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NATIONAL GEOGRAPHIC

The Patowmack Canal

WATERWAY THAT LED TO THE CONSTITUTION 716

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ANYONE who hasn't been impersonating Rip Van Winkle in recent weeks knows that 200 years ago—on May 25, 1787, to be exact—a meeting was convened in Philadelphia to improve the government of the United States. It ended up creating a whole new one.

That the delegates did a fine job, no one will deny. That they succeeded at all is a miracle. Many leaders such as Patrick Henry avoided the meeting because they opposed a stronger central government. Why should 13 separate and diverse governments surrender power when they had fought to unburden themselves of a tyrannical English ruler? And when did politicians ever give up power without a fight?

In the political baggage of those delegates who framed the Constitution were countless schemes, dreams, problems, state and factional loyalties, and powerful egos. To succeed, the delegates had to compromise strongly held positions for the common good. In doing so, they created a document that itself permits and encourages compromise in the interests of peaceful change. All mankind was the winner.

Continuing success depends on informed citizens able to compromise for the greater good. Like all governments past or present, ours is far from perfect. To help the continuing evolution toward a better one through peaceful means, we need to look realistically at those Founding Fathers and their motivations. They were not the simplistic cardboard patriots we tend to paint in gaudy colors, but like politicians and citizens of today, they had the usual mix of greed, ambition, idealism, and loyalty.

We discovered in preparing the Patowmack Canal article for this issue that improvement of the waterway was a major factor that led to the Philadelphia meeting. Further, George Washington's personal business interests and regional loyalties were as important to his dream of opening the West as was his dream of a bigger and better nation. Such human qualities take nothing from his brilliant leadership nor in any way tarnish his well-deserved title of Father of His Country.

We felt you would enjoy knowing more about Washington's waterway and might even lend your support to preservation of its sadly neglected remains. It was the only project ever built by Washington the businessman and civil engineer—a project much on his mind as he chaired the Constitutional Convention.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

JUNE 1987

COVER: *An 18th-century-style bateau moves up the Seneca Bypass, where water still runs in the Patowmack Canal. Photograph by Kenneth Garrett.*

TORNADO!

KENT AND CHRIS OTTO

Keeping both eyes on a ghostly white twister, young Kent Otto races back toward his farmhouse in Osnabrock, North Dakota, in July 1978. With winds clocked as high as 230 miles an hour, tornadoes pack earth's strongest weather punch.

By PETER MILLER Photographs by CHRIS JOHNS

NATIONAL GEOGRAPHIC EDITORIAL STAFF

HAILSTONES rapping on her bedroom window woke Kimberly Lewis one April morning last year in Sweetwater, Texas. Her husband, Terry, had left for the gypsum plant half an hour before. Two of her children, Nathan and Ashley, were sleeping beside her. Eleven-month-old Amanda was in her own room.

"I looked out the window and saw a couple of garage doors fly across our backyard and my heart froze," she said. "I tried to go get Amanda, but I never made it."

Windows shattered, the bedroom floor tilted, and the ceiling collapsed. "Next thing I knew, I was outside in the rain." Struggling to see without her glasses, her gown ripped off by the winds, she saw Nathan and Ashley stumbling near the wreckage of the mobile home. They were covered with small cuts and bruises, but otherwise were uninjured. But where was Amanda?

