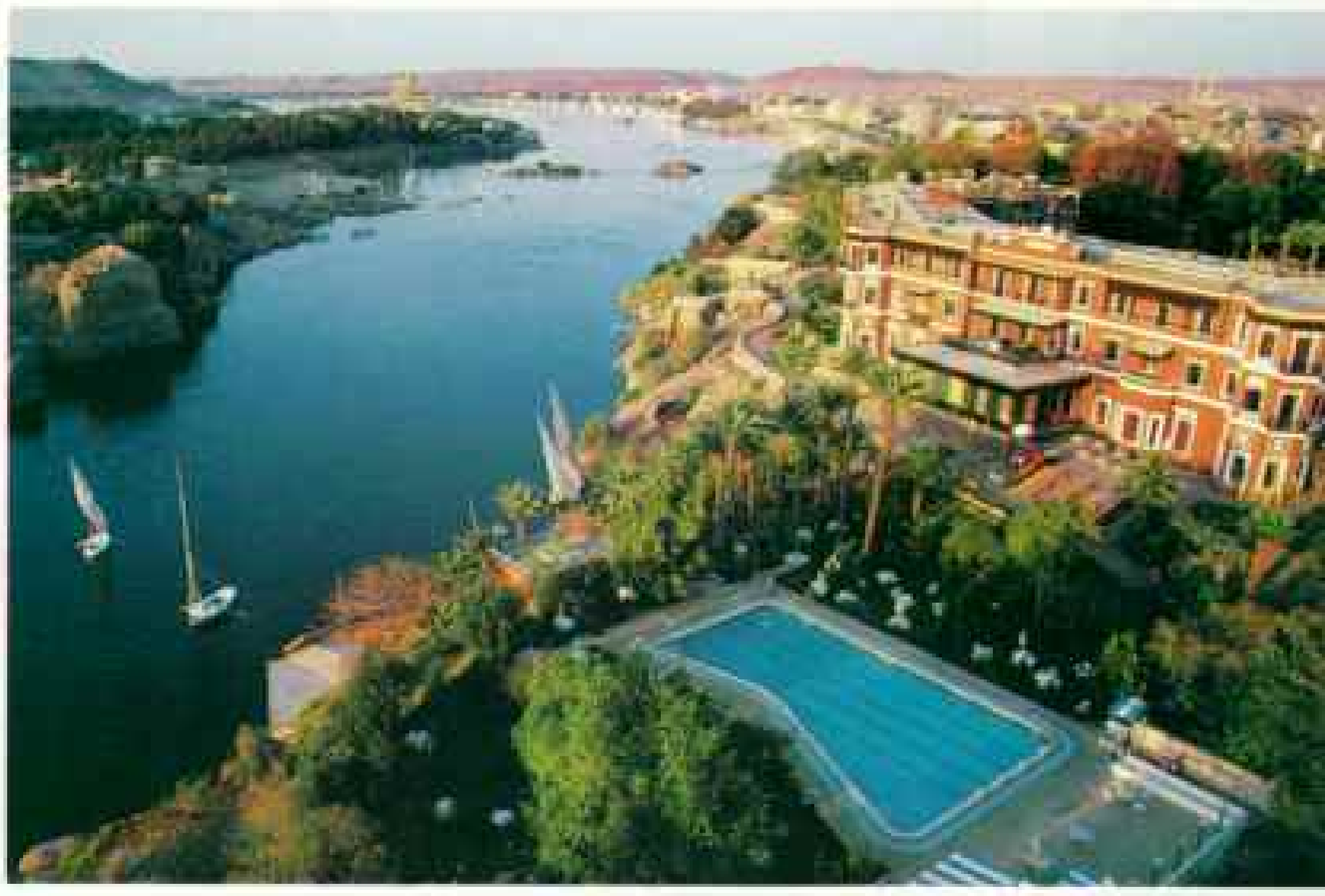
Near Karima fields of wheat and clover gave way to groves of mango, grapefruit, tangerine, and date trees. Here I came upon northern Sudan's ancient past: Along the Nile between Wadi Halfa and Khartoum are several archaeological sites, all that

remain of the Kingdom of Kush. It thrived near present-day Karima in the eighth century B.C., and its powerful monarchs ruled all of Egypt as the pharaohs of the XXV Dynasty. Though driven out of Egypt in 663 B.C., the Kingdom of Kush flourished in Sudan until the fourth century A.D. The ruined temples, tombs, and pyramids lie quietly in the desert near the Nile, free of hawkers, guides, and tourist buses.

At Abu Hamed I met the main track and railway line and turned south toward Khartoum. The fertile alluvial banks disappeared, replaced by rolling sand dunes that sweep right into the river. There were no farmers here and no houses, only nomads driving their thirsty flocks to water.

the desert east of the river, I met a group of Birbanega nomads. Their camp was two hours away—all the land nearer the well had been long since overgrazed. The herdsmen lowered goatskin buckets on long ropes into the well, 125 feet deep. Donkeys and camels hauled the dripping skins to the surface to be emptied into other skins and loaded onto other animals for the journey home.

Abbas Muhammad Kheir, a teacher at a nearby boarding school, interpreted for me at the well, meanwhile complaining about the difficulties of working with the nomads: "These people do not want their children to go to school; especially, they don't want their girls to go to school, but only to fetch water and look after the flocks. They just do not understand why it is necessary."



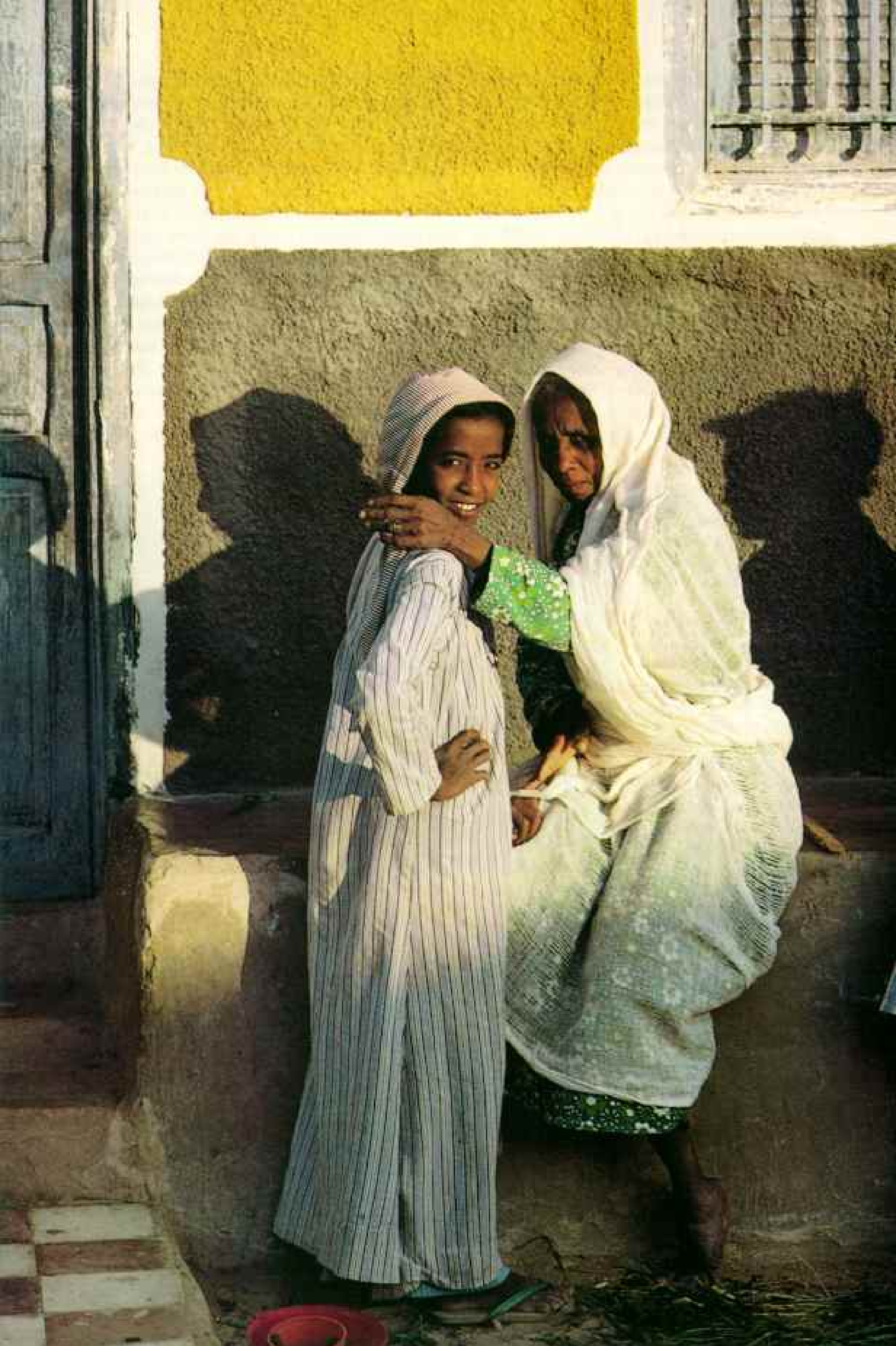
Oasis *of Old World elegance, the Cataract Hotel sits high above Nile waters, offering views of feluccas shuttling to the sights of Aswan, just downstream from the High Dam. The hotel takes its name from the first of six cataracts, or rapids, that hindered early exploration of the Nile. As the ancient gateway to Nubia, source of gold for the Egyptian monarchs, Aswan held a key position in river commerce.*

The six cataracts of the Nile were numbered by foreigners traveling upstream, so that when I rested in the shade of a lone *duom* palm at the fifth cataract, I was really at the second cataract as the Nile flows. The "cataracts" are rapids, not waterfalls. After passing through a blinding *haboob*, or sandstorm, I crossed the Atbara River where it meets the Nile after an 800-mile westward journey from the highlands of Ethiopia. Though it flows only in season, the Atbara at flood contributes 22 percent of the Nile's volume. It is the only tributary between Khartoum and the Mediterranean.

At a well near the Kushite ruins of Musawwarat es Sufra, 100 miles to the south in

SUDDENLY, about 40 miles north of Khartoum, after 1,100 miles of dust and sand and anxiety, I was on asphalt. I let out a yell of joy as I took the car out of four-wheel drive and zipped along. But with the pavement came traffic and its rules, and I had to remind myself not to wander around as I had in the desert.

At the hotel I parked my unwashed vehicle in a line of sparkling luxury sedans, and with sweat-streaked face and gritty clothes gingerly made my way across a lobby of men in Western suits and flowing white galabias. Was I fit for civilization? Fortunately, the



receptionist remembered me from previous visits, and soon I was lolling in an air-conditioned room and gazing out the window upon the confluence of the Blue and White Niles, an event referred to in Arabic poetry as "the longest kiss in history."

The Blue Nile rises in the mountains of Ethiopia, where seasonal rains cause the annual floods that inundate the Nile Valley with water and silt. But the White Nile is the mother river, steadily supplying the desert with water from central Africa. From this confluence to the Mediterranean, the Nile travels 1,900 miles through one of the fiercest deserts in the world, with no unfailing tributary and scant rainfall. Having just come that route myself, I was amazed that the river did not evaporate along the way.

I planned to follow the White Nile to the great lakes of Victoria and Albert, and beyond. This meant traversing one of the most troubled regions on earth.

Sudan, huge and diverse, is a country divided.* In the north, where most of its 22 million people live, Islam and the Arabic language have created a certain unity. The African south, however, is composed of many different tribes, each with its own language and customs. The north has always controlled the country and until the turn of the century saw the south as simply a hunting ground for slaves and ivory.

For 17 years, until President Gaafar Muhammed Nimeiri ended it in 1972, civil war raged between north and south. At least half a million people died. As I arrived at Khartoum, war had rekindled.

"The war is part of a larger conspiracy," a government official told me. "The southerners are being used by the Marxist Ethiopians and by [Col. Muammar] Qaddafi of Libya to cause trouble for Sudan. They want to destroy us, and then Egypt."

"That is the typical northern attitude," a southern student countered, "the same attitude as in the slaving days. Northerners think we are too ignorant in the south to organize ourselves and carry out a war on our own. By believing it, they are denying that there is any real problem in Sudan and making war the only alternative."

Tensions were increased by President Nimeiri's edict to make Islamic law the code of the land, enraging the animist and Christian southerners. The guerrilla war is being fought mainly by the Sudanese People's Liberation Army, which includes many southern deserters from the army, headed by a former Sudanese army colonel—and Ph.D. in economics from Iowa State University—named John Garang. Withal, there was a nervousness in Khartoum that infected the stranger.

I HAD ARRIVED in Khartoum with only four of the 120 gallons of diesel with which I had left Aswan. Getting permission to refill the tanks took a couple of days—fuel is rationed in cash-strapped Sudan—but was absolutely necessary, as I could not count on getting fuel again until I reached Uganda.

I replenished the rest of my supplies, changed oils and filters, checked that all nuts and bolts were tight, and set off for the great clay plains of the south. Rain falls on this land, so life here is not confined to the banks of the Nile. The vegetation thickened. Villages of beehive huts stand well away from the river; straight lines hardly exist. The people grow darker. I was moving deeper into Africa. I fell asleep to the high-pitched call of jackals.

Drifting away from the Nile, among stands of flat-topped acacias and vast expanses of yellow grassland, I drove for two days without seeing another human being. The Nilotic tribesmen who live here were off near the river with their cattle herds. It was the height of the dry season. Eight-foot grass, rustling like fire in the hot wind, rose out of the cracked, baked clay.

The track, impassable with mud in the rainy half of the year and so hard and rough

*The author reported on "Sudan: Arab-African Giant," in the March 1982 NATIONAL GEOGRAPHIC.

***Her home and land vanquished** by the Aswan High Dam, an elderly Nubian woman had to start life anew in a relocation village near Kom Ombo. The flooding by Lake Nasser forced the Egyptian government to resettle some 60,000 Nubians in desert villages.*

Smoothed by centuries of sandstorms, *pyramids at Nuri in northern Sudan recall the Kingdom of Kush, now the realm of sedentary farmers and nomadic*

herdsmen. Superb horsemen, Kushite warriors pushed north to subdue Egypt in the eighth century B.C. but were later repelled by the Assyrians.

the other half that it wrecks vehicles attempting to use it, seemed to symbolize the state of communication between south and north. On this difficult and primitive road, one must creep along, as any greater speed means shaking the car to bits.

The Shilluk live in a frieze of villages on the west bank, north of the Sudd, the great swamp that blocked river traffic and exploration until the mid-1800s. There they grow sorghum and graze cattle. Their *reth*, or divine king, is believed to be the incarnation of Nyikang, mythical ancestor of the tribe.

When the king dies (usually from natural causes nowadays, though monarchs who lost their perfection through illness or other causes are said to have been put to ritual death in the past), a new one is elected and taken to Fashoda. The person of the king must be flawless. If even a tooth is broken, or if he is ill, he is no good, for his well-being symbolizes that of the entire tribe. From the day of accession on, his power is held in awe: "Even without the government in Khartoum, the Shilluk would be all right," a tribal spokesman told me. "The power and justness of the king are very great."

The 33rd reth, Ayang Anei Kur, graciously received me in the royal village, made up of a large courtyard surrounded by several small huts for the people and one large one for the cattle, about three miles from the Nile. While I waited for the audience, I joined a group of royal advisers in one of the huts. They wore traditional pink togas, and their brows were marked with a row of beadlike scars, symbol of the Shilluk. One of the king's many wives served us *atabobo*, the local sorghum beer, in a clay pot that was passed around the circle of men. Though a bit nervous about drinking water from the Nile, I could not show it, for the advisers watched curiously for my reaction.

The king sat in an open courtyard, cross-legged on a small platform draped with leopard skin. He held a fly whisk in one hand and his staff in the other. Petitioners approached, crouching, touching the ground with their fingertips. On the ground near him were arranged a large tape deck, a litter of cassettes, and a spittoon. Like nearly all Shilluk men, the king uses snuff, but it is taboo for his spittle to touch the ground.

Over the blare of Afro-rock music on his tape deck, the king spoke to me with grave dignity. "You have come from a long way off and have seen many things, but not the Shilluk," he said. "You must stay." I remained for several days, overwhelmed by kindness—sorghum beer at dawn, hippo stew, and much conversation. One day, as I sat on the ground next to the king, he confided a problem. "We are suffering here," he said. "We have to bring water from the river, and it's very heavy. We wish that America could help us, to make wells in our villages."

The king's secretary explained that this was a gentle hint to use my car to bring water from the river. Happy to be able to help, I unloaded equipment and filled the car with young warriors who joyfully climbed in, leaving spears and shields behind. At the Nile, watchful for hippos and crocodiles, they leapt in for a swim. We made two boisterous trips between river and village, passing women of the tribe who had walked to the water's edge to fill their own cans and carry them home—a twice-daily task.

The Shilluk take their cattle to the river every day and then drive them back to the villages. Innocently, I suggested that they could lash the water cans onto the backs of the cattle. The tribesmen were shocked. "Women have always brought water," the king's secretary explained. "Cattle are our wealth. It would be a very bad thing to make them work—it would be *torture*."

ON THE EDGE of the Sudd, Chevron had found oil; a 1,000-mile-long pipeline was planned to carry crude petroleum to Port Sudan on the Red Sea. At Rub Kona, Chevron's base camp near Bentiu, I found a beehive of growling trucks, riverboats laden with supplies, helicopters and airplanes buzzing overhead—and an atmosphere of anxiety. The guerrillas had taken several Chevron workers hostage a few months before, and it was rumored that they were about to strike again.

I have a friend among the Nuer people called Peter. Just three years earlier he had happily told me stories about the Nuer, accompanying me to their cattle camps and to the tree where his people believe man was created. Peter was a far sadder person as he described the fear his people felt toward

army and rebel alike: "They are killing us and taking our cows. Our world has come to nothing. They do not respect us." Soon after I departed, the camp at Rub Kona was attacked by rebels. Three men were killed, and Chevron suspended all oil exploration in southern Sudan.

From Juba to Khartoum the White Nile travels 1,100 miles but falls only 240 feet, a drop of about a foot every five miles. In the Sudd, that vast desert of water, at flood larger than the state of Maine, the incline is even less, and the Nile is a maze of shifting channels. I had entered the Sudd as the guest of Capt. John Mason on the Chevron tugboat

bee eaters, fish eagles, herons, egrets, pied kingfishers, and saddle-billed storks skimmed above the river or perched along the bank, feeding on the abundant insects and fish. The rare shoebill, or whale-headed stork, unique to the deep swamps of Africa, joined in, looking like some demented artist's idea of a prehistoric bird. At Lake No we joined the Nile and turned south into the Sudd. Fifteen-foot-high walls of green vegetation closed in on us. Climbing to the roof of the wheelhouse, about 30 feet above the river, I could see for miles around—and all I could see was a wind-tossed fringe of reeds and papyrus, stretching in

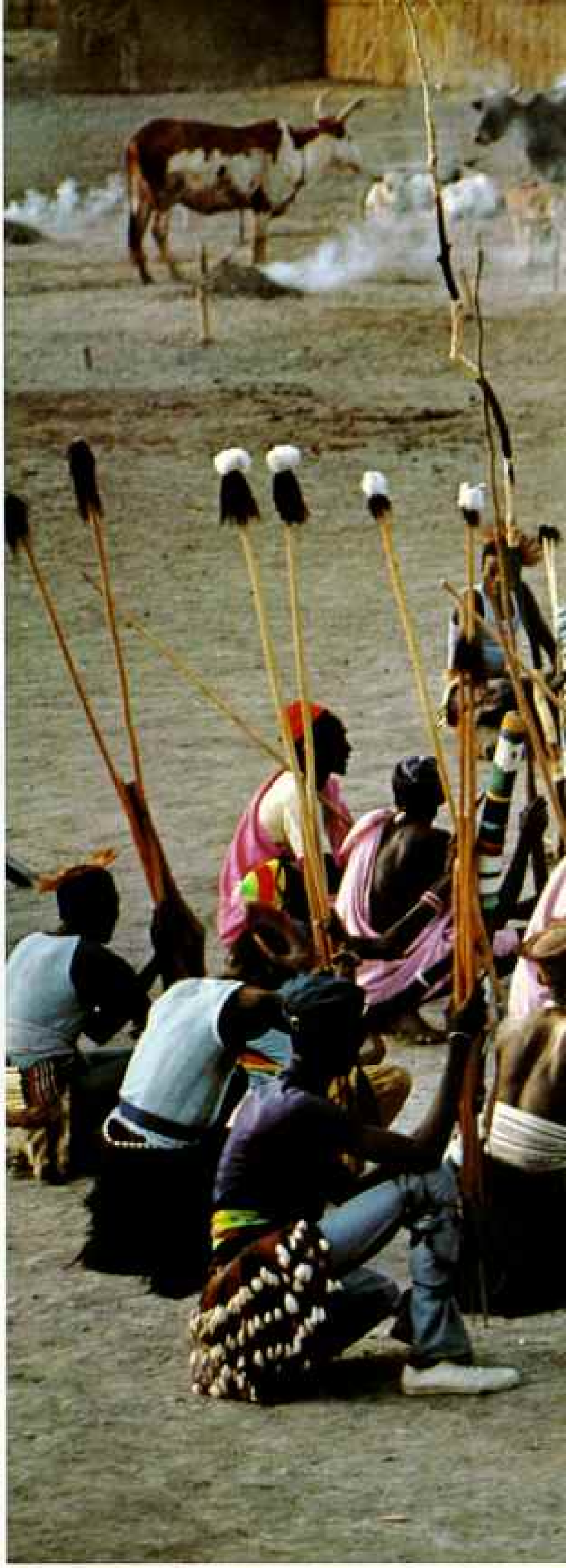
Instant service: *A bus driver in Sudan finds the Nile a handy pit stop for washing the grime of the desert from his diesel engine. The country has only one major paved road, from Khartoum to Port Sudan, and the author found his own driving skills challenged. "Once you hit Sudan, it is just tracks running across the desert," he recalled. "It's difficult enough to drive in the daytime, since a sandstorm can wipe out the tracks. I never drove at night."*

Saria, bound for the company's camp at Adok, in the middle of the swamp. Maneuvering supply barges down the Bahr el Ghazal, a western tributary of the Nile, among floating islands of water hyacinth and reed, Captain Mason explained the problems of sailing through this flowery labyrinth. "This stuff is like icebergs," he told me. "Below the surface there are extensive root networks full of earth and decaying vegetation, all tangled together in a solid mass."

In the first 12 hours we made 20 miles through a reed-choked river. It was a paradise for birds—plovers, swifts, carmine

rippling monotony from horizon to horizon.

I spent a week in Adok, flying around the Sudd in helicopters and occasionally being dropped at remote cattle camps to visit with the astonished Nuer. From the air all the world was water, in open lakes large and small sparkling amid the stupendous vegetation. Buffalo and Nile lechwes splashed through the swamp; huge monitor lizards, easy to mistake for crocodiles, basked on termite mounds jutting out of the water. On specks of dry land Nuer fishermen made their camps—two or three mosquito nets, a fire, and a rack *(Continued on page 620)*



Divine king *Ayang Anei Kur* ***(above)*** *adorns his brow with the mark of the Shilluk: nodules raised by rubbing ash into small cuts. Though elected by the tribe, kings are considered the incarnation of a godlike figure who brought the people to the southern Sudan area. Woe to kings who fall short of the Shilluk ideal of physical excellence. Even a missing tooth is enough for dethroning; once, it is said, less than perfect kings were put to death.*

One prerogative of a ruler is priority in home repairs. At the king's village ***(right)*** *tribesmen celebrate the annual thatching of their leader's roof, required before they can begin on their own.*

Togetherness makes a boat. *This Nile steamer consists of five barges lashed to each other and a stern-wheeler, identified by its wheelhouse. Passengers go topside for breathing room as the conglomerated vessel threads the Sudd, a vast swamp in southern Sudan. Principal mode of transportation from Juba to Kosti during the rainy season, steamers carry as many as 1,000 people on the 900-mile trip. If all goes well, the trip takes six days, but breakdowns and running aground may*

stretch it to six weeks. Passengers board in a rush to secure a prime spot for their sleeping mats and charcoal stoves. As the vessel stops en route, merchants stand by to sell produce and firewood. In the heyday of British rule, wedding parties embarked on ships with first-class cabins equipped with fine linen and staffed by servants. But now the honeymoon is over. Even worse, southern guerrillas have attacked the steamers and killed passengers.


PARKER DRILLING

Citizen of two worlds, *a Nuer tribesman wears a hard hat* ***(left)*** *for his job on a Chevron oil rig near Rub Kona. His facial scars serve as ornaments as well as distinguishing him from members of other tribes.*

"It was a giant leap," says the author of the Chevron operation, now suspended. "They hired tribesmen who walked in stark naked, carrying spears and shields. Two weeks later they were working on a rig and wearing hard hats and steel-toed boots."

Yet the pattern of a Nuer family residence ***(right)*** *near Adok stays the same. The family's cattle live in the large hut; the family lives in the smaller one. Mounds of earth seen in neat geometric patterns are used to plant sorghum, one of the tribe's chief crops.*

Rehearsing warrior skills, Nuer children ***(below)*** *throw clods of mud at each other in mock combat and defend themselves with reed shields. Their seniors use deadly spears and hippopotamus-hide shields.*

of drying fish. Near the edge of the Sudd, on larger islands, were the Nuer homesteads' chocolate-drop-shaped huts among duom palms and maize and sorghum fields.

A team of French technicians had been working on a new canal, the Jonglei, at the eastern edge of the swamp. It is designed to divert 20 percent of the Nile water around the swamp, reducing the tremendous loss of water from evaporation and cutting the journey between Malakal and Bor by a third. The guerrillas regarded this project as a new attempt by the north to exploit the south. The job site was raided in November 1983, and several workers were taken hostage. They were released after a few days, but it was a message. The guerrillas would not tolerate completion of the 225-mile canal, which was then two-thirds finished.

The French company halted work temporarily, but in December 1983 it resumed excavations; the canal is of great importance to the thirsty irrigation schemes of northern Sudan and Egypt. The guerrillas attacked again, taking more hostages. With this action and the one on Chevron's base camp, the rebels have shut down two of Sudan's most important development projects.

From Nimule, the last town in Sudan, there is a fine view of the Nile, very wide in the broad plain as it makes a sharp bend between two high ridges and falls over the Fula

Rapids. At the Uganda border the road deteriorated into a mess of ruts and holes. I was in no-man's-land. My stomach felt queasy, my hands sweated as memories of Idi Amin's Uganda flooded into my mind. In 1979, when Tanzanian troops were in the process of driving Amin out of the country, I had been arrested, with two other journalists, on the Ugandan border by members of the dictator's notorious State Research Bureau. At gunpoint our captors herded us into a shack. Only a few weeks earlier four Western journalists had been shot in Uganda. The floor of the shack was smeared with dried blood, and we could hear the groans of a prisoner being beaten in another room.

After spending some time in a cell and undergoing a frightening interrogation, we were released. "You are always welcome in Uganda," our interrogator had snarled. Since then, Amin had been deposed. I knew that I would not meet the State Research Bureau at the border this time, but Uganda was still a place where one breathed in fear with the blood-drenched air.

After driving through ten miles of uninhabited bush, I came to an army roadblock. Drunken soldiers in unkempt uniforms—shirttails out, muddy boots unlaced—flourished automatic rifles. "Get out! Papers! Everything out of the car!" Soldiers swarmed over the car, spilling my baggage onto the

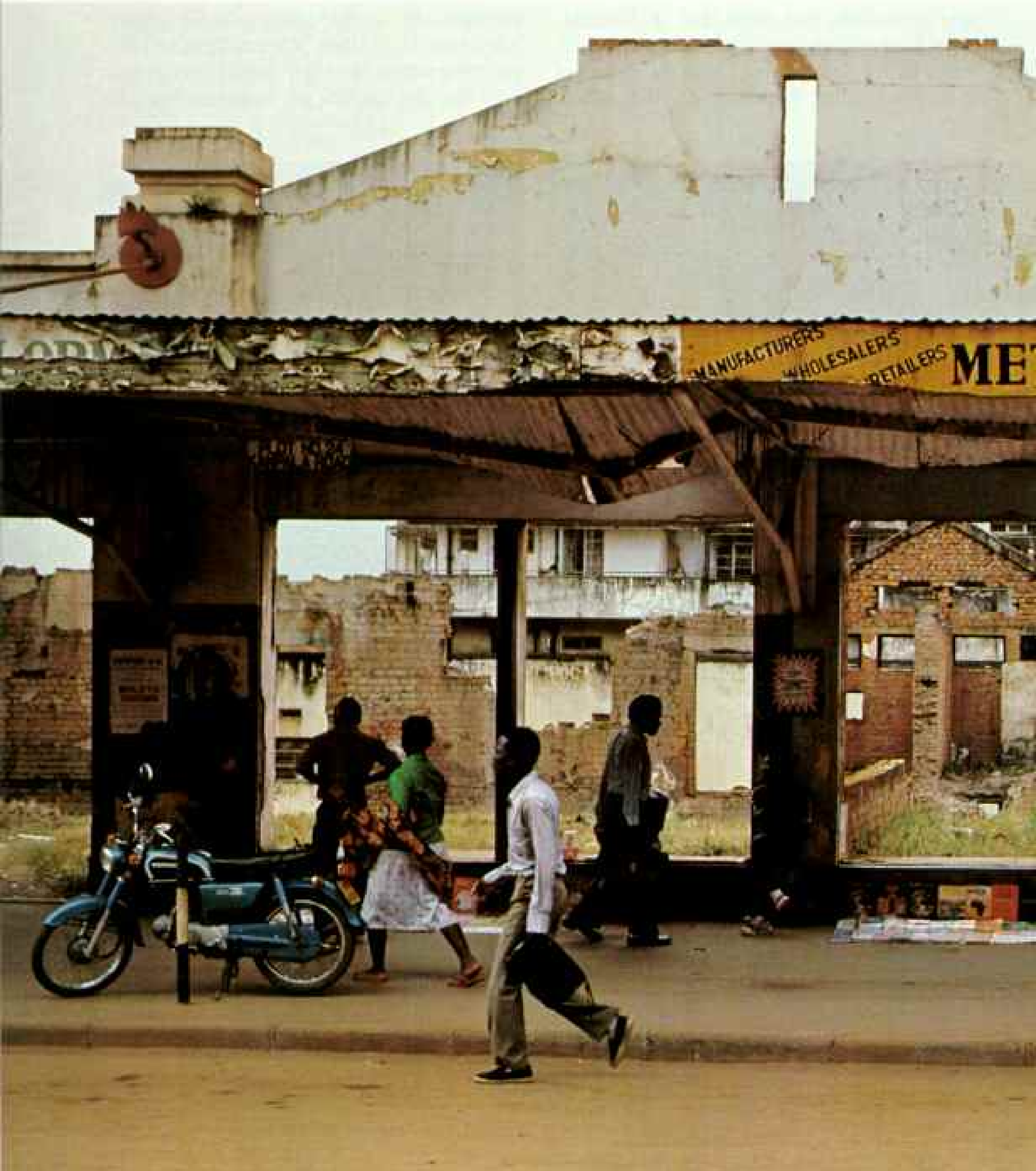
Cattlemen turn fishermen *on a termite mound* ***(left)*** *in the Sudd. Here six Nuer, as well as others of their tribe on other islands, spend several weeks during the dry season catching catfish, tilapia, and Nile perch. They dry the fish and market them in Adok.*

Barb on the bill of a shoebill, or whale-headed stork ***(above)****, helps this awkward-looking resident of the Sudd capture lungfish.*

ground. Anything they could easily slip into a pocket was fair game. Finally they were done, and with a sigh of relief I repacked the car and drove away. But half a mile down the road I reached another army roadblock and went through the whole process again.

"These soldiers, they don't know any rules," a Ugandan farmer told me. "They come to a village and steal food from the people, and they take the girls away to their barracks. We have lived with the gun for so long now that the children do not know anything else. Guerrillas, bandits, the army—all do just as they want."

I was surprised to hear many people tell me that conditions are worse now than under Amin. Then, they say, murder and torture were systematic. Now the killing is random—in the first days of my visit 200 people were reported massacred in a refugee



camp north of Kampala. It was unclear whether this was done by the army or by the guerrillas. In a nearby village a mass grave containing 50 bodies was discovered.

Winston Churchill called Uganda a "pearl" along the Nile, and indeed the beauty of this verdant upland country with shining lakes makes the bestiality that grips it all the more hideous. Hoping to escape into the country's beauty, I headed for Murchison

Ruined shell *of a pharmacy in Kampala stands as it was after being bombed in 1979 during the civil war. Since then, four successive governments have failed to quell the waves of anarchy, murder, and chaos that plague Uganda.*

Elephants band together ***(overleaf)*** *under a flight of cattle egrets in Murchison Falls National Park, Uganda.*

Falls National Park, which straddles the Victoria Nile to the east of Lake Albert. In Uganda there is no single Nile as in Egypt. Rather, the Nile is a network of streams, rivers, and lakes mingling together to create their mighty offspring.

These waters also have their source: As I drove into the park, torrents of rain fell from the dark sky. Buffalo, Uganda kob, and hartebeest bunched on the rolling grasslands, still and patient. They, too, were survivors—during Amin's rule, his retreating army and the advancing Tanzanians, along with civilians taking advantage of the chaos, shot elephant and rhino for their tusks and horns, and other game for meat or just for the thrill. At Paraa, the park headquarters, Iain Douglas-Hamilton, a Scottish-born wildlife expert, recited some grim statistics: "In 1973 there were 14,300 elephants in the park. By 1980 only 1,400 were left. Automatic-weapon-toting man has become the dominant ecological factor here."* Today no rhinos are known to remain alive in the park.

Later, in Iain's airplane, I flew over Murchison Falls, where the Nile crashes 130 feet downward into a caldron of spume. Through the open door of the plane, I could see at a glance the whole southern system of the Nile: Lake Victoria, fed by rivers of its own, gives birth to the Victoria Nile, which flows north into Lake Kyoga, exits westward, spurts over Murchison Falls, and flows into the northern end of Lake Albert. Lake Albert is fed in the south by the Semliki River, which drains Lakes Edward and George, themselves fed by the runoff from the Ruwenzori, the Mountains of the Moon. From Lake Albert the Nile emerges finally as the single river I had followed to this place.

From my camp at the head of Murchison Falls, I climbed down wet cliffs and wandered along the bank of the river. Colobus monkeys cavorted in the trees. Fat crocodiles, some 12 feet long, slipped into the river and watched me with beady eyes. Farther down the river, herds of hippos snorted and lolled in the water. Birds of prey traced lazy circles in the blue sky. I bathed in a clear pool, unworried about crocs and hippos, as I thought the current was probably too strong for them. But the bank was lined with thick bush, a perfect hiding place for lions and other predators. Across the gulf of time I understood with

Hogging the kill, *a male lion crunches the bones of a baby giraffe* ***(left)*** *in Masai Mara Reserve in Kenya, where the plains of East Africa serve as rain catchers for Lake Victoria, largest reservoir of the Nile.*

A hippopotamus bellows ***(right)*** *in Queen Elizabeth National Park in Uganda. Poachers with automatic rifles have exacted a fearsome toll of wildlife in Uganda's parks, even attacking park rangers. Now the poachers have been thwarted and the animals are increasing.*

*See "Africa's Elephants: Can They Survive?" by Oria Douglas-Hamilton, in the November 1980 NATIONAL GEOGRAPHIC.

"***Of the source of the Nile*** *no one can give any account," wrote Herodotus, who turned back in frustration at the first cataract at Aswan about 460 B.C. For more than 2,000 years after that, the font of the Nile remained an enduring geographic preoccupation as explorers vied for the glory of finding it.*

In 1858 John Hanning Speke discovered Lake Victoria (**left**)*, where fishermen still catch Nile perch* (**top**)*. When on a subsequent expedition in 1862 Speke found a river that issued from the lake to the north, he impetuously cabled the Royal Geographical Society in London, "... the Nile is settled."*

But the true sources of the Nile lay upstream, as Speke's rivals—Richard Burton, David Livingstone, and Henry Morton Stanley—endeavored to prove. It was not until 1937, however, that a German explorer, Dr. Burkhart Waldecker, traced the southernmost source of the river to a spring in Burundi.

a shiver the fears of my primitive ancestors.

In Kampala I climbed one of the hills overlooking the city. As I stood there taking pictures, a young boy from a nearby house came up to watch. Suddenly five bursts of automatic rifle fire, very close by, ripped the stillness of the evening. I jumped in my skin.

"Don't be alarmed," the boy said. "That is just Kampala life—we hear it every day."

"But aren't you afraid?" I asked.

"Of course we are afraid," he replied. "But where could we run to?"

Poor Uganda goes on suffering.

Yet some see rays of hope. On the shores of Lake Victoria I encountered Meena Madhvani, whose family had been among the 70,000 Asians Idi Amin expelled from Uganda in 1972. The Madhvani Group, built up by Mrs. Madhvani's husband, Jayant, had once controlled 38 percent of the industrial investment in Uganda.

"We came back to Uganda because this is our home," she told me. "Our family put 80 years of work into this place. If we can build it back up, it will help the country, our country. The economy is getting back on its feet, and I think we can make Uganda live up to its promise—if we can have stability. Roads are being rebuilt, schools and hospitals opened again. The World Bank and the International Monetary Fund are helping—1981 was better

A fine catch brings a satisfied smile to a Tanzanian fisherman on the Kagera

than 1980, and 1982 was better than that."

Lake Victoria is the great reservoir of the Nile, but the source of the Nile is reckoned to be the river that feeds more water into the lake than any other. That river is the Kagera, which has its ultimate source some 500 miles southwest of its entrance to the lake.

Where the Kagera forms the border between Rwanda and Tanzania, I stopped for a while in a Wahaya village of about 30 huts, fishing in the river with my hosts and conversing in a funny mixture of broken English, French, Kinyarwanda, and Swahili. From there I followed roads through Rwanda and Burundi that wound their way in and out of supremely beautiful agricultural valleys, the land of the Tutsi and Hutu people.

Finally, on a windswept hill in southern Burundi, I came to the end of my journey and the beginning of the Nile. A tiny trickle of water issued from the earth. *Caput Nili*, read a weathered metal plaque on a little stone pyramid—"Source of the Nile." From this southernmost headwater, the Nile runs 4,160 miles to the sea.

THIS WAS THE SOURCE of the Victoria system of the Nile. I wanted to see the beginnings of the Albert system as well, so I retraced my steps back north to Uganda, to the

River, whose headwaters are regarded as one of the sources of the Nile. 631

Ruwenzori, the fabled Mountains of the Moon, their six crowns bearing permanent snow and glaciers—right on the Equator. Glacial melt and more than 75 inches of annual rainfall rush down from the peaks in rivulets and streams that feed Lakes George, Edward, and Albert below. The Nile begins here at 16,763 feet—as ice.

Accompanied by porters and a guide, I climbed into the mountains along the course of the Bujuku River through deep gorges choked with nettles, bushes, and ferns. I heard a chimpanzee call, but did not see any sign of other game apart from a troop of colobus monkeys shrieking in the canopy. On the narrow footpath we encountered a group of Bakonjo hunters returning to their village with several hyrax—diminutive relatives of the elephant that resemble rodents. The Bakonjo said there were very few hyrax left in the mountains.

At Nyamuleju (10,900 feet) we passed into a weird world hard to imagine in the center of Africa. The ground was like an immense sponge. For the whole ten-day hike my feet, and usually my legs as well, were soaked in near-freezing water. Yet life flourished here. Giant lobelia and groundsel, 20 feet tall, stood like sentinels in the mist-covered slopes and valleys. There were mosses in brilliant greens, crimson, browns and gold, tussocks of sedge, and a profusion of everlasting flowers.

I saw the sun only once, and then briefly, when I stood at the base of the great glacier that caps Mount Stanley's highest peak. "It is Kitasamba, the god of the mountains," my guide told me. "He is showing us his place."

We camped the last night beneath an overhang of cliff, under a waterfall that shot out over my head and fell 50 feet to a stream below. I lay tucked in my sleeping bag, watching the thinning clouds being swept past a full moon that lit up the jagged peaks across the valley. The cold night air was filled with the roar of water rushing downward, seeking the level of the sea.

From my little shelter high above the Equator, I thought about that long journey the Nile makes, and my own along its course. The Nile is a thread that connects the African and Arab worlds, the present with the ancient past. Though the sources of the Nile became known to Europeans just 125 years ago, it struck me that perhaps there had been a clue from long, long before. Almost 5,000 years ago, near the mouth of the Nile, the pharoahs built great artificial mountains encased in gleaming stone—the Pyramids. They still stand today, a mirror image of those gleaming white peaks at the other end of the Nile, where I fell asleep, in the Mountains of the Moon. □

Mountains of the Moon: *The name immortalized by Ptolemy bespeaks the aura of mystery surrounding the peaks of the Ruwenzori Range* ***(right)*** *on the Uganda-Zaire border.*

Through an intelligent surmise, Ptolemy about A.D. 150 listed the Mountains of the Moon as the source of the Nile. Actually he had identified only one of the river's watersheds. This cascade ***(left)*** *tumbles into valleys below to feed Lake Albert, a major reservoir of the Nile.*

WORLDS WITHIN THE ATOM

Beacon to the peculiar geography of the atom—once thought to be the smallest unit of matter—a light guide bends the paths of massless photons at a West German laboratory. Human sight depends on response to subatomic photons traveling with the energies of visible light, yet paradoxically the atom's interior cannot be seen. Exploration into the domain of the ultrasmall is by theoretical physics, elegant mathematics, and giant machines. Within this strange territory—where the raw materials for existence are processed—matter is bound energy, particles and waves are one, and reality itself is a kind of uncertainty.

By JOHN BOSLOUGH

Photographs by
KEVIN FLEMING

Illustrations text by
DAVID JEFFERY
NATIONAL GEOGRAPHIC SENIOR STAFF

IN THE SOUTHWEST CORNER of Switzerland, deep beneath tidy farms and villages, lies a maze of tunnels where it can be hotter than at the heart of the sun.

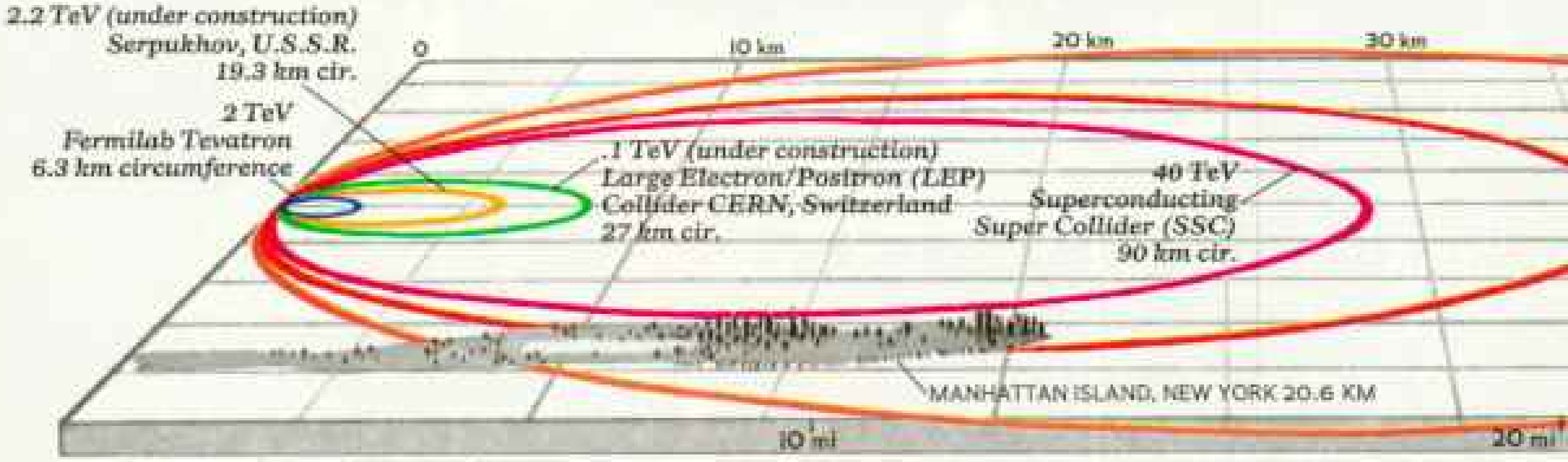
The source of this awesome heat lies within a thin steel pipe encased in magnets—a particle accelerator. Operated near Geneva by CERN (the European Laboratory for Particle Physics), the accelerator is more than four miles long and one of the largest machines ever built. It produces temperatures as high as 7,000 trillion degrees Celsius, comparable to conditions an instant after the superhot explosion that created the universe itself.