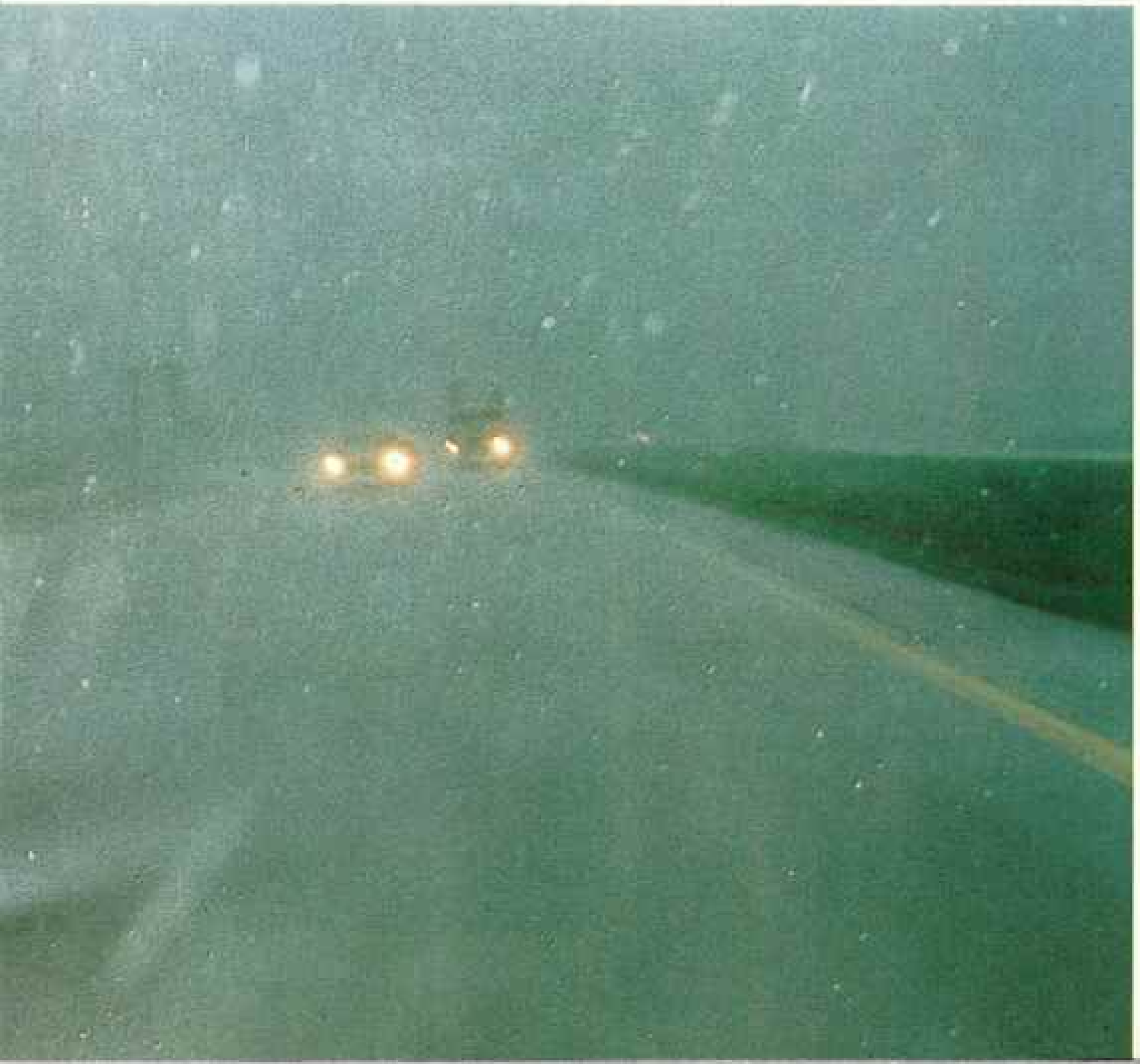
"I can't find my baby!" she cried to her uncle, John Brown, who came running down the street from his house. Debris lay scattered across the neighborhood. Carpet was draped around trees. Pieces of the roof were blown across the street. Furniture, clothes, and magazines were strewn over the yard. In the middle of the road was the crib in which Amanda had been sleeping. It was twisted like a pretzel.

Neighbors arrived to help John search through the rubble. In anguish he lifted one piece of wall after another. Then he found Amanda. She was wrapped snugly in her crib mattress, unharmed except for a few scratches near her right eye.

"She never made a sound," Kimberly said. "She just held out her arms."

There had been no warning of the tornado that ripped through Sweetwater that morning, destroying 161 homes, injuring 92 people, and taking the life of an 87-year-old

To study a twister's anatomy, a research team from the National Severe Storms Laboratory (NSSL) in Norman, Oklahoma, plunges through rains (below) to catch a tornado spinning out of the clouds. Earlier a team leader (right) had briefed the staff on likely tornado areas, using images beamed from a weather satellite. Once in the field, the team is guided toward target storms by Doppler radar reports from the NSSL control center.



man. There had been no time to sound the town's sirens. No tornado reports had been broadcast on television or radio. Local weather radar had indicated nothing unusual about the storm until it was too late.

The tornado had struck with the suddenness that makes all tornadoes so terrifying. In a few moments of violence it changed hundreds of lives.