Using the CERN accelerator like an immense microscope, physicists are probing the structure of the atom, an inner cosmos of subatomic particles as remote from our daily experience as the farthest reaches of space. Yet that structure may hold an explanation of how the universe was born.

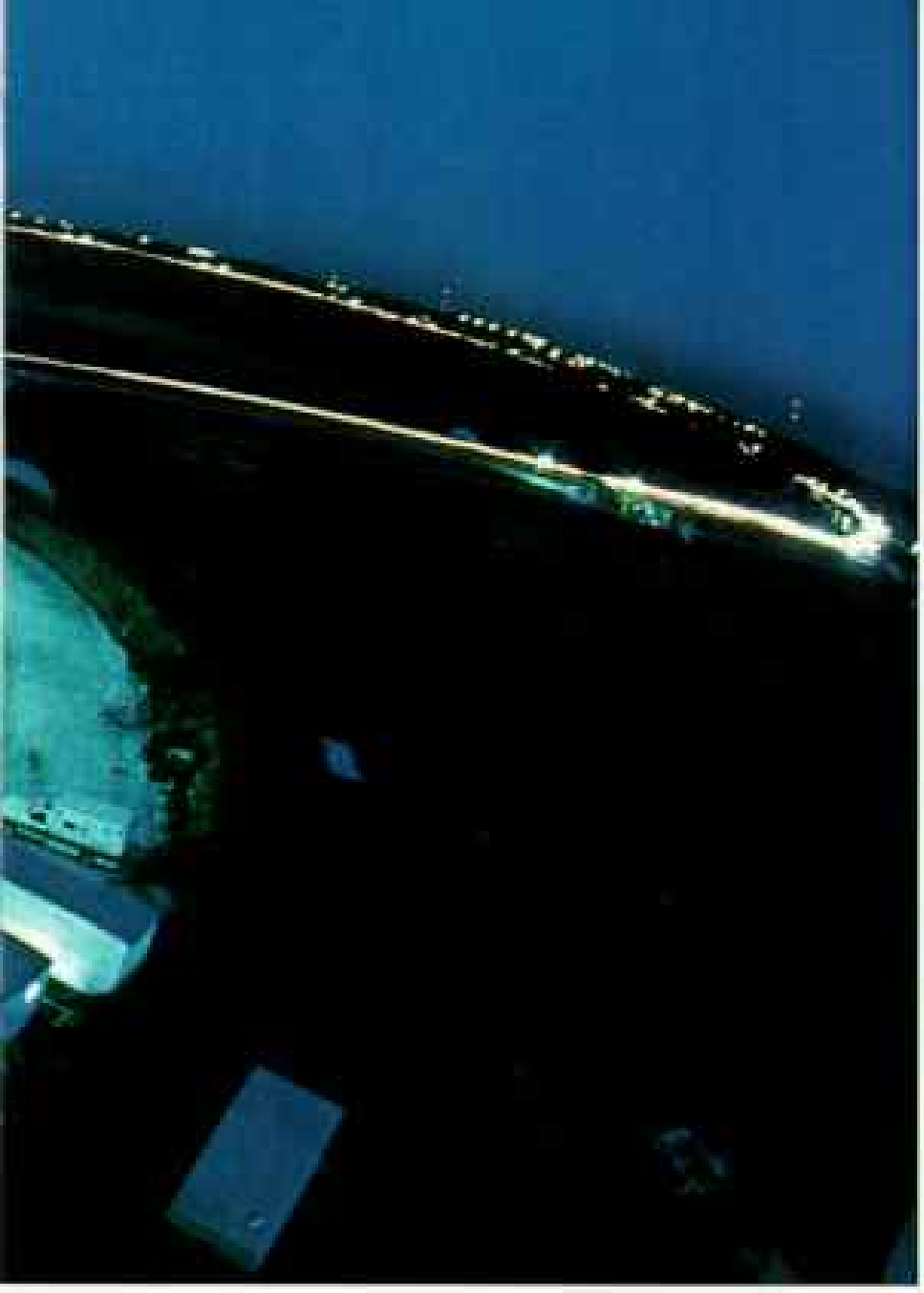
During the past 50 years scientists exploring the atom's interior have solved many age-old mysteries of matter and energy. This new knowledge has brought us lasers, computers, transistors, space travel, and nuclear energy for weapons and power.

"But what we're really after is a new concept of reality," says Leon Lederman, director of the Fermi National Accelerator Laboratory in Batavia, Illinois. "We're after something akin to the revolution in thinking that followed Copernicus's announcement that the earth circles the sun."

Lederman and other physicists are searching for the ultimate building blocks from which all things—the stars, the earth, you, I, and the atom—are made. Because everything in the cosmos has been composed of these particles since the primordial big bang, scientists also hope to learn the origin of the universe, *(Continued on page 640)*



TeV = one trillion electron volts



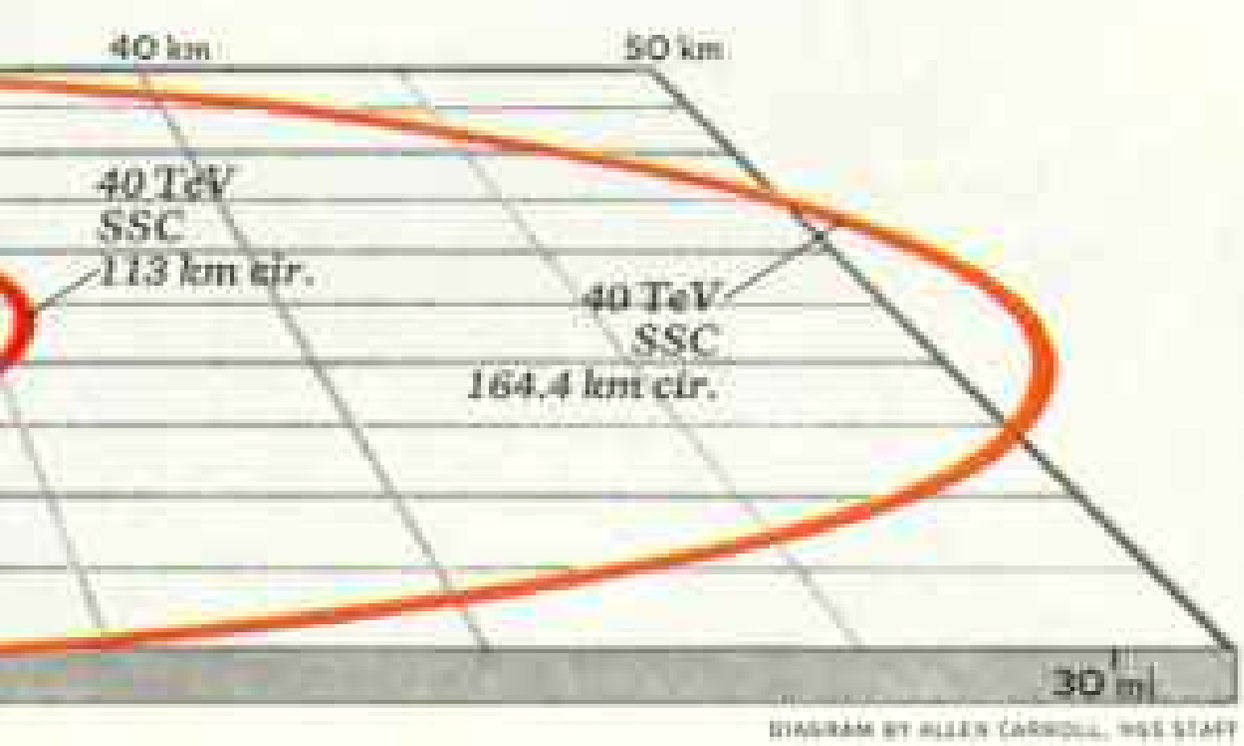


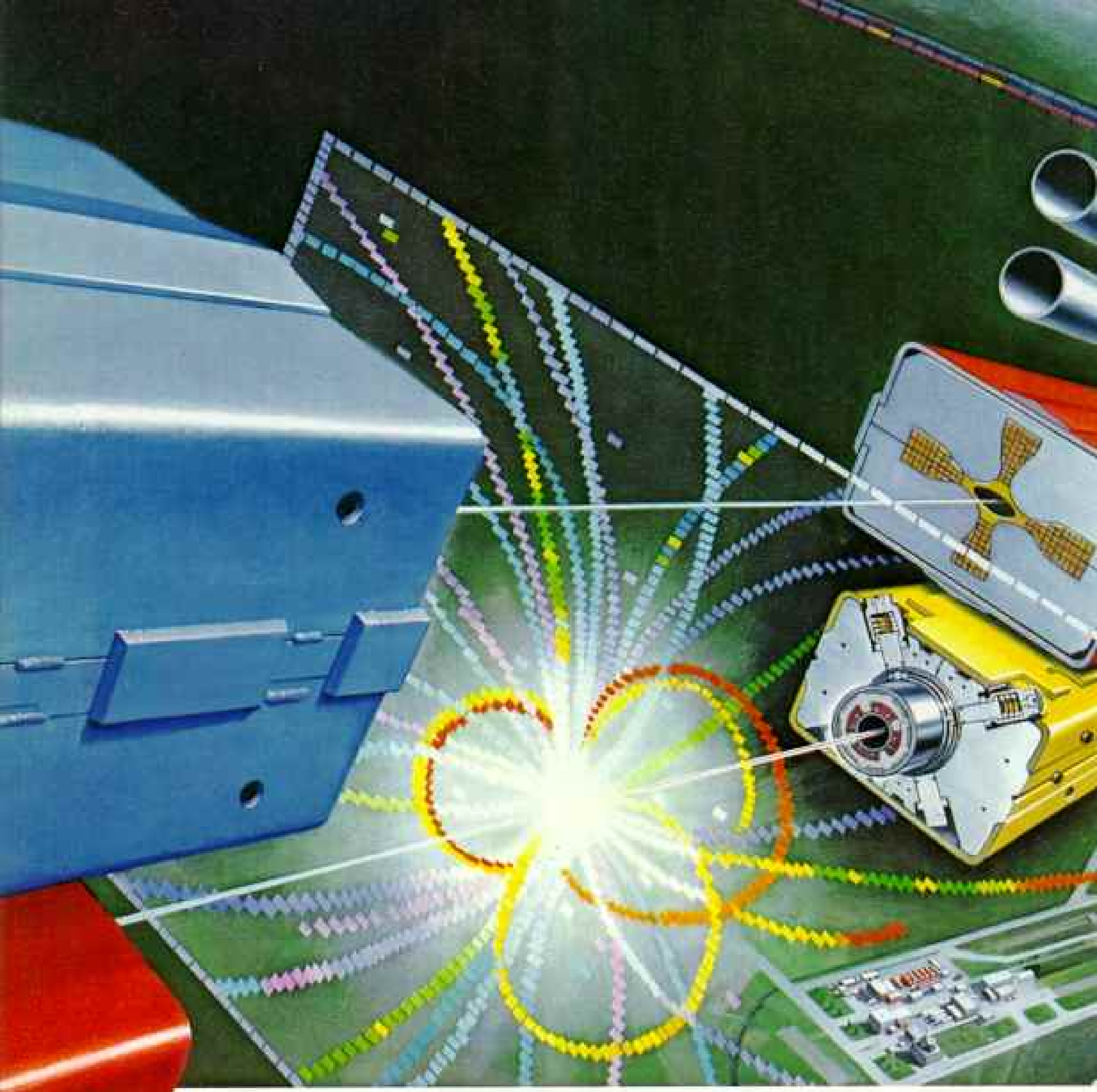
DIAGRAM BY ALLEN CARROLL, 1985 STAFF

Atomic-particle demolition derby *is played on ever bigger tracks at ever higher energies. When the accelerated particles collide, energy is converted into mass in the form of exotic short-lived subatomic particles. Grandfather of all such circular-path tracks, the cyclotron tested in 1930 by Ernest O. Lawrence* (**above right**) *was a semicircular electrode above a gap where particles were accelerated. This first successful model was four inches in diameter.*

Four miles in circumference, the larger of the two underground tracks of Fermi National Laboratory near Chicago (**above left**) *is outlined by a time exposure of white vehicle lights. The magnets that guide the particles—protons at Fermilab—are located 30 feet underground, where physicists accelerate to work by tricycle* (**below left**)*, Peter Limon pedaling and colleague Rich Orr riding.*

Accelerator size and power have grown enormously since Lawrence's day as physicists require ever more violent particle collisions, for only at such higher energies can the more basic of subatomic particles be created for observation.

Largest descendants of the original cyclotron now running, under construction, or planned (**diagram**) *include the Superconducting Super Collider (SSC) proposed by American physicists. Several alternates are under study for cost trade-offs; longer tunnels cost more, but their magnets cost less. By the mid-1990s SSC could perhaps answer a basic question. Are particles such as electrons and quarks truly fundamental, as now believed, or do they, too, have "parts"?*



A PARTICLE FACTORY

TEVATRON

THAT RELATIVITY IS REAL, that mass and energy are equivalent as in Einstein's $E=mc^2$, is the basis for Fermilab's collider now being built. Protons will be boosted to more than 99 percent the speed of light (red arrows at right), then routed to collide with manufactured antiprotons (blue arrows) of opposite charge. Upon collision, these particles of matter and antimatter annihilate each other in a burst of energy. The energy then congeals into other particles that leave characteristic tracks in a magnetic field, as shown schematically above.

The hardware is laid out in an exploded view. The top tier contains system control and monitoring cables. Next are pipes carrying water to cool the long narrow magnets below. The bottom train of magnets is supercooled with liquid helium. The magnets direct the particles, while radio waves accelerate them. Finally the particle beams are forced to collide, and detectors record the results.

To do an experiment, ions are made in a Cockcroft-Walton accelerator **1**. *Ion energies are progressively boosted in a linear accelerator* **2** *and a small synchrotron* **3**, *where ions are stripped of their electrons to leave naked protons. They are further accelerated in the top tier of the large synchrotron* **4**. *Some protons are switched to the bottom tier* **5**. *Others are routed to a beryllium target* **6**, *which produces antiprotons at a slow rate. They are stored within a magnetic "corral"* **7**. *When enough antiprotons have been accumulated in the corral, they are released to the large synchrotron and, because of their opposite charge, travel in the opposite direction of the protons. Only when guided to intersect do the two particle beams collide* **8**. *Protons can be shunted from the magnet rings* **9** *to other targets for other kinds of experiments.*

(Continued from page 634) a goal that eluded even Albert Einstein. Today his successors, at CERN and elsewhere around the world, think they are getting close.

CERN's doughnut-shaped particle accelerator lies 15 stories belowground, in a gracefully curving concrete cavern that twice bores through the rock of the Franco-Swiss border. It takes more than an hour to walk the four-mile circuit of CERN's Super Proton Synchrotron, a frontier crossing that subatomic particles make 43,000 times each second without benefit of passport.

During a brief shutdown for repairs, British physicist Vince Hatton led me to the accelerator's beam line, a waist-high steel tube outfitted with alternating red and blue magnets. The air smelled of oil and machinery. The beam line looked like a snake winding through a high-tech hole on another planet.

The magnets guide a stream of protons around the beam line at nearly the speed of light (186,282 miles per second) before they collide with a beam of antiprotons whirling in the opposite direction. The impacts are so violent—like volleys of cannonballs smashing into each other—that energy is transformed into matter, creating subatomic particles that fly wildly in all directions. Most of these particles are short-lived—some last only a trillionth of a trillionth of a second before vanishing—and are rare in the universe. But as debris from a collision inside CERN's accelerator, they occur in sufficient numbers for physicists to study them to learn what makes up atomic matter.

When running, the accelerator also produces lethally intense radiation, and steel doors operated by electronic keys keep out humans. "The system is foolproof," said Hatton, as warning horns sounded. The machine was about to be switched on. But the vault-like exit door was locked shut. My apprehension grew until Hatton picked up a telephone. "It can't be turned on while we're in here," he said, as someone half a mile away pushed a button and the door opened.

Minutes later the beams were again circling the accelerator ring. In a control room, colorful computer screens blinked with graphs that charted subatomic collisions at two points along the ring. Computer operators adjusted the flow of electricity to the ring's magnets, steering the beams to increase the collision rate. Experimenters fretted at computer terminals, brandished printouts, and haggled over operating procedures with Hatton, who oversees the accelerator.

Each of the world's ten big accelerator

Author **John Boslough** lives in Arlington, Virginia, and frequently writes about scientific subjects. Delaware native **Kevin Fleming** is a regular contributor to the magazine.

Endgame of the universe *is a stalemate for now, because the rules are unknown. Drasko Jovanovic of Fermilab stands before an array of detectors for neutrinos, chargeless subatomic particles that flood space. If they are proven to have mass, gravity may overwhelm the universe, in which case it will eventually collapse on itself. If it does not, and if protons decay, as certain theories predict, atoms must finally dissolve into a thin gruel of aimless particles and random radiation.*

centers—in the U. S., Europe, Japan, and the Soviet Union—wants to be first with a major discovery. As Nick Samios, director of the Brookhaven National Laboratory in New York, puts it: "Nobody remembers the *second* person to say 'E=mc².'" The large European accelerators, CERN and the Deutsches Elektronen-Synchrotron (DESY) in Hamburg, West Germany, are generally better funded than their United States competitors. Survival—funding—depends upon scientific breakthroughs.

So too does continued exploration of one of man's last great frontiers, the inner world of the atom. It is a world where matter and energy are interchangeable, where empty space is not really empty, and where gravity is overwhelmed by far stronger forces that bind together matter.

MAN HAS SPECULATED endlessly about the nature of matter. Some 2,300 years ago the Greek philosophers Democritus and Leucippus proposed that if you cut an object, such as a loaf of bread, in half, and then in half again and again until you could do it no longer, you would reach the ultimate building block. They called it an atom.

The atom is infinitesimal. Your every breath holds a trillion trillion atoms. And because atoms in the everyday world we inhabit are virtually indestructible, the air you suck into your lungs may include an atom or two gasped out by Democritus with his dying breath.

To grasp the scale of the atom and the world within, look at a letter "i" on this page. Magnify its dot a million times with an electron microscope, and you would see an array of a million ink molecules. This is the domain of the chemist. Look closely at one ink molecule and you would see a fuzzy image of the largest atoms that compose it.

Whether by eye, camera, or microscope, no one has ever seen the internal structure of an atom: Minute as atoms are, they consist of still tinier subatomic particles. Protons, carrying a positive electric charge, and electrically neutral particles called neutrons cluster within the atom's central region, or nucleus—one hundred-thousandth the diameter of the atom. Nuclear physicists work at this level of matter.

Whirling around the nucleus is a third subatomic particle, the electron, which carries a negative charge. Electric current consists of flowing electrons, point-like particles literally impossible to measure.

Electrons "orbit" an atom's nucleus according to principles governing the motion of waves. Unlike planets revolving around the sun, electrons do not follow fixed paths. Yet the probable location of electrons can be calculated using quantum mechanics, a mathematical system developed in the 1920s to describe the weird behavior of matter and energy at the subatomic level, the world of particle physicists.

That particles can act like waves may seem bizarre. But no more so than some other oddities suggested by quantum theory: That how we probe matter affects its behavior and form; that some particles exist so briefly that they are not real but "virtual"; and that well-ordered reality—the whole of the universe—rests on chance and randomness at the subatomic level.

Besides quantum mechanics, the other concept crucial to our modern view of the atom and its parts is Einstein's special theory of relativity. His formula, $E=mc^2$, where E is energy, m is mass, and c is the unvarying speed of light, states that mass and energy are merely different versions of the same thing. Einstein, however, never accepted quantum mechanics. He felt that randomness could not be the ultimate reality, and he debated the point with another titan of atomic theory, Danish physicist Niels Bohr.

On this point Einstein has been proved wrong, yet his special relativity theory is routinely put to work in accelerators, where energy is transformed into subatomic particles in a hint of how the universe may have come to be.*

PARADOXICALLY, exploring the smallest things in the universe requires the largest machines on earth. As physicists have penetrated from the molecule to the atom and then to the atom's nucleus with its protons and neutrons, they have pulled back layer after layer of matter as if *(Continued on page 653)*

*See "The Once and Future Universe," by Rick Gore, NATIONAL GEOGRAPHIC, June 1983.

SEARCH FOR THE ATOM

"UNCUTTABLE" is the literal meaning of the word atom in ancient Greek. Leucippus and Democritus advanced the idea of atoms more than 2,000 years ago, rivaling the view that the world was composed of air, earth, fire, and water. Their concept of atoms persisted through Roman times but fell into decline during the Middle Ages. By the 17th century, atomism had been revived, especially in Isaac Newton's work on light, which he conceived as being made of "corpuscles," or particles—although later theory held that light was made up of waves. In 1808 chemist John Dalton argued that for each chemical element there is a corresponding atom, and that all else is made from combinations of those atoms.

The discovery of radioactivity by ***Henri Becquerel*** in 1896, elaborated by ***Marie*** and ***Pierre Curie,*** indicated that atoms had internal structure. So too did the 1897 work on cathode rays by ***J. J. Thomson,*** which identified electrons, charged particles much smaller than the hydrogen atom. The uncuttable was cut; there was a *subatomic* world.

COMPLEXITY was about to enter from another direction. Scientists in the 1890s had difficulty explaining how a heated object like a black chunk of iron could glow in the colors observed. ***Max Planck***'s assumption in 1900: Energy was not exchanged in a continuous flow but by individual packets, or quanta; energy moved not like a river but like raindrops. In 1905 ***Albert Einstein*** was developing what would become his special relativity theory equating energy and mass. That same year he proposed that light was itself quantized, or particle-like, to explain how electrons were emitted when light hit certain metals. His work was verified by ***Robert Millikan,*** who also measured the negative charge of the electron.

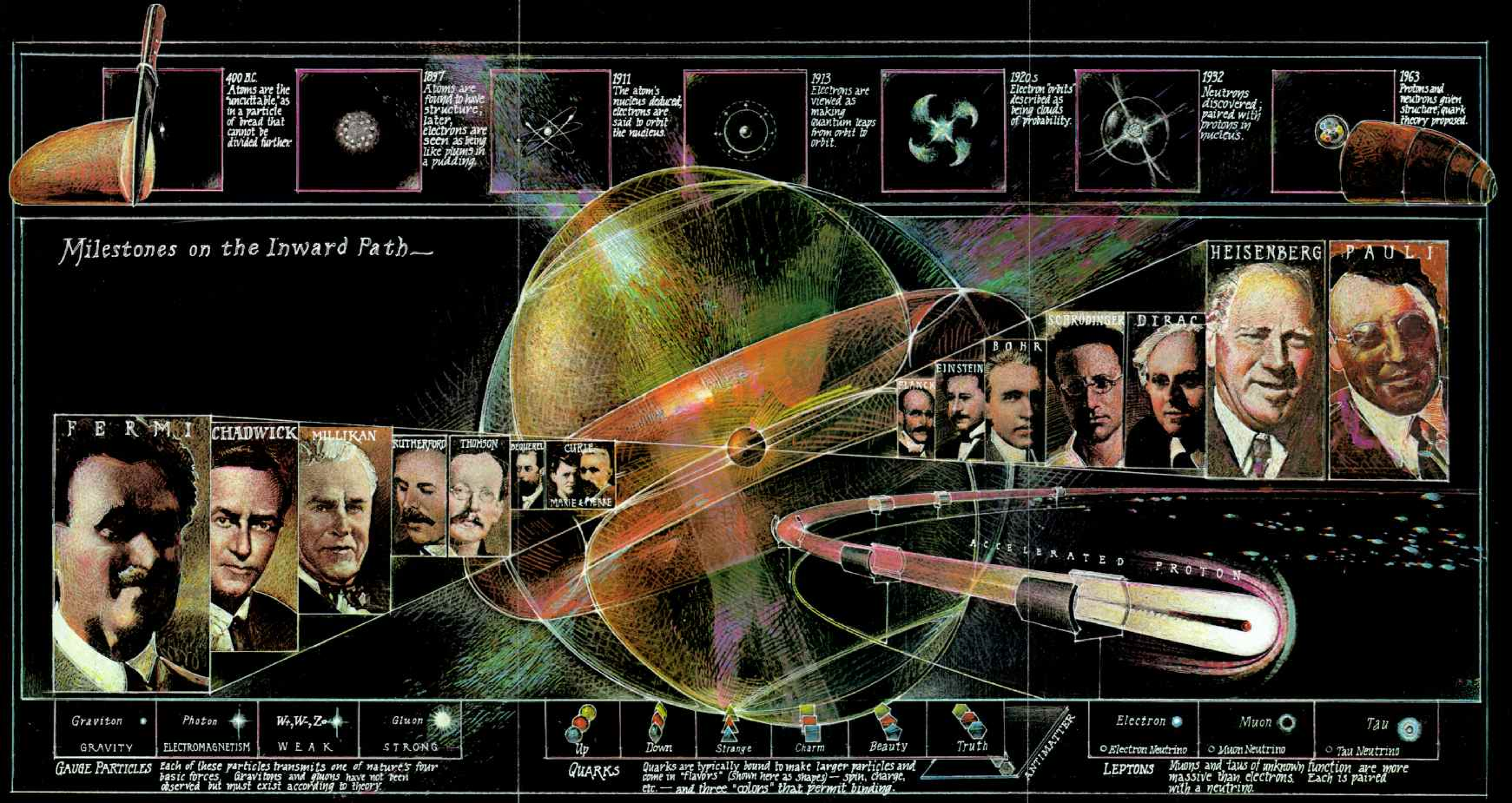
Ernest Rutherford beamed charged particles at gold foil. He observed that while most particles went through the foil, some bounced back. In 1911 he theorized that atoms must be mainly empty space with a small nucleus in the center. That being so, electrons must orbit the nucleus; yet wouldn't charged electrons lose all their energy and fall into the nucleus? In 1913 ***Niels Bohr*** proposed that electrons behaved in quantum fashion. They remained in fixed orbits and moved from one orbit to another—in quantum leaps—when they emitted or absorbed energy.

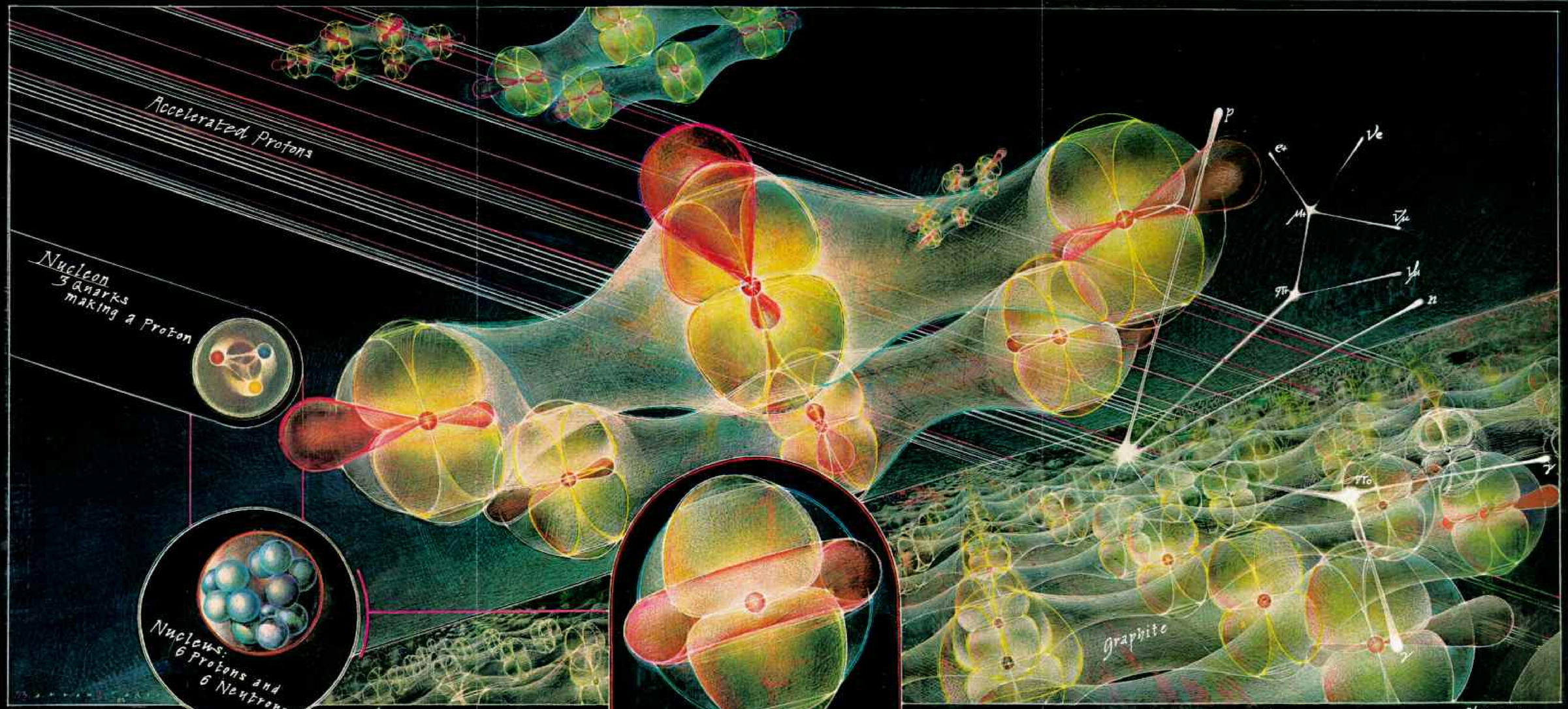
THE NEUTRON, the atom's last part until accelerators revealed more, was found in 1932 by ***James Chadwick.*** Theorist and experimenter were united in the person of ***Enrico Fermi,*** who studied electrons and gases before building the first fission reactor that led to the atomic bomb and nuclear power.

As quantum theory was developed, the very nature of reality seemed elusive. In 1927 ***Werner Heisenberg*** formulated the uncertainty principle: It is impossible (not just technically difficult) to measure simultaneously both the precise momentum and position of a subatomic particle. ***Wolfgang Pauli*** proposed in the exclusion principle that no two like electrons could occupy the same orbit, a theory necessary to understand the chemical bonds between atoms. Were electrons actually waves (an old debate)? ***Erwin Schrödinger***'s work suggested they were, but Max Born theorized that the wave idea was useful for describing the *probability* for an electron's location. ***Paul Dirac***'s mathematics predicted antimatter.

Taken together, these and other aspects of quantum theory postulate that observation not only affects reality but in a way creates it—we can choose to measure light as particles or as waves. Physicists now restrict subatomic particles to three families: gauge particles, quarks, and leptons. The desire for ultimate simplicity remains elusive. Niels Bohr is quoted as saying: "It is wrong to think that the task of physics is to find out how Nature *is*. Physics concerns what we can say about Nature."

Paintings by BARRON STOREY


400 B.C.
Atoms are the "uncuttable," as in a particle of bread that cannot be divided further.
1897
Atoms are found to have structure; later, electrons are seen as being like plums in a pudding.
1911
The atom's nucleus deduced; electrons are said to orbit the nucleus.
1913
Electrons are viewed as making quantum leaps from orbit to orbit.
1920s
Electron "orbits" described as being clouds of probability.
1932
Neutrons discovered; paired with protons in nucleus.
1963
Protons and neutrons given structure; quark theory proposed.
Milestones on the Inward Path
PLANCK
EINSTEIN
BOHR
SCHRODINGER
DIRAC
HEISENBERG
PAULI
FERMI
CHADWICK
MILLIKAN
RUTHERFORD
THOMSON
BECQUEREL
CURIE
MARIE & PIERRE
ACCELERATED PROTON
Graviton
GRAVITY
Photon
ELECTROMAGNETISM
W+, W-, Zo
WEAK
Gluon
STRONG
GAUGE PARTICLES
Each of these particles transmits one of nature's four basic forces. Gravitons and gluons have not been observed but must exist according to theory.
Up
Down
Strange
Charm
Beauty
Truth
ANTIMATTER
QUARKS
Quarks are typically bound to make larger particles and come in "flavors" (shown here as shapes) — spin, charge, etc. — and three "colors" that permit binding.
Electron
Electron Neutrino
Muon
Muon Neutrino
Tau
Tau Neutrino
LEPTONS
Muons and taus of unknown function are more massive than electrons. Each is paired with a neutrino.



Scale : within an atom

Collision : short-lived particles

INSIDE THE ATOM

TO HIT AN ATOM'S nucleus with a charged particle is something like playing pool in the dark on a table as big as Texas. The cue ball, a proton with positive charge, is shot at nearly the speed of light. The object balls, the positively charged nuclei of the target atoms, are scattered across an open landscape. Fortunately, the player can fire many cue balls at the same time. At least one of the object balls, the nuclei, will be hit by a proton. Scoring is done by observing what other subatomic particles are created out of the energy transformed into matter by the force of the collision.

In the painting, the cue ball proton, at far left, is made up of three quarks that orbit each other. (Their shapes here are not significant.) Directly below is the object ball nucleus of a solitary carbon-12 atom with its six protons and six neutrons. This nucleus is far too small to be visible at the center of the entire spinning atom, shown in the arched inset at lower center. The scale of proton, nucleus, and atom is depicted beneath the nucleus.

At the bottom of the arched inset, the orbits of the solitary carbon-12's electrons are: two electrons in the small red circle, one electron in the yellow double mushroom, one electron in the red doughnut, or torus, and two electrons in the larger blue circle. It is important to note that the shapes merely show "clouds of probability," where electrons are statistically most likely to be. An electron could be anywhere in or near the cloud. We now know that electrons do not orbit the nucleus in a two-dimensional plane as planets orbit about the sun. Orbit is a term left over from what has become an outdated view of atoms.

ATOMS ARE "MESSY" to our conventional way of thinking about objects. As described by the Heisenberg uncertainty principle and the whole of quantum theory, the kind of objects they seem to be depends on how we observe them. But by our observation we alter their states. (How can an elephant closely inspect an ant except by destroying it?) In proton pool, this is like being forever behind an eight ball that blocks total understanding. The strangeness of quantum reality has led some thinkers to speculate that reality is a meaningless idea and others to ponder mysticism. If the parts of atoms seem always elusive, their behavior is statistically predictable to a high degree of accuracy and is sufficient for detailed scientific study.

Atoms are not typically solitary, as in the inset, but are bonded into molecules by sharing electrons. Six carbon-12 atoms bond together chemically to make a graphite ring, shown floating above a great plain of such rings. This filmy structure may be thought of as the finely sharpened point of a pencil lead.

The floating ring shows the shared electrons as blue hourglasses and yellow butterflies. Not shown are other graphite rings that share the yellow butterflies and red lopsided dumbbells. Hourglasses, butterflies, and dumbbells are, as before, clouds of probability, thicker where the probability is greater, thinner where it is less.

PROTON CUE BALLS are streaking in diagonally from an accelerator pool shark. Most pass right through all the atoms. Only rarely does a proton strike a carbon-12 nucleus. When it does, the energy of the collision is transformed into a shower of very short-lived subatomic particles, which in turn decay into other particles. Their tracks are recorded in a detection chamber and classified as in the inset at near left. Carbon 12 is of particular interest, for its atomic weight has been established as the basis for the weights of all other atoms.

Now the game moves on to higher stakes—more powerful accelerators firing at more specialized targets. The tournament prizes? More profound knowledge of the very stuff of existence.

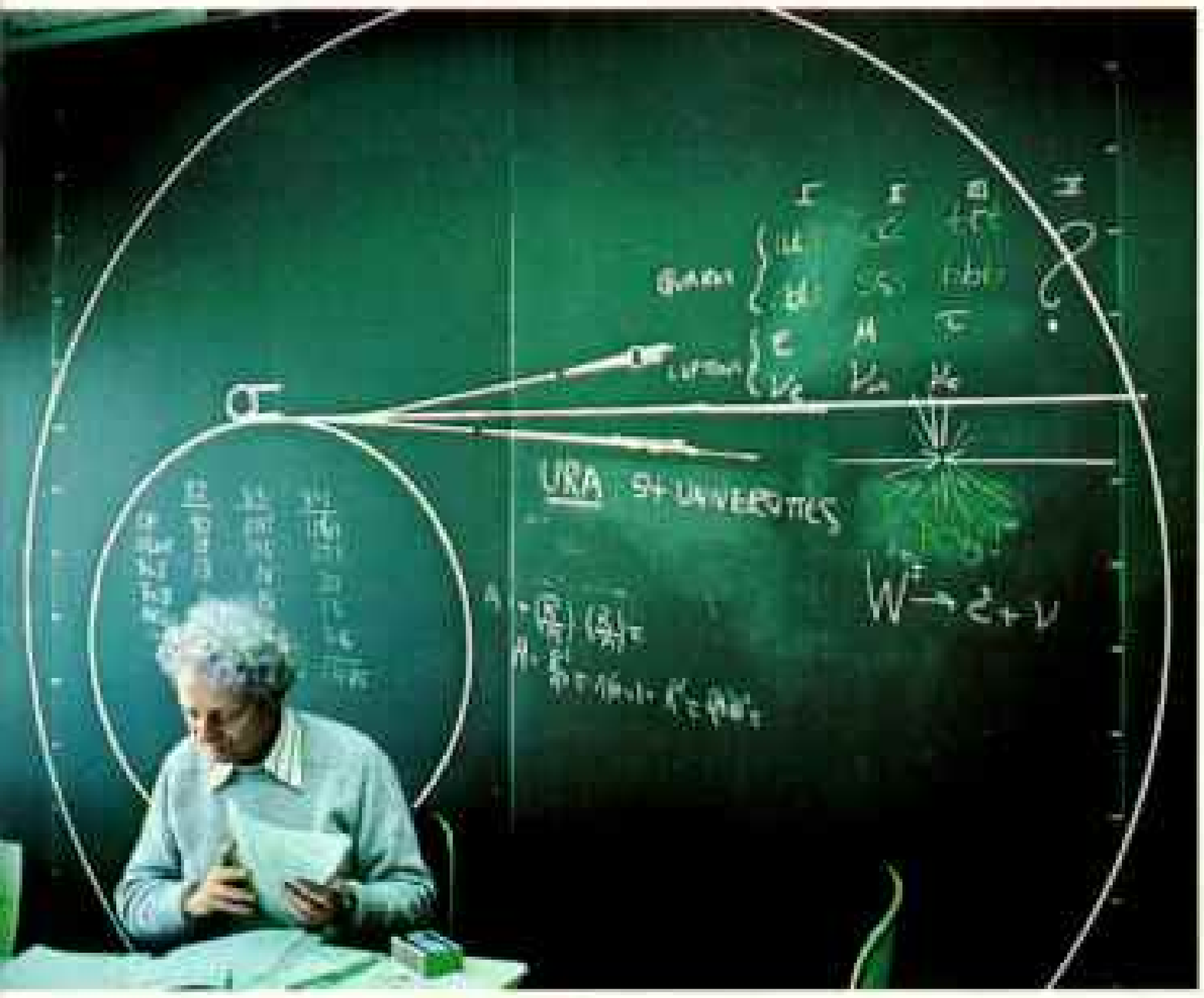
AN OUTBREAK OF QUARKS

"A PARTICLE ZOO" confronted physicists at the start of the 1960s. Dozens had appeared in accelerator experiments. This violated scientists' sense that basic atomic structure should be profoundly simple. In 1961 Murray Gell-Mann (**top left**) *proposed the "eightfold way," a scheme to relate particles by mathematical symmetries.*

This brought some order to the zoo and led to the idea of Gell-Mann's and, independently, of George Zweig's (**top right**) *that particle symmetries could be explained if each particle was made from yet more fundamental ones—"quarks" to Gell-Mann, "aces" to Zweig. At first it seemed there were only three.*

Ah, simplicity! But it was not to last. In 1974 Burton Richter (**bottom left**), *shown standing on the two-mile-long Stanford linear accelerator, and, simultaneously, Samuel Ting* (**bottom right**) *found evidence for a fourth quark. In 1977 Leon Lederman* (**center**), *now director of Fermilab, came upon a more massive particle, the fifth quark. And in 1984 evidence of the sixth turned up at CERN laboratory in Europe.*

Was that all, or was this another zoo in the making? And what of experiments by William Fairbank of Stanford (**right,** *at top*) *indicating that he may have corralled free quarks, as unlikely as unicorns according to current theory?*




CAUTION
RADIOACTIVE
MATERIAL

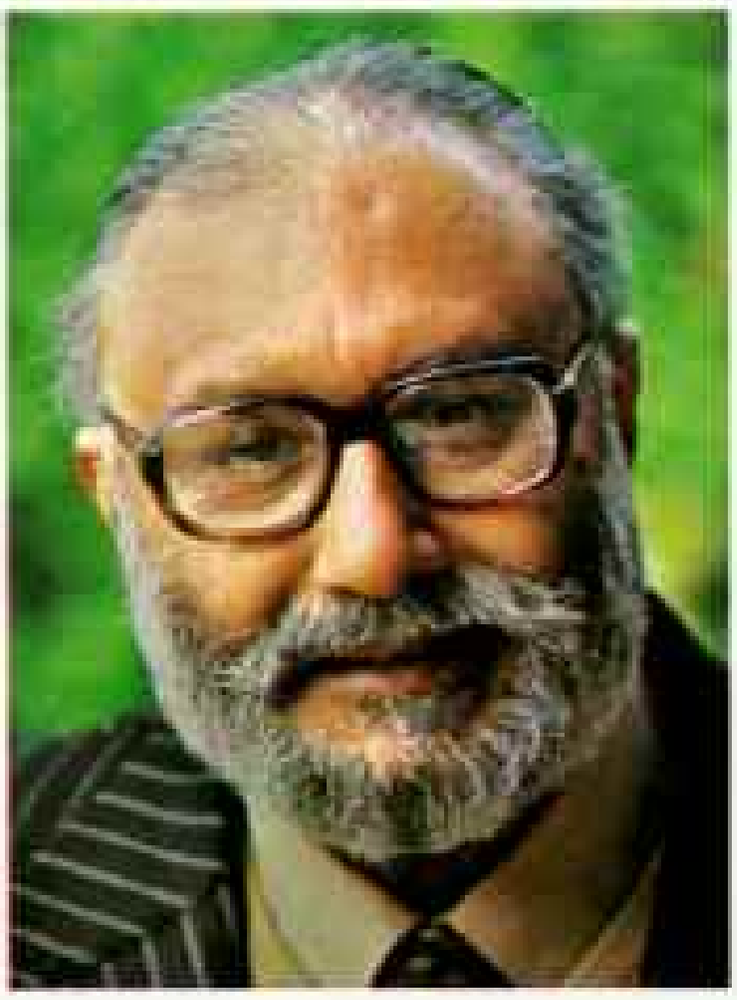
A UNIFICATION OF

FORCES

*AT THE BIG BANG, when time, space, and energy came into being, was there an essential unity to nature? Theorists think that before gravity separated at 10^{-43} second, it, the strong and weak nuclear forces, and the electromagnetic force were unified. As the universe cooled, the unity and symmetry of those interactions were broken one by one. First steps in reunifying them are by mathematical constructions called gauge theories. For their conceptual work in unifying the weak and electromagnetic forces into the "electroweak," Steven Weinberg (**top**), Abdus Salam (**center left**), and Sheldon Glashow (**center**) shared a 1979 Nobel prize.*

*Theory requires proof by experiment. CERN physicist Carlo Rubbia (**below**), whose personal energy is legendary, led a team that found the W and Z particles, which carry the weak force—Nobel-winning work.*

A problem: Big-bang energies can never be duplicated, yet experiments rely on applying ever more energy to the atom. Atoms are end products, born to a 10,000-year-old universe and far removed from big-bang conditions.



(Continued from page 641) peeling an artichoke. To reveal each layer requires increasing amounts of energy provided by massive atom smashers.

No two of these giants are alike, but there are two basic types. Some, like Stanford's linear accelerator near Palo Alto, California, fire negatively charged electrons at atomic nuclei. Two miles long and as straight as the laser beam used to align it, the accelerator hurls electrons at 99.99 percent the speed of light. But like the one at CERN, most accelerators are circular and use protons as projectiles. Protons are heavier and generate more collisions. However, collisions in an electron accelerator are easier to analyze.

Almost every American home has a primitive accelerator: the television picture tube. Inside it electricity heats a metal filament, boiling off negatively charged electrons and accelerating them through a positively charged wire grid. A magnet then steers them at the phosphorus-coated TV screen, which glows from the collisions.

In most high-energy physics labs the first step in accelerating subatomic particles depends upon an accelerator, invented in 1932 by John Cockcroft and Ernest Walton. It extracts protons or electrons from atoms of hydrogen gas.

In 1978 an elderly Ernest Walton visited Fermilab and inspected such an accelerator. Covered with metallic balls for discharging electrical energy, the monstrous contraption seemed fit for a horror movie, and as Walton looked on, it spat a huge bolt of lightning. "Ah," said the delighted Walton, "the machine knows its master."

The particles liberated by a Cockcroft-Walton accelerator are boosted to greater and greater velocity in copper chambers called radio-frequency cavities. Electric pulses fed to the cavities millions of times each second lift the particles to high energy and sweep them down an accelerator's beam line on traveling radio waves, like surfers riding a crest. In ring-shaped machines such as the CERN accelerator, electromagnets focus the particles into a pencil-thin beam and steer it in a circle. To prevent unwanted collisions with stray atoms, oxygen and other gases are pumped from the beam line tube, leaving it nearly as airless as the moon.

Particle physicists measure an accelerator's power in electron volts; the more electron volts that an accelerator produces, the deeper it can delve into the atom. One electron volt (eV) is about the energy gained by a single electron flowing from the negative to the positive end of a flashlight battery.

Slightly greater energies can strip electrons from atoms, but it takes millions of electron volts—MeV—to probe the nucleus. Energy a thousand times higher still, in the billion eV (or GeV, for giga-electron volt) range, is needed to propel particles with enough force to shatter protons and electrons and thus create new matter.

One way to boost energy is to fire two beams of particles in opposite directions around a ring, so that they slam together. This doubles the energy, giving the CERN accelerator, for instance, an energy of 630 GeV. Yet the attractive force binding together the constituents of protons and neutrons is so immense—trillions of trillions of times stronger than earth's gravity—that even the CERN machine can only pick and poke at the atom's inner structure.

"It's a bit like finding out how cars work by smashing them together and seeing what falls out," Dr. Carlo Rubbia told me at CERN, where he was on leave from Harvard. "But in particle physics, when you smash two cars together, you get 20 or 30 new cars, or even a truck or two. We're repeating one of the miracles of the universe—transforming energy into matter."

IN 1911 the New Zealand scientist Ernest Rutherford presented a theory that overturned the belief that the atom was solid and that set the stage for today's physics. It resulted from an experiment in which gold foil was bombarded with alpha particles, fast-moving helium nuclei. Most particles shot right through the foil, although a few—one in 8,000 or so—bounced back.

Rutherford's reasoning in solving this puzzle was perfect. Since most particles zipped through the foil, gold atoms must be mostly empty space, but with something small and hard in the middle—the atomic nucleus. His experimental method—similar to shooting bullets at a shrouded object and studying the ricochet to deduce what is inside—is still used in modern accelerators.

Rutherford had understandably pictured the atom as a tiny solar system. But by the start of World War II, physicists had sharpened their picture of the atom's structure. The atoms of all the elements then known were described as combinations of protons, neutrons, and electrons—held to be the fundamental building blocks of matter.

At the center of each atom, in this view, was a nucleus of neutral neutrons and positive protons, the number of protons identifying the element. The lightest was hydrogen, with one proton. The heaviest naturally occurring element, uranium, had 92 protons.

For each proton in the nucleus, there was a negatively charged electron, gyrating around the atom's core at a distance 50,000 times the diameter of the nucleus. If a hydrogen atom's nucleus were the size of a tennis ball, its electron would be two miles away.

Besides accelerators, particle physicists need detectors to record the collisions of subatomic particles. Among the first detectors were cloud chambers, in which particles from collisions swept through water vapor, leaving tracks of droplets that could be photographed for analysis. In modern bubble chambers, invented by physicist Donald Glaser, a liquid is used in place of water vapor. Legend has it that Glaser was inspired by watching bubbles form in a beer glass.

Detectors can be grand in scale. The Big European Bubble Chamber at CERN is a four-story steel tank holding more than 10,000 gallons of liquid hydrogen and neon chilled to minus 243°C (30° above absolute zero). I clambered atop the tank on ladders and catwalks resembling the superstructure of a battleship.

On top were four cameras. Chargeless neutrinos, debris from proton collisions in the accelerator, enter the bubble chamber, collide with hydrogen and neon nuclei, and create a spray of wildly scattering high-energy particles. In their wake the liquid begins to boil, and at that instant the cameras fire to record the particles' bubbly tracks.

Computer-controlled electronic detectors, which record signals generated by passing particles, are replacing bubble chambers. These detectors are sensitive enough to record an event shorter than the time it takes a particle to zip across a nucleus at virtually the speed of light.

"We can tell exactly what particles have been caught, by the direction and length of their tracks," Carlo Rubbia told me. He admits it's an Alice-in-Wonderland approach, "like trying to tell the color of invisible jerseys on invisible football players by watching the movement of the ball."

ONE OF THE MOST provocative ideas of modern physics arose from the 1928 equation of British theorist Paul Dirac, which predicted the existence of antimatter. Carl Anderson of the California Institute of Technology confirmed this idea in 1932, with his discovery of a positive electron, or positron, a particle just like an electron but with a positive rather than a negative charge. When matter and antimatter meet, they annihilate each other in a burst of radiation. Since Anderson's discovery physicists have shown that for every type of particle there must also be an antiparticle.

This quirk of nature has led physicists to speculate about encounters between the universe and an anti-universe. In a poem, Harold Furth, now director of Princeton's Plasma Physics Laboratory in New Jersey, imagines that Dr. Edward Teller, a creator of the hydrogen bomb, meets a Dr. Anti-Teller. In Furth's poem, "Their right hands clasped, and the rest was gamma rays."

Antimatter poses a mystery: If particles vanish when they meet their opposites, and if every particle can have an antiparticle, why is the world made only of matter? There appears to be no more than one part in ten billion of antimatter in interstellar space. Where has all the antimatter gone?

Physicists think they know: During the first split second after the big bang, there was a small excess of matter over antimatter. Particles and antiparticles collided, annihilating each other and leaving behind only radiation and the surplus matter. These residual particles make up almost everything in the universe today: stars, galaxies, the earth, and Edward Teller.

The two decades after World War II saw the blossoming of the atomic age, and to confident physicists full understanding of the atom, indeed, of the entire universe, seemed at hand. But larger and larger accelerators—most of them patterned after a

palm-size cyclotron proposed in 1929 by Ernest O. Lawrence of the University of California at Berkeley—constantly uncovered new particles. By the early 1960s dozens were known, a mélange that physicists began calling a zoo. There seemed to be no truly basic unit of matter.

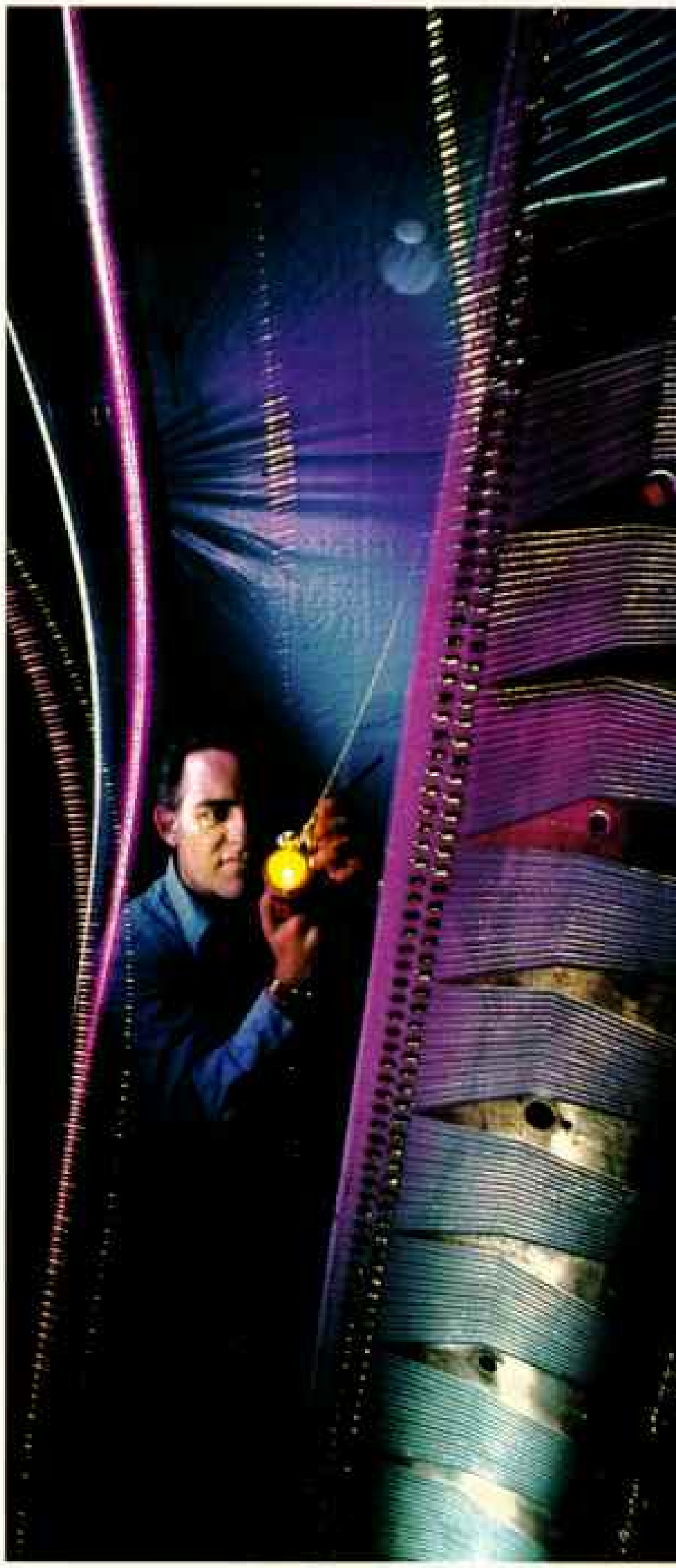
Order came to the zoo in 1963. Murray Gell-Mann at Caltech and George Zweig at CERN independently accounted for the newly discovered particles by theorizing that they were composed of three smaller building blocks. Zweig called them aces, from the expression: "Dealer's choice—aces are wild." Gell-Mann named them quarks.

"I liked the sound," Gell-Mann told me. "Later I read *Finnegans Wake*, by James Joyce, and came upon the line, 'Three quarks for Muster Mark!' There were three of them, and there were three particles in the proton. I knew the name was right." In 1969 the Nobel Committee awarded the physics prize to Gell-Mann for his work in classifying particles.

Gell-Mann's whimsical choice of the name quark set a trend. In order of ascending mass, the three quarks then known were called "up," "down," and "strange." These labels do not reflect relative position or eccentricity. They distinguish quarks according to their properties, including their electric charge—always plus or minus one-third or two-thirds that of a proton.

QUARK THEORY—since confirmed by experiment—restored simplicity to nature. The new particles and the two old members of the atomic nucleus—the proton and the neutron—could be explained as combinations of quarks, bonded together according to their "color." Color is a special property of quarks that enables them to join and form new particles. A quark's other properties, among them its electric charge, determine its "flavor"—whether it is up, down, or strange. A proton consists of two up quarks with a positive charge of two-thirds each and one down quark with a negative charge of one-third; together they yield a single positive charge. In the same way, one up and two down quarks combine to form a neutral neutron.

In 1974 a fourth flavor of quark was produced in accelerators. It appeared as part of



As if tuning an outsize harp, *Fermilab physicist Charles Brown inspects a panel of glass embedded with fine wires to detect pions. These short-lived particles, with positive, negative, or no charge, are quark/antiquark pairs that help carry the strong force between protons and neutrons to bind them in the nucleus.*

a meson, a high-energy embrace of quark and antiquark that lasts only an instant before ending in mutual annihilation.

"Most of us had assumed there were just three quarks. We weren't looking for more," said Samuel Ting of MIT, in charge of an experiment at Brookhaven National Laboratory. Ting shared the 1976 Nobel Prize in Physics with Burton Richter, who had led a similar experiment at Stanford.

The fourth quark's existence had been predicted by Sheldon Glashow, a Harvard theorist who christened it a "charmed" quark. Fanciful classification continued in 1977, when Leon Lederman and a Fermilab team discovered a fifth quark called "bottom" or "beauty."

While the up and down quarks make up protons and neutrons in our everyday, low-energy world, the other quarks exist only at extremely high energy, such as is found in the biggest accelerators. In 1984 CERN announced that colliding beams of protons and antiprotons had produced evidence of a sixth quark—"top" or "truth." Some physicists hope that it is a final truth.

However many flavors of quark there are, one oddity stands out about these subatomic particles: It seems impossible to jar loose a single quark from a proton or neutron. Quarks apparently exist only in trios or in quark/antiquark pairs.

This trait, called confinement, inescapably binds single quarks together. "Remember energy is matter and matter is energy," Sheldon Glashow told me. "When you throw energy at a proton in an effort to shake loose one quark, you create quark pairs out of the energy from the accelerator."

Glashow and other theorists remain skeptical of the provisional announcement in 1977 that William Fairbank, an experimental physicist at Stanford, had found something that looked like a free quark. I visited Fairbank in his lab, a clutter of pipes and wiring that resembles an illegal distillery.

Genial and bespectacled, Fairbank said he and colleagues had found quark-like electric charges in dust-mote-size spheres of niobium metal levitated by magnets. Fairbank believes he has detected these charges in units of one-third in at least four test balls. "This means it's possible for fractionally charged particles, perhaps quarks, to exist free in nature," Fairbank said.

Fairbank's presumed find has set off a worldwide rush to hunt free quarks. His supporters suggest that a few quarks escaped confinement the instant after the big bang, and that Fairbank has trapped some of these free-spirited particles—spares at the creation. But firm evidence of a solo quark remains elusive, leaving most physicists certain that lone quarks are locked forever within larger particles. Proclaims Murray Gell-Mann: "I don't believe Bill Fairbank has found a free quark, but if he has, it's one of mine."

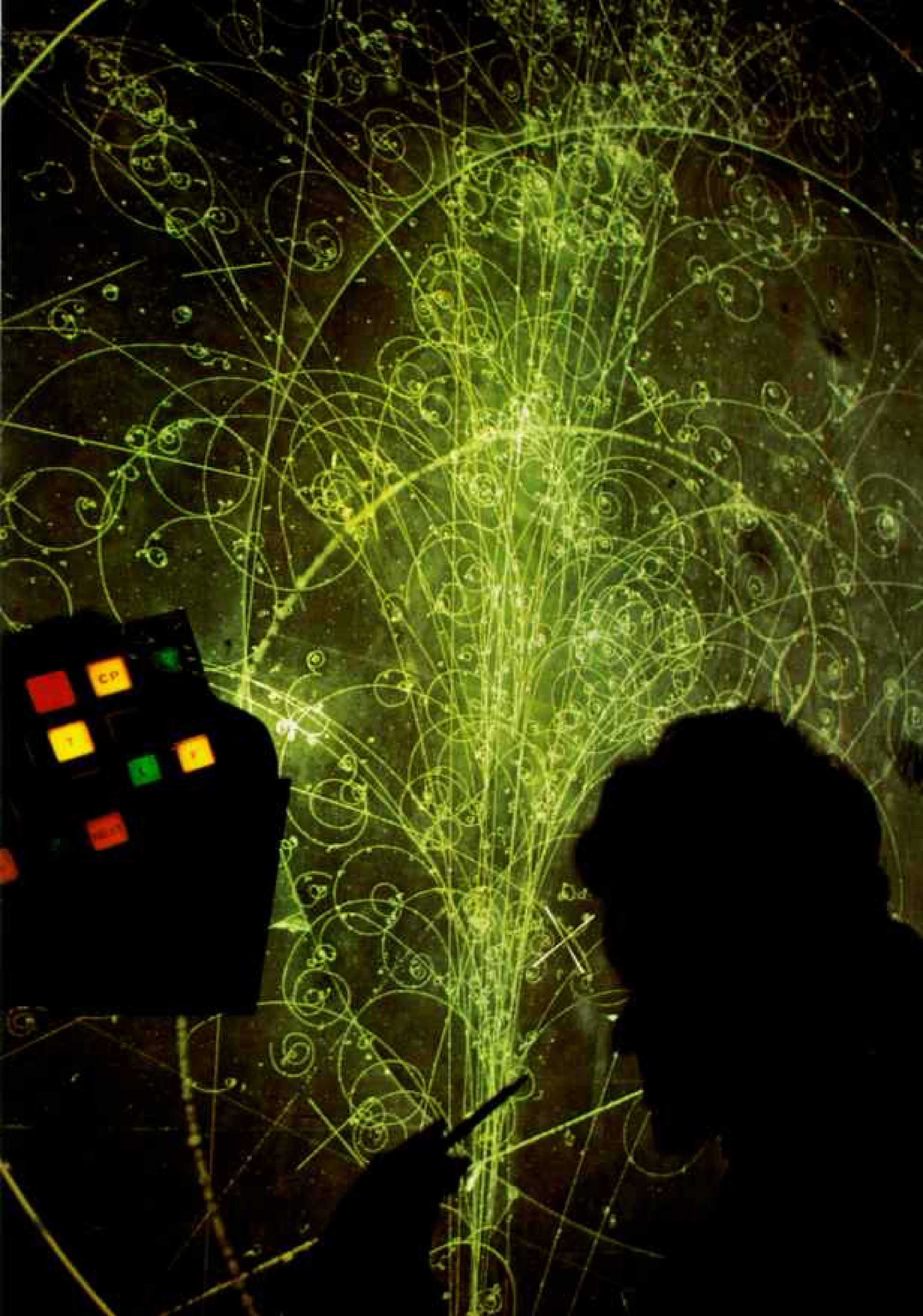
NEARLY ALL the several hundred known subatomic particles are made of quarks, bound together by what physicists call the strong nuclear force. The exceptions are called leptons, Greek for "slight."

The best-known lepton is the electron, first identified in 1897. As electric current, electrons put us in daily contact with the subatomic world and are the only leptons vital to the atom's structure.

Physicists are not sure why two other leptons even exist. Muons, discovered in 1937, have about 200 times as much mass as electrons and are the major by-product of the cosmic radiation that constantly bombards earth. Far heavier and equally furtive is the tau, a lepton discovered in 1976. Like the electron and muon, it carries a negative electric charge.

The other leptons are neutrinos—"little neutral ones"—that carry no charge and are so light that their mass, if any, has so far gone undetected. Each of the neutrinos seems to couple with a heavier partner—a tau, muon, or electron. Scientists are still searching for the tau neutrino.

Particle-track pyrotechnics *from a bubble-chamber detector flash on a screen at CERN. Debris from subatomic collisions leave distinctive wakes. For instance, electrons and positrons spiral tightly in opposite directions. Computers now sort through such jungles of tracks to pinpoint results significant to experimenters.*



Drasko Jovanovic at Fermilab told me that because neutrinos react only very weakly with other matter, they whip through everything. Several million neutrinos, traveling at the speed of light, are flying through your body at this instant. "Nothing stops them, not even a slab of lead as thick as the earth," said Jovanovic. "It's been suggested that beams of neutrinos passing through the earth be used for communication. It could work, but it would be expensive."

Meanwhile Jovanovic participates in a five-million-dollar experiment to determine if neutrinos have mass. If they do, they could account for as much as 90 percent of the mass of the entire universe since, ghostlike, they fill the cosmos.

Most physicists believe that the six leptons and the six flavors of quarks account for all matter, although a few theorists toy with the idea of particles more fundamental yet. The universe also contains force carriers called gauge particles.

Carlo Rubbia began capturing certain gauge particles at CERN in 1982 and 1983. "They're little beasts we call W's and Z's," says Rubbia, an animated Italian. "We've been on their trail for years." W and Z particles exist for less than a billionth of a billionth of a second and more often than not spend their brief lives within the nucleus, where they cause radioactive decay in atoms of such elements as uranium.

Rubbia commands a 20-million-dollar electronic detector built specifically to find the W and Z particles. Big as a house, the detector is a vast network of coaxial cables and battleship-gray steel plates straddling a

section of CERN's main accelerator where protons and antiprotons collide. The charged particles liberated by these collisions streak through the detector's gas atmosphere, generating trails of tiny signals. Their tracks appear on computer screens as V-shaped patterns, the arms of the V indicating where one particle has decayed into two or more other particles.

"We don't actually see the particles. Their lives are too short," Rubbia told me. "But decay products from W particles, for instance, fly predominantly forward. When we see this, we know we've got one."

For his pioneering work Rubbia shared the 1984 Nobel Prize in Physics with CERN colleague Simon van der Meer.

The W and Z particles carry the weak force, one of three forces governing the behavior of atoms. The weak force breaks down each neutron in the nucleus of a radioactive atom into a proton, an electron, and an antineutrino. Other gauge particles, called photons, impart the electromagnetic force, about 100,000 times more powerful than the weak force. The electromagnetic force is responsible for keeping electrons in orbit around the nucleus, making atoms—and this magazine—seem solid. Most powerful of all—a hundred times more powerful than the electromagnetic force—is the strong force. Carried by gluons, it holds together the atomic nucleus.

Besides these three forces, the other known force at work in the universe is gravity. It is by far the weakest—the strong force is some 10^{38} (1 followed by 38 zeros) times more powerful. A still undetected particle, the graviton, may be the carrier of gravity, which has no meaningful role inside atoms. Without gravity, however, there would be no universe, since it binds together stars and galaxies, holds the earth in orbit, and keeps our feet planted on the ground.

MIDWAY in the seven-mile auto tunnel that cuts through the Alps between Italy and France, the air is rank with auto exhaust. In a cavern just off the smoggy roadway, shielded from cosmic radiation by the bulk of Mont Blanc, a special detector is testing whether the proton decays like most other particles, an idea that two decades ago would have been considered scientific heresy.

In the 19th century the Scottish scientist James Maxwell discovered that electricity and magnetism are two aspects of the same force. Today some physicists believe that the universe's four forces are but manifestations of a single and deeper force. In the past two decades these scientists have proposed mathematical explanations—"grand unified theories"—of how the weak force, the strong force, and the electromagnetic force

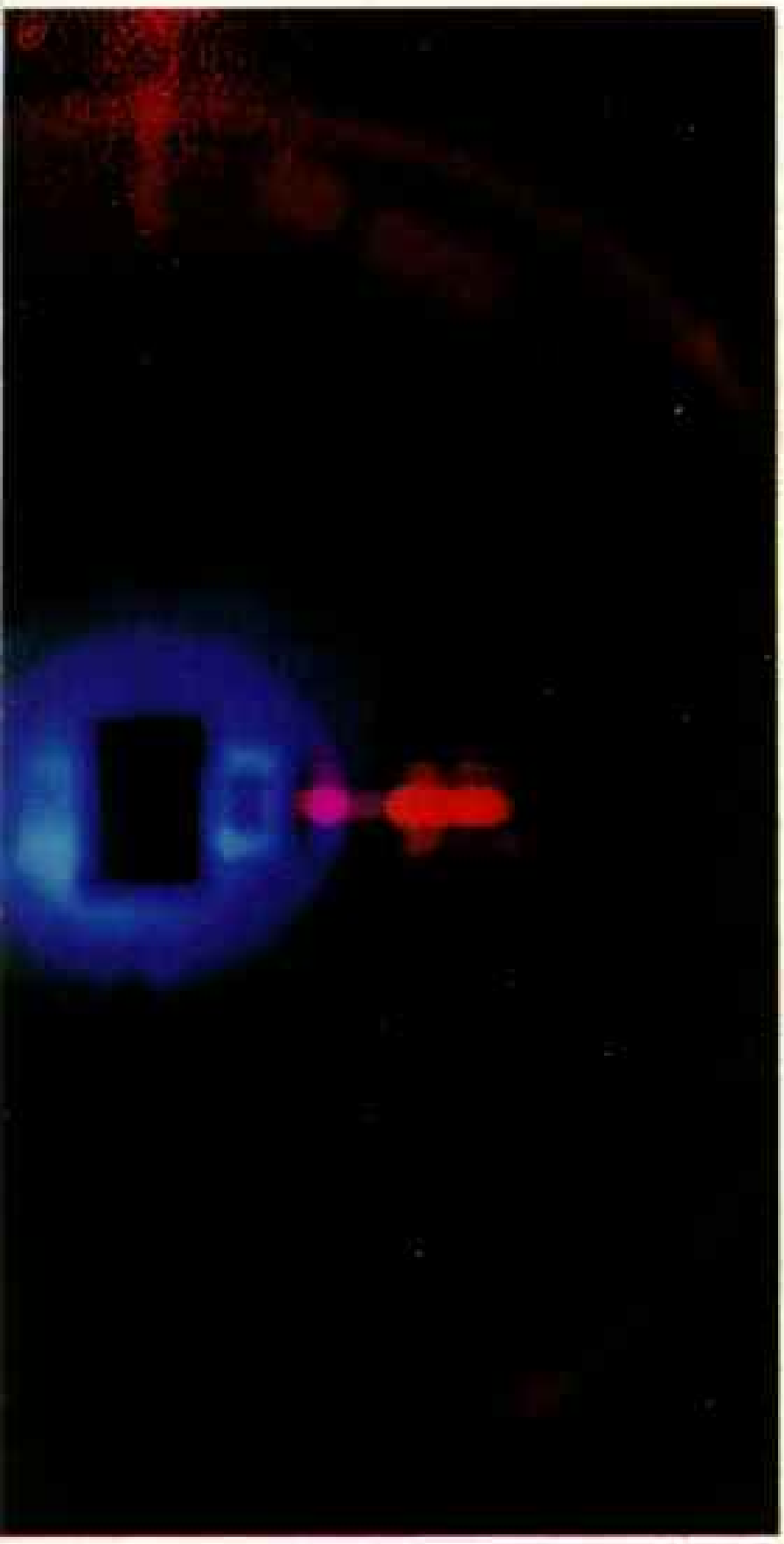
***Round-the-clock shifts** are the norm at Japan's KEK laboratory. Ryuhei Sugahara adjusts a vacuum chamber, part of an apparatus that uses soft X rays to study atomic crystal structure and advance communications technology.*

may be entities of a single underlying interaction.

None of these theories yet embrace the universal fourth force, gravity. But they do predict that protons decay into other particles, because the strong force that binds a proton together and the weak force that causes radioactive decay may spring from the same basic interaction. The grand unified theories also predict that an average proton would take a million trillion trillion years or so to decay—more time than has passed since the universe began. How can short-lived humans hope to measure the life span of such a durable subatomic particle?

"Obviously we can't wait billions of years to watch one proton and see if it disappears," Italian physicist Pio Picchi told me deep inside Mont Blanc. "But we can assemble immense numbers of protons and see if one decays during a one-year period." If protons do indeed decay, then at least one should die during the course of the year.

Picchi keeps watch on the hundred million trillion trillion protons in a 150-ton stack of iron slabs. These are fitted with thousands of detectors similar to Geiger counters, each waiting to pick up an infinitesimal burst of radiation emitted by a dying proton. So far at least one candidate event has been noted, the



APPLICATIONS FOR THE FUTURE

MOST MICRO OF ALL SURGERY is the technique of beaming subatomic particles at cancer cells. Barbara Bennett of Fermilab takes the part of a patient about to undergo treatment. The plastic chain-mail helmet immobilizes the head. The photons of a laser position the patient in line with a neutron beam produced by a linear accelerator. In actual treatment the beam would emerge from the area highlighted in blue.

Certain cancers resistant to X rays are sensitive to chargeless neutrons. Neutron therapy is slowly moving from the nuclear laboratory setting to the more widely available setting of hospitals.

The technology of superconductivity, which eliminates resistance to electric current at low temperatures, has been advanced by Fermilab's ultracooled magnets. It has potential applications in energy transmission, fusion research, separation of ores, and designs of new generations of computers that can process immense amounts of data at ever faster speeds.

While the descent into the atom has produced the bomb, it has also brought forth a variety of applications that have become useful tools of contemporary life: Transistors and microchips, timepieces as cheap as a digital watch or as expensive as the kind of atomic clock that confirmed Einstein's hypothesis—a moving clock runs slower than one at rest.

possible decay of a proton into a muon and another particle called a kaon.

Similar experiments in the United States, Japan, India, and France have yet to deliver results, forcing theorists to rethink their grand unified theories. But if proof is found that protons decay, it will mean that matter is inherently unstable. It would also prove what poets have said all along—that nothing lasts forever.

Besides predicting proton decay, grand unified theories attempt to trace the history of the universe back to its creation in the big bang some 15 billion years ago. Since then the cosmos has been constantly expanding. Today the visible universe is growing every second by a volume equal to that of the Milky Way galaxy.

During the 1930s astrophysicists realized that the particle reactions that other physicists were studying in cyclotrons were identical to those occurring in stars. Today physicists of both stripes have joined forces to theorize that all matter was born at the big bang.

In the extreme heat of that instant all four forces, including gravity, may have been unified as one. Then, as the universe cooled, the forces split apart and their underlying unity became obscured.

NO ACCELERATOR will ever match the energy released in the big bang, and some physicists once thought it might be a waste of money to build bigger machines. However, Sheldon Glashow says: "We will find nothing if we do not look. We theorists are dependent upon experimental discoveries. Without them we are no better than medieval theologians, who endlessly debated how many angels might dance on the head of a pin."

Theorists like Glashow work in a delicate balance with experimentalists to uncover the hidden unity linking the three basic forces to gravity. Says avowed experimentalist Carlo Rubbia: "Theorists tend to forget that every time we look someplace new with a bigger machine a surprise awaits us."

Experimentalists like Rubbia prevail for the moment at CERN, and they are building a new accelerator 17 miles in circumference. The mammoth machine will cost half a billion dollars, a remarkable investment considering that in its lifetime it will propel less than a gram of matter.

At Fermilab in Illinois, physicists have doubled up by constructing a new accelerator ring inside the tunnel housing their first machine. Eventually the newer accelerator will boost protons and antiprotons to a colossal collision energy of two trillion electron volts as they travel a circuit equal in distance to five round-trip journeys to the moon, 2,400,000 miles. Even more ambitious is the accelerator, perhaps 100 miles around, that U. S. scientists want to build. It would dwarf Fermilab's four-mile accelerator, visible from 500 miles in space.

Perhaps the biggest obstacle to such mega-engineering projects is the shrinking federal science budget. "We practically have to beg for money," says Fermilab director Leon Lederman. CERN, a comparable laboratory, enjoys about twice as much funding as Fermilab. Lederman and other American particle physicists fear that tight budgets may cost the U. S. its traditional lead in the exploration of the atom.

Money-conscious federal officials often ask Leon Lederman why the U. S. needs costly machines that cannot help solve pressing social problems. His answer never varies: "Learning about the ultimate nature of matter is of fundamental importance to the human race. It gives us a vision of ourselves, who we are, where we are going."

Physics has always drawn powerful intellects and personalities, such as Murray Gell-Mann, who with Lederman and others has

An exaltation of quarks *in Chicago was inspired by work at nearby Fermilab. Art is imitating art. By drawing order and unity from apparent chaos, scientists sound the underlying harmonies that score the universal dance.*

set the pace of particle research for three decades. Small and intense, with steel-gray hair and penetrating eyes, Gell-Mann's mind encompasses quarks and proton decay as easily as mushrooms or obscure languages, two of his other numerous interests. I asked him one day if physicists were not profoundly arrogant to think that they could explain the origin of the universe and everything in it by using only accelerators, telescopes, and equations.

"We believe," he said, "that our calculations are essentially correct and that we are on the edge of fully understanding the atom as well as the beginnings of the universe. It's a little like the ant contemplating the skyscraper, isn't it?"

And where will an understanding of the universe's deepest secrets lead us? "There will be new technology, certainly," Murray Gell-Mann went on. "But most remarkable will be that a handful of beings on a small planet circling an insignificant star will have traced their origin back to the very beginning—a small speck of the universe comprehending the whole." □

A Short Hike With
BOB MARSHALL

By MIKE EDWARDS
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by DEWITT JONES

THE BANCROFT LIBRARY, UNIVERSITY OF CALIFORNIA

TAKE 30 STEPS, or maybe 20, then stop and gulp air. Then try for 20 more. First days on a long trek are agony for me. My pack is too full, my muscles too flabby.

On this first day, at the edge of the Bob Marshall Wilderness in Montana, the trail seemed to reach for sky. In truth, the topographical map showed a moderate climb—2,000 feet in three miles—but I felt my 60-pound pack down to my toes and wondered if each digital tingle forecast a blister.

I can imagine ascending these switchbacks with Bob Marshall. He'd be freighted with a canvas pack heavier than mine. He'd be wearing sneakers, which he liked because they were light and dried quickly. I'd note his belly—Bob had a round one—and wonder if he were in no better shape than I. He'd settle that. Breezing past, he'd shoot a grin and exclaim, "Gee, this is swell!"

There were nine of us who set out on this trek at the end of summer. Ten, if you count relentless, irrepressible Bob, whose love of wilderness surged like the ridges we were to cross. He rejoiced in plunging into vast regions like this precinct of the Rockies, where time (as he would say) is measured not by the hour but by the century. He'd start early and log 35 miles by nightfall. After dinner he might take a short walk, just to round his mileage off at 40.

To colleagues he was seldom "Dr. Robert Marshall"; he didn't flaunt his Ph.D. Though blessed with family wealth, his

*"**I yearned for adventures** . . . of Lewis and Clark." In Alaska about 1930, Bob Marshall (**above**) found them. His work to preserve pristine lands is commemorated by Montana's Bob Marshall Wilderness, slashed by the Chinese Wall—prime example of Overthrust Belt geology that beckons oil and gas hunters.*

Aspens of autumn *gild the Bob Marshall Wilderness near the Sun River's North Fork. Outfitter Max Barker rides by a salt lick frequented by deer and elk.*

The indefatigable Marshall, forester, author, and millionaire socialist, trekked the Adirondacks of his native New York, the Ozarks, southwestern canyonlands,

and throughout the West. In all, he hiked 30 or more miles a day some 250 times. A founder of the Wilderness Society, first recreation chief of the U. S. Forest Service, he helped preserve millions of acres in his busy, short life; he died at 38 in 1939. Created a year later, this wilderness is widely revered as "the Bob."

pleasures were simple. He never owned a car. He was addicted to keeping records—records of baseball, an early love. Records of his hikes, of *anything*. Once it was the profanity of lumberjacks—in ten conversations "an average of 136 words, unmentionable at church sociables, were enunciated every quarter hour."

Hot-gospeler of the primeval, he strode through the 1930s exhorting public officials to save the wild. In this role he was partly responsible for the preservation of 5.4 million acres. As the first recreation chief of the U. S. Forest Service he drew up regulations giving wildland greater protection from the bulldozer and the ax. Thus he was a crucial player in the chain of events leading in 1964 to the Wilderness Act, which today shelters 88.5 million acres "untrammeled by man."

Bob had other achievements—all tumbled into a brief span of years. His most productive time measured just a decade. He was only 38 when he died in 1939.

* * *

OUR WILDERNESS TRIP would be a leisurely one of 80 miles in 13 days—not even close to Bob's speed.

That first day's ascent to Headquarters Creek Pass, a blade of limestone—ancient seabed now hoisted 7,743 feet above the oceans—proved easy for the three Montanans who guided us. Once on a winter outing I had marveled at the ease with which Bill Cunningham trod snow; I was surprised he made tracks. Lester Loble II, like his father, had led many mountain expeditions. Ellie Arguimbau, though decidedly feminine, holds a black belt in karate.

Ruth Young caught her breath and exclaimed, "I'm leaving the world behind for 13 days!" Dedicated hikers, Ruth and her friend Jean Bangham had traveled from Oak Ridge, Tennessee, to go on this trek. We three, in our 50s, were the seniors. "I'm not fast," Ruth said, "but I have endurance." She also had, as we would learn, a touch of class. The rest of us bore trail grime like a second skin. Emerging from her tent wearing lipstick and powder, Ruth dazzled and delighted us.

Jean proved as sturdy as her friend. "She's like a machine on the trail," said my tentmate, Tom Robinson, from Boise, Idaho. "Her legs just keep churning."

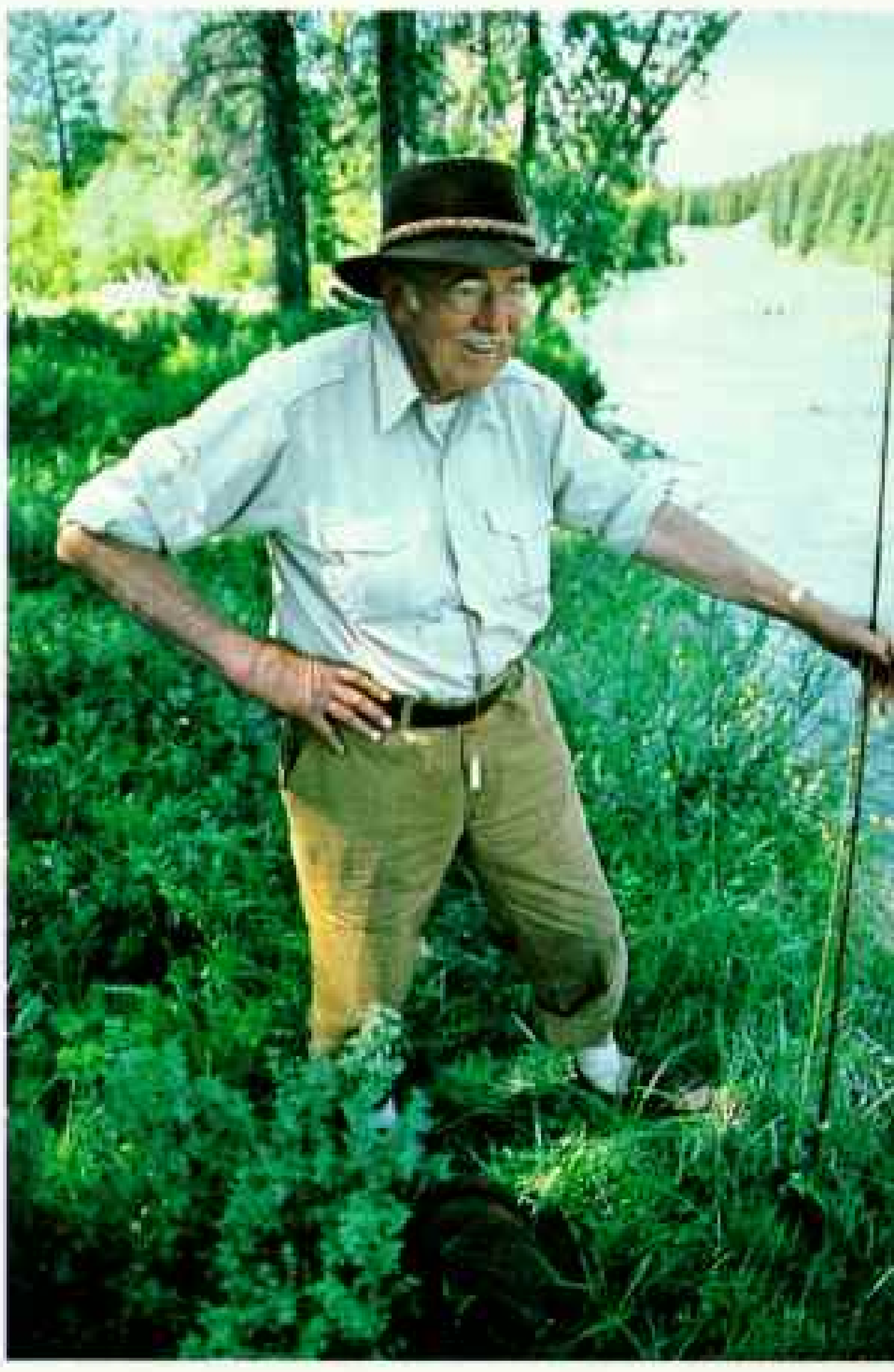
Norman Eshoo, a physician, and his wife, Judy Haynes, a nurse, came from Bismarck, North Dakota, and would administer first aid if needed. Suffering in new boots, Norm trod as if trying not to break eggs, and mostly ministered to his own distress.

The sprawl of the Bob Marshall Wilderness, designated a year after Bob's death, would have pleased him. Bigger than Rhode Island, it encompasses a million acres in two national forests, the Lewis and Clark and the Flathead. North and south, it is joined by two other protected wildernesses, the Great Bear and the Scapegoat (map, page 691). This makes nearly two Rhode Islands—though it is a mere dab in Montana, the fourth largest state. Farther north, Glacier National Park has been largely spared man's imprint. Boundaries of these wildernesses touch another 878,000 roadless acres, mostly national forest, and produce, finally, a pristine tract larger than Yellowstone National Park.

On the edge of this immensity we felt an almost giddy euphoria. A mile south, Rocky Mountain Peak hurled its 9,392-foot summit eastward toward the plains. Many peaks and ridges in "the Bob," as Montanans call the wilderness, seem so inclined. Great slabs of earth's crust, they were pushed up and over the crust to the east millions of years ago. To geologists this is part of the Overthrust Belt that reaches from Alaska south into Mexico.

We spiraled down and threaded a valley dark with conifers. The day's hard work was behind now; eight miles farther, when we dropped our burdens on gravel by the North Fork of *(Continued on page 674)*

Shinnying a snag *over Bear Creek, Rosemary Rowe gets a shove from her husband, Ed Madej. Of 25,000 annual visitors to the Bob, 57 percent shoulder backpacks; the rest ride horses or raft the Flathead River's South Fork. Ed is a vice president of the Bob Marshall Alliance, 31 groups united to expand the wilderness.*



Wilderness gathering *in the Bob unites the Prud'homme clan and friends from Connecticut to British Columbia. With Keith Shaw* ***(above)****, a naturalist with Klick's K Bar L Ranch of Augusta, Montana, outfitters since the 1920s, they rode to the Chinese Wall. Gear was stowed aboard "the most beautiful pack mules you ever saw," says Hector Prud'homme* ***(right)****, whose flies capture cutthroat and rainbow trout. A campfire works marshmallow magic for grandson Anthony* ***(above right)****, while mountain air seasons lunch* ***(left)****.*

Those fleeing backcountry congestion are seldom disappointed. A study found that campers encounter an average of only one other party a day—in line with Marshall's desire for space enough for a traveler to spend "a week or two . . . without crossing his own tracks."

Engines are banned *in a million acres of solitude encompassed by the Bob, which straddles the Continental Divide. Alpine slopes of Engelmann spruce, larch, and whitebark pine descend to valleys such as that of Monture Creek* ***(left)****, a proposed addition. The Bob and adjacent lands shelter some of the nation's most vital wildlife populations, including grizzly bears, elk, mountain goats, bighorn sheep, and a few Rocky Mountain wolves. Wildflowers such as elk thistle* ***(right)*** *adorn meadows at times carpeted with snowy stands of blooming bear grass. Reward for a long day on the trail, a sunset highlights a phenomenon called wave, or lenticular, clouds* ***(above)****, partly created by strong winds blowing perpendicular to a mountain range.*

Marshall saw land later included in his wilderness in 1928 on a 288-mile hike made at a typical clip of 36 miles a day.

the Sun River, we had descended 2,500 feet. Such is the roller-coaster pattern of crossing the Bob.

Tents bloomed and packets of freeze-dried food came out. We weighed each in our hands—chili mac against chicken chow mein, brown Betty versus rice pudding—and demolished the heaviest first.

* * *

Bob, who possessed a good streak of mirth, probably would have urged us to try "broiled" eggs—eggs boiled, then fried. In his first Forest Service job, fresh out of forestry school at Syracuse, he served them to colleagues. When forked, they bounced off the plates like golf balls.

Though born in New York City, Bob was a child of wilderness—and an image of his remarkable father. Louis Marshall was the son of immigrants from Germany (where the name was Marschall). Prospering at law, he devoted much of his energy to the civil liberties of blacks, Jews, Indians, and others outside the mainstream. His wide purview also included the protection of New York's Adirondack Forest Preserve. Foreshadowing Bob's life mission, Louis helped draft a constitutional guarantee to keep state lands in the Adirondacks forever wild.*

Into that leafy upstate domain the Marshalls repaired each summer—to a comfortable home on Lower Saranac Lake that the family referred to as a camp. Here, statistician Bob recorded, he played 130 baseball games in eight years, and batted an impressive .706 in 1919.

And he walked. On an August morning Bob and his younger brother, George, set out to describe a great circle. They returned late at night.

"Bob in his inimitable way calculated that we'd only gone 58 miles," remembers George, now 81 and a resident of London. "So we walked out a mile and back on a road to get two more."

George let me examine the penciled sheets on which Bob cataloged his Adirondack summers—60 hikes of 30 miles and more, most miles in two days (88), most miles carrying a pack basket (34). Some of his entries were devoted to beauty—favorite flowers, prettiest lakes—but many reflect challenge.

"Bob tried to make new records for himself all the time," James Marshall told me. Bob's older brother, James, at 88 still practices law in New York. "These weren't records against anybody else; they were records for himself, of himself."

He was a shy lad, "desperately shy," a friend remembers. Perhaps physical achievements compensated for the discomfort he felt outside the family circle. And perhaps in hiking and climbing he gained the confidence that marked his later years.

Presently his records included standing atop all 46 Adirondack peaks that rose 4,000 feet or higher. He set a goal of walking 30 miles in a day in every state. When a train carrying him west was stopped by mud and rock, with a 10-hour delay in prospect, Bob got off and notched Iowa. Record keeper, record maker—that was Bob.

* * *

WE DAWDLED by the North Fork of the Sun, immersed in solitude. Morning brought a little rain, a little snow, then sunshine; at summer's end this is a country of multiple weathers.

Bill and Ellie fished the Sun, a favored trout stream, and returned with cutthroats enough for all. Night transformed the tall conifers around our camp into phalanxes of sentinels, clasping us under a sky dazzling in the brilliance of its spangles.

Onward. Across the river we entered a forest so thick as to seem solid. Trees rasped against one another in the soft wind, scratching one another's back. Now and then a squirrel fussed at our intrusion. Otherwise, silence, awesome silence, one of the wonderful gifts of the Bob.

The tunnel that was our trail had been heavily used—elk, deer, and coyote tracks abounded. At noon we caught up with Tom, who had ranged far ahead. "I thought I'd wait for the rest of you," Tom said, nodding toward bear tracks, large and fresh.

Wildlife experts say the animal population of the Bob and adjoining lands is one of the greatest in the lower forty-eight. But the future of this marvelous agglomeration is by no means secure. (See the article beginning on page 690.)

*Anne LaBastille wrote of "My Backyard, the Adirondacks," in the May 1975 GEOGRAPHIC.

We followed the bear's tracks for a mile. The sun vanished and the rising wind warned of change. Bill wanted to make My Lake, near the bluff called the Chinese Wall. He reckoned the distance at 14 miles.

I think it was 40. This became a day of misdeeds. I lagged, needing rest. At one of those rest stops I forgot my gloves. I didn't miss them until, a couple of miles farther on, I realized my hands were cold. Not only that: My whole body was cold. Wearing too many clothes, buttoned up tight, I was drenched with sweat.

The sky poured out big flakes that obscured all. The trail inclined; we had a 1,500-foot ascent. I remember a figure appearing in swirling white and saying we still had a mile and a half to go. Finally, My Lake. Tom and I managed to get our tent up, but by then I was shivering so badly that I could not strike a match.

"The first stage of hypothermia," Bill diagnosed my condition. I despised him, and all my other companions. They were so chipper, so *warm*. They redeemed themselves by building a roaring fire and pouring into me three cups of hot Tang.

* * *

PEERING into the gloom, Bob would have said, "Gee, this is swell!" (In a memo to his Forest Service boss, he began, "It was swell to hear. . . ." In a letter to a friend: "Gee, that was a swell day. . . .")

Montana was always swell to him. After earning a master's degree in forestry at Harvard in 1925, he joined the staff of the Forest Service's Northern Rocky Mountain experiment station at Missoula. He studied tree regeneration and growth, counted seedlings on hands and knees. He found friends who enjoyed hiking and climbing. Missoula became "my best loved city."

He also liked to hike alone. In the Coeur

First light *bathes mule deer in a meadow. During the homesteading era around 1900, the species was decimated by loss of habitat and market hunting. Today about 15,000 thrive here, along with white-tailed deer and moose. Watching a bull moose, Marshall observed, "Everything he did . . . had a dignity appropriate to an environment which measured changes by the century instead of the hour."*

*"**A bit of heaven on earth**" led Max and Ann Barker to sell their Iowa farm in 1976 and strike out for the eastern edge of the Bob, where they set up the JJJ Wilderness Ranch. A rope bars horses from a footbridge (**above**) leading to the main lodge, where a fire is welcome even in July.*

*The Barkers' daughter, Christa Mattingly, bakes brownies (**right**) in cozy surroundings shared by Christa's daughter Kate (**far right**). With the temperature below zero in December, Max temporarily moves his deer-butchering work from the barn into the lodge; a Siamese approves (**upper right**).*

One of some 50 outfitters that serve the Bob, the Barkers annually lead about six summer horseback trips of seven to ten days with six to eight guests. They also accommodate guests in their lodge and occasionally support backpackers by placing caches of food and gear on trails. From mid-September to December they lead seven eight-day trips for hunters. "We had three hunters from Germany out here one year who compared the experience favorably with their own in the Bavarian Alps," says Max. "People that come here get a great uplift. Wildlife is everywhere. You can listen to the quiet. It's almost a religious experience."

d'Alene Forest in Idaho: "I took a very enjoyable two-day, 72-mile walk over Labor Day weekend." In Yellowstone Park: "This was the 100th time I have walked 30 miles or more within 24 hours." In December snow in the Montana-Idaho Bitterroots: "Commenced my long 29-mile walk along a road almost untraveled in winter."

"He wasn't faster than anybody else—he just walked longer." That is the recollection of John Sieker, resident of Arlington, Virginia, who was Bob's deputy in the Forest Service. On those dawn-to-dusk forays Bob took time to observe flowers and landscape and scribble notes, Mr. Sieker told me.

From Bob's records I calculate his speed at two and a half to three miles an hour, the speed of a man walking to work. But there were times when, lugging a pack, he got up to four miles an hour—good time for a burdened walker.

By the mid-1920s the Forest Service had taken the fundamental step of acknowledging wilderness values. At the behest of such wilderness pioneers as Arthur Carhart and Aldo Leopold, several tracts were set aside in a natural state.* Chief Forester William B. Greeley urged his regional officials to delineate still others. These men in the field enjoyed wide latitude, however, and many resisted Greeley's plea. As one retired forester recalls, the agency in those days was dominantly a "timber-cuttin', fire-fightin' outfit," only modestly interested in preservation.

In 1928 Bob was one of a score of foresters who discussed preservation at a meeting in Missoula. He wrote his family that he heard little sympathy for the idea.

A few months later Bob stated his views in the Forest Service newsletter. He acknowledged that relatively few people appreciated the primeval. But, "To them the enjoyment of solitude, complete independence, and the beauty of undefiled panoramas is absolutely essential to happiness." Bob had staked out the high ground of his immortality.

* * *

At My Lake I tried to dry clothes between snow showers and wished I'd gone back to retrieve my gloves. From here on I'd wear socks on my hands.

Carrying lunch, we set out to climb to Larch Hill Pass on the Continental Divide. The day was cloudy, and the stunted subalpine larches were daubed with snow.

Then the sun broke through, and trumpets seemed to sound from the heavens. To the north, sharp peaks gleamed as if enameled. Some of these, rising to 9,000 feet and more, stood 70 miles away in Glacier National Park.

To the south the Chinese Wall rippled across the landscape. It does not look like China's wall, except that it crowns all and is gray rock, mostly limestone. To my eye it is a juggernaut of a tidal wave, surging out of the west, lifting its crest a thousand feet. Mountain goats ride this wave; Tom spotted puffs of white upon a ledge.

The next day we broke camp and swung west and down. On this, the moister side of the Continental Divide—collecting a third more rainfall than the eastern slope—the sweet aroma of huckleberries and whortleberries suffused the air. We harvested greedily.

Presently we were beside the White River, tributary of the Flathead's South Fork, whose waters ultimately merge with those of other streams that take the snowmelt of the Chinese Wall's back side to the Columbia and finally to the Pacific. By evening we had tents up in a piny grove. A mule deer, ears wriggling, came close to stare.

* * *

BOB ALMOST CERTAINLY saw the Chinese Wall in 1928. In the Bancroft Library at the University of California at Berkeley, where many of his papers are preserved, I leafed through a pocket notebook. It detailed an eight-day hike of 288 miles. Ever precise, Bob noted that he reached the divide at 1:35 p.m. on the third day.

In 1929 his career took a detour to Alaska. On leave from the Forest Service to pursue a doctorate at Johns Hopkins University, he decided to summer under the brow of the Brooks Range. He liked what he found: a funky town called Wiseman and a vast emptiness of nameless peaks and unmapped rivers. With a prospector and packhorses, Bob

*See "Aldo Leopold: 'A Durable Scale of Values,'" by Boyd Gibbons, NATIONAL GEOGRAPHIC, November 1981.

roamed for 25 days in the Koyukuk River drainage. Seventy-four miles from any other human, by Bob's reckoning, they camped beneath "a precipitous pair of mountains . . . I bestowed the name of Gates of the Arctic on them." The name was later applied to a 7.5-million-acre Brooks Range national park.

Bob flew back to Wiseman in 1930. This time he was freighted with comforts for a long visit—books such as *War and Peace* and phonograph records of Liszt's *Hungarian Rhapsody* and jazz. He stayed more than a year.

What a time! He journeyed with packhorses for four weeks; mushed with sled dogs for ten days, while the temperature sank to 40° below zero; and mounted a 50-day expedition by boat and afoot. Craggy peaks lured him; eventually he climbed 28.

No hunter, Bob seized a rifle and shot an advancing grizzly. He christened the nearby stream Grizzly Creek—one of the 137 names he put on Alaska's map.

He studied arctic tree growth and the human agglomeration of the Wiseman area: 77 whites, 44 Eskimos, 6 Indians. At dances he enjoyed the company of unmarried Eskimo girls called *nivershaks*—chickens—and made notes about these all-night occasions. He delved into marital customs. He administered intelligence tests to white adults and Eskimo children, finding both superior to U. S. norms.

Bob's observations appeared in 1933 in the 382 pages of *Arctic Village*. The frontier's romance was irresistible; the book was a best-seller. Bob divided his royalties with Wiseman's citizens, $18 for each adult.

* * *

Braiding bars of gleaming limestone rubble, the White River is well named. Norm, Judy, and I fished it. In small pools I discovered cutthroats so naive that even I could catch a skilletful.

I returned to camp to learn that Bill and Ellie had day-hiked 14 miles. There were still a couple of hours of light left. So Bill grabbed his rod and ran three miles downriver to fish. He caught his limit—fish bigger than mine—and ran three miles back.

Bill considered this no feat; he once walked 37 miles in a day, in Marshall's league. A compact man of 40 years with a brushy mustache, he would declare as we came to a majestic vista: "Out here isn't wilderness; this is civilization at its finest."

Educated in forestry and resource policy, Bill worked for the Forest Service for a year. "But I wasn't cut out to be a sawlog forester." Instead, he devoted himself to environmental causes, especially wilderness.

Between Bill and Bob lies much common ground. But Bob pursued his grail from a position of affluence. When I hiked with Bill, he was conservation director of the

Birds of the Bob *include a northern flicker feeding its young. The divide marks the easternmost range for western species such as varied thrushes. Alpine lakes harbor Barrow's goldeneyes and common loons, and meadows feed the calliope hummingbird, at 3¼ inches long the smallest bird on the U. S. mainland.*

*"**The spiritual dimension** of the Bob can never be more fully appreciated than in the wintertime," says Bill Cunningham, left, skiing with Ellie Arguimbau near the North Fork of the Teton River. Winter use is virtually nil, leaving utter solitude for those like Bill, a Helena conservationist who has trod the Bob for 25*

years and has served as one of its most ardent defenders with groups such as the Wilderness Society and the Montana Wilderness Association. With the enthusiasm of Marshall himself, he enjoys skiing 70 miles in a week across the breadth of the Bob, calling it "truly the flagship of our nation's wilderness fleet."

Montana Wilderness Association, getting by on $18,000 a year.

* * *

By 1933 the Forest Service's wilderness program was developing, despite in-house resistance. Assistant Chief Forester L. F. Kneipp, a little-sung hero of the movement, had drawn regulations for setting aside areas called "primitive"; 8.5 million acres had been so designated. What was needed now was a man to head a recreation office dealing with these areas. Bob was an obvious choice. *Arctic Village* had been preceded by a major magazine article extolling wilderness. Also in 1933 appeared a Forest Service self-study to which Bob, as a collaborator, contributed chapters on recreation.

Finally—still in 1933—there was a second book. While advocating wilderness, *The People's Forests* was an indictment of timber companies for mismanaging their lands. Bob argued that the government should take over most of those lands.

As the Depression scourged the nation, he had emerged a socialist—a wealthy one—espousing an economic order based on production for use, not for profit. He contributed to organizations that sprang up to secure workers' rights and civil liberties. A member of the House Un-American Activities Committee would later cite Bob as a contributor to an alleged Communist front.

"He was accused of being a Communist, but he never was," James Marshall said. "I think he had absorbed some Marxist doctrine, but I don't think that he had much political background or judgment. He was emotional in these things, not practical."

The Forest Service was undismayed by his views. The Roosevelt New Deal, after all, had brought many liberals to Washington. Bob was asked if he would accept a recreation post with the same salary, $2,600, he had received as a researcher in Missoula. But then the offer was withdrawn; the Forest Service, anticipating severe budget cuts because of the Depression, concluded it could not spare even that modest sum.

Bob had another offer—to become chief forester in the Indian Service, helping tribes to manage timber. While holding that job from 1933 to 1937, he became wilderness's most formidable advocate.

DAY EIGHT. We trudged out of dark valley forests and climbed to the crest of another bony ridge. Our packs were heavy once more as we started this 1,875-foot ascent; along the White we had resupplied with food hauled in by a dude outfitter.

The Bob's sprawl makes it prime horse country. But hikers are increasing; more than half of the Bob's visitors go on their own two feet. Some 50 outfitters take in fishermen, hunters, and plain nature lovers.

We departed the White's valley beneath 8,030-foot Pagoda Mountain. Atop the pass a buffeting wind made the going hard. We ate lunch in the meager shelter of little limber pines, awed by the enormity of the timbered valley ahead. In the distance, the sun gleamed on a sliver of the Flathead's South Fork, our day's destination. Farther yet, clouds skimmed the snowy Swan Range.

We could have reached the South Fork via a trail that beelined down into timber. "But it's heavily used," Ellie said. "Horses have probably churned all the boggy places to mud." Bill and Ellie favored a trail less taken, dropping 3,400 feet while more or less paralleling Damnation Creek. Damnation! The man who named it had a gift for description—no doubt about that.

At first there was a trail of sorts. It led to a vertical bluff of red shale. After scrambling down, I think we saw no trail save those made by elk and deer.

On the steep descents my toes crunched against my boots, my knees screamed. Then—ye gads!—uphill stretches. For the first time on this trip, I counted the days until I'd be out. We picked through a tangle of trunks, remains of a once great forest laid low by wind, lost our way, and found it again. Jean, trapped in a fiddlesticks, let out a little cry as she lost her balance and sprawled, immobile.

"Only another 800 feet down," Bill called cheerily. Loose shale clinked as we sidestepped and slid. Finally we bulldozed through thick growth and emerged on a spit of sand by the South Fork's fast waters. Tents went up as a coasting half-moon pumped luminescence into clouds.

* * *

In the Indian Service (today the Bureau of

Indian Affairs) Bob displayed an omnivorous appetite for work. In his notebooks, which George now has, I found not only entries about sawmills and timber sales—ingredients of his job—but also tribal boundary disputes, fishing rights, even one tribe's need of medical facilities.

The mesas and arroyos of Indian lands in the Southwest captivated him. Bob set out one morning with another Indian Service official. They walked all day, then all night under "the most beautiful full moon light you would ever hope to see." After 52 miles Bob's companion dropped out. Bob kept on until he had done 70.

He was instrumental in setting aside almost five million acres of Indian lands as roadless and wild. Bob may have been indulging his own viewpoint, not that of Indians; in any case, the Bureau of Indian Affairs long ago rescinded the designation. Meanwhile, he detoured into national forests to tramp other pristine land—the San Juans of Colorado, the Wind River Range of Wyoming.

I don't envy the Forest Service's chief, Ferdinand A. Silcox. From the Chippewa Reservation in Minnesota on June 24, 1935, Bob fired off to him two letters. One complained of the work of the "CCC boys"—jobless young men recruited into the Civilian Conservation Corps—in the Superior Forest. They were cutting roads, thinning timber, building unnatural "highly manicured" trails. "Cannot something be done?"

The second letter began: "The bull-dozers are already rumbling up into the mountains. Unless you act very soon. . . ." Bob reminded Silcox that he had previously urged protection of seven areas from roads.

Fortunately Silcox was a friend—"a swell guy." He caused the plans to be reviewed; some roads were eliminated.

Bob produced maps showing 30 million acres of roadless lands. The Forest Service obliged him by sending his maps to its regional offices—with a recommendation that no roads be constructed in the national forest areas pending more complete reports. Silcox let Marshall plead for wilderness at a meeting of regional officials.

Bob was a curiosity to many of them. "He wasn't the kind of man the Forest Service was used to," a retired forester said. He was wealthy and he was outspoken, not worrying about position or pension. Some foresters thought his hikes were ego trips. As one said, "He liked to be able to say he'd gone up and down a mountain in the same day."

John Sieker, his Forest Service deputy, disputes that. "Bob was no show-off. He was a thoroughly decent guy." And reasonable, Sieker *(Continued on page 688)*

Along came a grizzly, *passing near the Chinese Wall. The Bob, where several hundred black bears also roam, lies within an ecosystem that stretches north into Glacier National Park and includes an estimated 440 to 660 grizzlies. A unique population of some 30 bears descends in spring from the Bob's high country to grasslands around Pine Butte Swamp—the only grizzlies outside Canada that still feed on the prairie.*

The game is big *but so are the challenges for hunters of elk, deer, black and grizzly bears, bighorn sheep, mountain goats, moose, and mountain lions. Light shines in the wilderness from Switchback Creek Camp* ***(facing page)*** *of the Barkers' JJJ Wilderness Ranch. Max Barker's son-in-law, Kirk Mattingly* ***(above)****, says, "We tell hunters that if they come out five times they can almost count on getting an elk—those are the odds." Hunters often settle for mule deer* ***(left)****, packed up by Steve Hilbers, at left, and Kirk. Healthy populations sustain hunting without decrease. Limited permits for goats, sheep, and moose are issued by drawings, and when 25 grizzlies die in a year from any cause in northern Montana, the season is closed.*

On crucial winter grounds, *elk graze in Montana's Sun River Wildlife Management Area before Sawtooth Ridge, part of the peaks known as the Rocky Mountain Front*

just east of the Bob. Deer, bighorn sheep, and grizzlies also depend on such habitat after descending the front, much of it proposed for addition to the wilderness.

added. "I never heard Bob say we've got to lock up all the undeveloped land. He knew there were resources in the forests that were needed."

Under the 1929 regulation, the sum of Forest Service lands set aside as primitive grew from fewer than nine million acres in 1933 to 14 million by 1939. Though Bob played a crucial role, the credit must be shared. Silcox and others in the bureaucracy had a part. So did the National Park Service.

"My God! Sil," Marshall scolded his friend in 1935, "it is hard to put up an argument for the Forest Service in view of the almost total disregard of any form of outdoor recreational planning . . . in many of your regions. No wonder the Park Service can put up such a strong argument for stealing your recreational areas." The Forest Service was uncomfortably aware that if it did not appear interested in its primitive lands some might end up as national parks. Some did.

Bob had a fledgling ally. As early as 1930 in a magazine article he had called for "the organization of spirited people who will fight for the freedom of the wilderness." On a trip to Tennessee he talked by a country road with three other men who shared his feeling. It was in a sense the first meeting of the Wilderness Society, which continues to rally support for the environment today. By 1935 the society had a Washington office, a small membership, and a magazine. The first expenses were paid from Bob's pocket.

* * *

THE SOUTH FORK'S WATERS, bottle green and cold, cleansed us of grime. We festooned ropes with laundry; our camp looked like a tenement. We enjoyed glorious leisure, lying on sun-warmed rocks, soothing muscles pained by the previous day's descent. Except, of course, for Bill, who wandered down the river and caught dinner.

We took a mainline trail from the South Fork, bound for Big Salmon Lake. Bill and Ellie probably had been right about trail mud; this segment looped from quagmire to quagmire. Because of budgetary restraints trail maintenance has a low priority in the Forest Service. Only half of the Bob's trails receive attention in a year.

But this squishy route has compensations. The virgin forest harbors towering larches and Douglas firs with trunks that two men can't reach around.

* * *

"Like a vast cathedral, out of doors." Thus did a writer hired by Bob describe forests in Oregon and Washington. Bob penned on his manuscript: "Gosh, I hate to hear such forests endlessly compared with cathedrals when cathedrals are at best weak imitations."

Bob had departed the Indian Service when he wrote that. Frequent pounder on Forest Service doors, he joined its Washington staff in 1937, after an office of recreation was finally created. As director, Bob promoted picnic grounds and ski areas, even advocated subsidies for transporting the city poor to the forests.

The 72 Forest Service primitive areas already set aside "were supposed to be kept natural, more or less," John Sieker recalled. But roads were not prohibited in 15, nor logging in 59. "That wasn't good enough for Bob." He began to draft tighter rules.

* * *

Night brought a disturbing wind. Ghostly whitecaps surged on Big Salmon Lake. I woke once to the mushy patter of rain mixed with snow. We emerged to a gray morning and sloshed on.

Sappho, Albino, Dart: We measured mileage by the creeks over which we hopped, skipped, and shinnied. Beneath crystal waters, stones beamed rust and olive, the only notes of cheer this gloomy day.

We left the main stem and climbed to the small Necklace Lakes. Also in the vicinity: Sapphire Lake and Pendant Creek. But our campground was no jewel; other campers had hacked down trees for shelter poles. We built a fire to try to dry our mud-caked boots.

Snow swept toward us at dawn. Judy, Norm, and I strung a tarp for a windbreak. We passed the day close to the fire. Ruth emerged from her tent like a model stepping from a cosmetics ad.

* * *

Bob often got out of his office to inspect the places that held his wilderness grail. After a trek in Wyoming's Absarokas in 1937,

he suffered "ptomaine poisoning which knocked me out of my head for 20 hours and gave me convulsions which caused me to bite hell out of my tongue." He spent three days in a hospital—but then took walks of 30 miles and 40 miles.

Within three years he announced additions to the list of protected lands, including the wildernesses we know today as the Superstition in Arizona, the Anaconda-Pintlar in Montana, the Sawtooth in Idaho, and the Three Sisters in Oregon. Added acreage: 750,000.

Thanksgiving 1938 found Bob in El Paso, Texas. He went on a 44-mile hike before his turkey dinner.

* * *

Thirteenth day. We shook the snow off our tents and took packs down from trees, where we had hung them, away (we hoped) from hungry porcupines and bears.

The snow was a foot deep as we trudged up one more ridge, toward the pass by 8,304-foot Waldbillig Mountain. In our final hours in the Bob, we enjoyed private reveries—and thought of the huge dinners we'd demolish that night.

The pass transported us over a soaring rampart of rock. Here we left the Bob behind—although the adjoining national forest land is just as spectacular—and dropped down to Upper Holland Lake. Clasped in white, it was cold and dark as death.

* * *

BOB WENT TO ALASKA in 1939 to try to climb Mount Doonerak, a peak he had named. He failed—and returned to government harness with demonic determination. In California he plunged through the San Gorgonio and San Gabriel wildernesses and Kings Canyon. "He outran us," said Earl Bachman of San Mateo, California, who was on those fearsome hikes. He recalls Bob's gait as a lope. "He seemed to me like he was overdoing it."

Bob wrote a friend on November 10, 1939: "Oh, yes, I have gotten completely over that sunstroke." In the Cascades of Washington in September he had been taken ill. Friends took him to Wenatchee to recover and advised him to slow down.

Meanwhile, Secretary of Agriculture Henry A. Wallace, whose domain included the Forest Service, gave Bob's brief career one more victory. He signed the "U" regulations ("U" being the Forest Service's designation for Bob's division) that Bob had roughed out. Regulation U-1 provided for "wilderness" areas of 100,000 acres or more; U-2 for "wild" areas of 5,000 to 100,000 acres. Roads and logging were prohibited.

It was not total victory. A lengthy review was required before areas hitherto called primitive could be placed in one of the new categories; the process went on for years. Some areas did not survive review. Some areas shrank. Nevertheless, one more step had been taken to make wildland secure.

Bob kept walking. He went 32 miles "in country I am hoping to add to the Wind River Wilderness" in Wyoming; 30 miles in Utah; 41 miles in the Missouri Ozarks.

On November 10—the day he had written that he was "completely over that sunstroke"—he boarded a train in Washington, D. C. When it reached New York City, a porter found him dead in his compartment.

Did Bob's hikes burst his heart? It is generally accepted that he had a heart attack, but a few persons believed he had previously suffered seizures of some other kind.

Though there were many women in his life, he had never married. From his 1.5-million-dollar estate (before taxes), his will devoted a fourth to the promotion of wilderness. Most of this went to the Wilderness Society. Three-fourths of his estate was to be used to foster civil liberties and his philosophy of production for use, not for profit.

* * *

I have tramped in some of the grand wellsprings of Bob's inspiration—though I suffered getting to them. I have hiked the Cascades of Washington, the Winds of Wyoming, the Weminuche Wilderness of Colorado, besides the huge wilderness named for him in Montana. I have pitched my tent in the San Bernardino Forest in California, in Oregon's Three Sisters. And some others.

But I've missed something. I've missed Bob's energy and overwhelming dedication. I wish I could have walked with you, Bob. I would have struggled up those ridges, gasping, while you zipped past. But on top, in abiding space and solitude, you and I would have exclaimed, "Gee, this is swell!" □

BATTLE FOR A BIGGER BOB

By MIKE EDWARDS
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by
DEWITT JONES

HOW LARGE should a wilderness be?

Around the Bob Marshall Wilderness in a vast corrugated stretch of the Montana Rockies, the question involves more than forbidding the works of man in a greater region of virginal land. The answer may affect the future of one of the greatest wildlife populations in the lower forty-eight states. In a small way it may affect the nation's energy supply.

The 1964 Wilderness Act already protects 1.5 million acres in "the Bob" and two contiguous wildernesses, the Great Bear and Scapegoat (map, right).

Preservationists hope that Congress will add more than half a million acres to this complex—most of it

to the Bob, the rest to the Scapegoat—from roadless national forest lands that are adjoining. The Forest Service has recommended much smaller additions, totaling 165,000 acres.*

The adjoining lands have other claimants. Commercial timber exists in a few valleys. The more serious competition may be deep down. These lands are part of the Overthrust Belt, a geologic structure extending from Alaska into Mexico, in recent years a significant source of petroleum and natural gas. Not surprisingly, energy companies and speculators have filed for leases to explore most of the acreage in the potential wilderness additions.

Development could seriously affect wildlife, game managers say. East of the Bob, along the Rocky

*See "Our National Forests: Problems in Paradise," by Rowe Findley, in the September 1982 NATIONAL GEOGRAPHIC.

Within earshot of wilderness, *seismic crews detonate charges* ***(facing page)****, testing for strata far below that may hold hydrocarbons. Such exploration continues in most of an 878,000-acre potential addition to the Bob Marshall, Scapegoat, and Great Bear Wildernesses. Together, they form a 1.5-million-acre enclave.*

*"**Devastation is sweeping** the country," declared Marshall, his concern for forestry symbolized by this clear-cut outside the Bob. Debate continues around his namesake wilderness where preservationists, fearing development if oil and gas are found, urge wilderness status for 544,000 acres, while the Forest Service supports it for 165,000.*

How many wilderness areas does the nation need? "How many Brahms symphonies do we need?" countered Marshall.

Mountain Front, where mountains meet the plains, are areas considered vital to abundant animal populations: thousands of deer and elk, the nation's largest native population of Rocky Mountain bighorn sheep, mountain goats, perhaps 100 grizzlies, as well as black bears, small numbers of mountain lions, moose, and the endangered Rocky Mountain wolf.

As winter approaches, most animals move down from the higher elevations into the fingerlike valleys of the eastern front, some passing through to three wildlife management areas in the plains to forage and give birth.

Buster LaMoure, energy expert in the Forest Service regional office in Missoula, advocates at least limited energy exploration around the wildernesses. "Seismic studies indicate that something is down there, but nobody has any idea what until we gather some data," he said. One or two drill rigs will not destroy an elk herd or decimate the grizzlies, he contends. "Drilling those wells, we'd learn how we can do a better job of protecting the animals and the environment."

LaMoure ticks off numerous restrictions already imposed on would-be drillers: "There are stipulations to provide for wintering herds, for protecting grizzlies, for fall feeding areas, for spring feeding areas, for every conceivable thing we can think of."

Counters Jim Posewitz, leader of the resource assessment unit of the Montana Department of Fish, Wildlife, and Parks: "I've yet to hear anybody say they would not go in and drill, even if wildlife conditions call for a complete prohibition against access."

A SPECIAL FEATURE of the Bob Marshall ecosystem is the quality of the experience it offers. "To hunters," Posewitz argues, "it offers wildlife, wildlands, an element of the chase. The hunter must have stamina and skill to succeed. The critter has at least half a chance to get away."

Development, he fears, will necessitate the kind of artificial game management now all too common in the United States. "We can raise elk in our parking lot—they're tough beasts. But it's not the same as having a self-sustaining herd out in the wild."

And so, battle lines are drawn. Were he alive, Bob Marshall would find this array familiar; it echoes many campaigns he waged in the 1930s. He was no hunter; wildlife—unfettered, unmanaged—was a feature of the wild places in which he rejoiced. And he loved Montana. I know which side he would take in this campaign—yes indeed. □

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WASHINGTON, D. C.

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THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D.C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization. Since 1890 the Society has supported more than 2,700 explorations and research projects, adding immeasurably to man's knowledge of earth, sea, and sky.

When Tom Sheppard isn't actually exploring deserts, he's looking for reasons to return to them. "I just love being there," he says. "It's like being the first man on earth."

Since 1967 he's found seven good reasons for desert exploration. Each became a major expedition. And each presented its peculiar dangers.

Tom, however, dislikes the "daredevil" label with its overtones of recklessness. "The desert is unforgiving," he agrees. "But you get through it by planning and being careful, not by being heroic."

In the desert Tom Sheppard can be sure of two things: the sun and his Rolex.

Even so, his latest venture evolved almost on its own. "Interest taken in my '79 expedition and contacts within the Royal Geographical Society drew me to a reconnaissance of the Ahnet massif. I decided to go and have a look around." "Having a look around" meant an off-tracks journey of nearly 500 miles in minimally mapped desert.

TOM MAKING A SUN COMPASS HEADING CHECK

But dust-laden winds gave poor visibility, often making it impossible to identify his position from landmarks shown on satellite pictures of the area.

A fault in his satellite navigator made his sun compass the main directional reference. As ever, Tom had taken his Rolex Oyster-quartz. "It has worked unfailingly in the past. Used with the sun compass, dead reckoning is the ultimate navigation fall-back." Its impregnable Oyster case proved equally reliable in one of the worst sandstorms Tom has ever experienced.

TIOUERINE ROCKSCAPE ON ROUTE FROM AHNET

"I find it easy to identify with the engineering superlatives of Rolex," he says. Tom is not the kind of man to overlook the smallest detail in his planning. And, in the desert, his watch is far from being the smallest detail.

ROLEX
of Geneva

THE ROLEX OYSTERQUARTZ DATEJUST CHRONOMETER IN STAINLESS STEEL WITH WHITE GOLD BEZEL. ALSO IN STEEL AND YELLOW GOLD.

Our research journal: dilemma and invitation

I AM OF TWO MINDS, and I think you will appreciate my dilemma. Last November I announced in this column the pending publication of a new magazine, *National Geographic Research: A Scientific Journal*. Since it is written by scientists for scientists, I implied that it would be of little interest to Society members. Now I am not so sure.

The first issue has been published, and it is a stunning piece of work. In design, typography, photography, illustration, diagrams, and printing *National Geographic Research* sets a new standard for scientific publishing. After all, the Society has had long experience and dedication to excellence in just such aspects of publishing.

AMULET, DEIR EL-BALAH, T. ALLON COLLECTION, JERUSALEM; PHOTOGRAPH BY EDDIE BRIMBERG

Do I therefore conclude that the Society membership should be invited to subscribe? Here is my dilemma. *Some* members would enjoy and profit from being subscribers, but *which* members? Probably those who would like to eavesdrop on scholars talking to each other in the vocabulary of their disciplines, those who fully realize they would not be reading journalism about science, or even a periodical where scientists write for a well-informed general audience.

Here are some examples. In the December 1982 NATIONAL GEOGRAPHIC, archaeologist Trude Dothan wrote an article entitled "Lost Outpost of the Egyptian Empire." It begins, "I had the uncomfortable sensation of going on a blind date—and for that matter a dangerous one." For the Winter 1985 issue of *National Geographic Research*, Professor Dothan wrote an article—about the same place—entitled "Deir el-Balah: The Final Campaign." It begins, "Deir el-Balah presented unique problems for excavation." Here is an archaeologist about to present her findings to other archaeologists. The tone and purpose are much different. We may listen in, if we choose.

In "Flowers, Saints, and Toads: Ancient and Modern Maya Textile Design Symbolism," author Walter F. Morris, Jr., writes as follows: "Obviously, I could not buy textiles from every woman . . . so instead I organized weaving cooperatives in coordination with the Mexican government." This helped his research and "also the people whose work I was studying, for the cooperative plan has now evolved into an organization that supports 1,500 weavers."

My journalistic sense tells me this is a story worth telling, but we hear no more of it, for Morris's purpose is to analyze the geometric motifs of Maya weaving and their connection to ancient designs.

Among other articles, three relate certain aspects of behavior in rattlesnakes, in walruses, and in cocks-of-the-rock. All are informative; all are technical; all employ statistics. None is easy reading.

The only solution to my dilemma is to pass it along to you the members. If such scholarly content published quarterly in a handsome format appeals, you may subscribe on a trial basis.

Gilbert M. Grosvenor

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY

Photographed by Robert Caputo *Simien Fox:* *Genus: Canis* *Species: simensis*
Adult size: Stands 60cm tall at the shoulder; similar in size to a coyote
Adult weight: Approximately 16—20kg *Habitat: Mountain plateaus above 3,000m in the Semien Arissi and Bale Mountains of Ethiopia* *Surviving number: Estimated at less than 1,000*

Wildlife as Canon sees it: A photographic heritage for all generations.

Stealthily hunting rodents by day, the Simien fox excels in its ability to stalk prey, remaining motionless for up to 10 minutes if necessary before making its final pounce. Nearly extinct in the mountains for which it is named, the Simien fox is considered today to be the world's rarest canid.

Nothing could bring back the Simien fox should it disappear completely. And while photography can record it for posterity, more importantly photography can help save it and the rest of wildlife.

The Simien fox is an integral part of high-altitude mammal fauna, thriving in open country where rodents abound. Photography can assist in efforts to learn more about the Simien fox and what it requires to survive, while promoting an awareness and understanding of this little-known mountain fox.

And understanding is perhaps the single most important factor in saving the Simien fox and all of wildlife.

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Members Forum

The Poppy

As a professional in the field of organic/medicinal chemistry, I congratulate Peter White and Steve Raymer on their article (February 1985). I was surprised that no mention was made of the accomplishment of Dr. Marshall D. Gates, in 1952 the first to prepare totally synthetic morphine. Indeed, the ideas leading to the synthesis of the morphine antidote called naloxone can be traced back to the basic principles that have come from Gates's laboratory.

Richard Partch
Potsdam, New York

Space precluded information on Dr. Gates's achievement, as well as that of Dr. Kenner C. Rice, who recently developed a simplified process that may lead to an economically viable morphine substitute.

Peter White quotes his doctor as saying that morphine is unequaled in relieving the pain of acute pancreatitis. Morphine, however, is less than ideal for this illness. It is well documented that morphine can cause the muscle surrounding the pancreatic and common bile ducts to go into spasm and then, in fact, reproduce the pain of acute pancreatitis. The drug of choice for this condition is meperidine (Demerol).

William M. Steinberg, M.D.
George Washington University Medical Center
Washington, D. C.

The article tells of smugglers utilizing opium-addicted camels to transport their illegal product. Are the dogs used by the U. S. Customs Service to detect narcotics also trained by addiction to the materials they seek?

Louis A. Jankoski
Piscataway, New Jersey

Customs Service dogs are trained solely by scent, and trainers go to great lengths to prevent them from coming into contact with narcotics.

Mummies

Thanks for an excellent article on the Qilakitsoq mummies (February 1985). However, the photograph of the insect buried with the mummies is of a psocid (bark louse or book louse) and not a bee.

Mark W. Moffett
Cambridge, Massachusetts

We were stung by the presence of a hive in the burial chamber.

I can understand why research into these 500-year-old preserved human corpses might be valuable, but the photograph of the dead infant—regardless of how long deceased—is, in my view, definitely not suitable for the cover of any magazine.

Barbara Kelsey
Lyme, Connecticut

The very interesting article has roused an idle question that has been in my mind for a long time: How long after burial, interment, entombment, etc., does a "grave robber" or "body snatcher" become an archaeologist?

M. C. Creer
Philadelphia, Pennsylvania

It is a matter not just of time, but also of intent.

The Planets

"The Planets: Between Fire and Ice" (January 1985) says that Pluto is approximately 3,000 kilometers in circumference and Mercury 4,878 km (larger than Pluto). But I was always taught that Mercury is smaller than Pluto. Which is correct?

Alfred Lee
Bryan, Texas

Following discovery of Pluto's moon, Charon, in 1978 and the calculation of its size, astronomers now list Pluto as our smallest planet.

Page 28 of your January issue states: "Eventually the sun ignited. . . . No planet would therefore be able to grow larger than Jupiter, and with its tremendous mass Jupiter could gravitationally dominate the further growth of its siblings." I am probably not the first to call your attention to the theological implications of this view. As Genesis 1:2-3 put it: "And the earth was without form, and void; and darkness was upon the face of the deep. . . . And God said, Let there be light: and there was light."

James A. Vasquez
Seattle, Washington

In your article you state that the icy planets are comprised basically of methane, ammonia, and water. Of course all astronomy is hypothetical, but I *do* know that should a chemical and warming trend occur on Pluto, Neptune, or Uranus, they would have the raw materials for creating forms of amino acids that, through evolution, would or could become lower life-forms. All you would need is some heat and an electric shock, and *voila!* . . . Otherworld.

Laura Jean Williams
Hurlock, Maryland

Yosemite

As a former seasonal ranger in Yosemite Park (January 1985), a rock-climber there for more than 16 years, and having backpacked literally

every established trail in the entire park and ski-toured much of the backcountry in winter, I feel I have a good sense of what the real Yosemite is. The problem is the private automobile. Special-interest groups are making demands for access to Yosemite that only benefit themselves at the expense of Yosemite's health. No one has a democratic right to destroy such a wonderland! The Holy Grail for Yosemite is to ban the automobile and provide shuttle-bus service into the park.

Jeff V. Middlebrook
Monterey, California

Koko's Kitten

Pictures of Koko and her kitten (January 1985) touched me, and I am thrilled by reports that humans and animals are communicating using a mutually understood system, but I must object to the statement about a "gorilla who converses in American Sign Language." ASL, or Ameslan, is a highly sophisticated language with its own unique grammar. Largely because it differs so drastically from English, ASL is hard for hearing people to learn. Therefore I strongly doubt that most of the hearing trainers and researchers working with Koko are users of true ASL.

Beth Eloe-Reep
Normal, Illinois

The signs taught to Koko and Michael are those used in Ameslan, and many who have worked with Koko are deaf individuals who are fluent in American Sign Language.

After reading your article "Koko's Kitten," my cat signed "preposterous!"

G. A. Goff
Athens, Georgia

Since King Kong stood on the Empire State Building, the journey has been long. Your cover and text must personify the real image of the gentle giant—the gorilla! Koko—fine gorilla!

Helen Bathé
Midwest City, Oklahoma

I suppose hundreds have already written to comment on the January cover of Koko and her kitten. So magnificent and provocative a photograph would, as a poster, surely be a blockbuster of a fund-raiser.

Maud de Luna
Babylon, New York

A poster is now available for $15.00 from the Gorilla Foundation, P.O. Box 620-530, Woodside, California 94062.

Jamaica

In "Jamaica: Hard Times, High Hopes" (January 1985, page 135) I don't know what's hanging on the drying racks, but the plant in front of the individual with the harvesting knife certainly isn't marijuana. Perhaps you need someone with more knowledge of contemporary culture to back up your writers and/or photographers.

Oattis E. Parks, Jr.
Freeport, Florida

From the number of letters pointing out that the large plant in the foreground is not marijuana (which indeed is drying on the racks), but cassava (tapioca), it seems many of our readers are experts in identifying one plant or the other. Those staff members responsible for not pointing out the cassava promise to turn over a new leaf.

In the otherwise superb article on Jamaica, you quote young Rastafarian singer Bunny Wailer. All true disciples of reggae music know that there was once a Bunny Livingston, who was an early member of the Wailers, but never a Bunny Wailer to my knowledge.

Bob Darden
Waco, Texas

Since the death of Bob Marley, Neville (Bunny) Livingston has launched a solo career under the name of Bunny Wailer.

Biotechnology

While reading Robert F. Weaver's article "Beyond Supermouse: Changing Life's Genetic Blueprint" in the December 1984 issue, a question came to mind. If allergies are caused by a hyperactive immune system and cancer occurs as a result of a suppressed or ineffective immune system, are persons who have allergies less likely to develop cancer? It would be interesting to learn whether any studies have been done to determine whether persons with allergies have a lower risk of developing cancer. If so, maybe there is some consolation for allergy sufferers.

Thomas A. Duke
Lexington, Kentucky

Epidemiologists at the National Cancer Institute tell us that allergies are localized and not as severe as auto-immune diseases in the scale of immune reactions. There is no finding that allergic people are less likely to develop cancer.

Members Forum

Congratulations on Members Forum, the part of the magazine I often turn to first.

Beacon, New York

Letters should be addressed to **Members Forum**, *National Geographic Magazine, Box 37448, Washington, D. C. 20013, and should include sender's address and telephone number. Not all letters can be used. Those that are will often be edited and excerpted.*

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On Assignment

THE NILE was three miles away, but that didn't stop Shilluk tribesmen of Sudan, eager to pose for author-photographer ***Robert Caputo***. When he asked to take their picture in a canoe, they quickly fetched half of their reed craft and jumped in (***right***). "I burst out laughing and so did they," Caputo recalls. "Before actual launching, they slip this half into a larger one and tie them together."

Upriver, Caputo photographed himself with his own conveyance (***below***), a Mercedes cross-country vehicle packed with cans of water and fuel, spare parts, camera gear, and food. Aluminum ladders helped him out of desert sand traps, and a cartop tent kept him out of reach of snakes and scorpions. Eight months and 12,000 miles later, Caputo had a lot of soup and corned beef left over. He had often dined with natives on sorghum stew, sometimes enhanced with hippopotamus meat.

Caputo owes the course of his career to a baby chimpanzee. After college, he and friends crossing the Zaire rain forest chanced upon natives trying to sell the animal because he was too young to eat. "He was about a month old, and he would just cling to you. If we didn't buy him, he would die. We fed him milk from a wine bottle and named him Kobi." Wanting to reintroduce the chimp to the wild led Caputo to Jane Goodall in her chimpanzee study area in Tanzania. While there, Caputo learned to shoot wildlife documentaries from Baron Hugo van Lawick.

Hooked on film and Africa, Caputo later obtained a degree from New York University Film School. He has written and photographed NATIONAL GEOGRAPHIC stories on Sudan and Ethiopia and is photographing another on Kenya. And Kobi? Unable to adapt to the wild, he found a home at the Primate Foundation of Arizona in Tempe.

BOTH BY ROBERT CAPUTO