It may soon become possible, however, to avoid such disastrous surprises. Weather forecasters, using advanced technology such as Doppler radar, satellite pictures, and high-speed computers, are learning how to predict strong tornadoes as much as 20 minutes before they occur. With this advance warning, residents of towns like Sweetwater could gain a fighting chance to find safe shelter.

The stories that came out of Sweetwater were like many others in a region where tornadoes are a way of life.

"I was looking to the southwest when I saw clouds coming together from opposite directions," said patrolman Joe Don Smith of the Sweetwater Police Department.

Closing in on a violent storm, Oklahoma University graduate student Lou Wicker (above) takes a few minutes to obtain crucial data from NSSL. The appearance of a rotating wall cloud beneath the flat base of the storm (right) signals even odds that a tornado will descend.

NATIONAL SEVERE STORMS LABORATORY (RIGHT)

Smith had taken a position near Interstate 20 after an earlier tornado sighting.

"The rain and hail had stopped, and it was starting to get light. I was talking on the radio when I looked back and saw a short, fat tornado just materialize a mile away. Then a sliver of another funnel appeared at the side, and the big one sucked it in."

Smith reported the tornado to headquarters, then drove to a nursing home to warn its residents. As he headed back into town, the whirlwind almost caught him. "Debris was swirling everywhere. Pieces of metal hit power lines. Insulation and dust filled the air. I crouched as low in the car as I could, for fear of something coming in a window. It lasted ten seconds, and then it moved on."

The tornado cut a path about a block wide and two miles long through a densely populated part of Sweetwater. Bill Swindle was in his tire store when the tornado roared by. It tore off the roof of the store and sucked out about 200 radial tires. "Most of which I haven't seen since," said Swindle.

Linda Sharp was watching cartoons on television with her nine-year-old son,

Michael, when the windows of her mobile home cracked and a roar came through the front door. "I said to Michael, 'Come here, baby,' and we rolled onto the floor between the couch and the coffee table. Michael asked, 'Mama, are we going to die?' and I said, 'I don't think so, honey.' And then we took a little joyride in the house." The double-wide trailer skidded 24 feet across the front yard before coming to a stop. "I could feel the house moving, and we just went with the flow," she said. "I didn't open my eyes, that's for a fact."

The tornado left the people of Sweetwater in shock. It severed power and telephone lines, knocked out the radio station, broke water pipes, and blocked roads with trees. Friends and neighbors checked up on one another while police and rescue squads searched through collapsed houses. In addition to the one fatality, there were 21 injuries requiring hospitalization.

There were also lighter moments. Police officer Ray Carnathan arrived at an accident where a car had been blown off the road into a tree. Its rear windows were gone. "A highway patrolman was helping a woman out of the front seat," said Carnathan. "There was a kitten lying on the back seat, all wet. So I told the woman we would take care of her cat for her. And she said, 'I don't have a cat!' Then this fellow came walking down the street holding two other kittens and looking for the third one."

FOR ALL ITS DESTRUCTION the Sweetwater tornado was not especially powerful compared with some of the 850, on average, that rumble across the United States each year. Swirling over the Texas plains, it struck Sweetwater with winds of 150 miles an hour or more.

The highest tornado winds ever clocked registered 230 miles an hour, but that's a limitation of instruments. Gauged by the damage in its wake, the tornado that blasted Niles and Hubbard, Ohio, and Wheatland and Mercer, Pennsylvania, on May 31, 1985, carried winds estimated at 260 mph or more. Such monster twisters are rare, but they do the most killing, taking more than two-thirds of the hundred or so lives lost to tornadoes in the United States each year.

The U. S. suffers more tornadoes than any other nation. Cool, dry Canadian air channeled eastward by the Rockies collides with warm, moist air washing north from the Gulf of Mexico, triggering the chain of events that leads to violent thunderstorms.

The tornado season generally begins in early spring in the Gulf Coast states, where twisters tend to be fast-moving and long-lived. Then, as the jet stream shifts northward during spring and early summer, severe weather moves into Tornado Alley, a belt of the central plains from Texas to Nebraska. Here tornadoes tend to be slower and short-lived, though more numerous. Texas, Oklahoma, and Kansas endure nearly a third of all U. S. tornadoes. As summer progresses, storms roar north into the Dakotas and Great Lakes region.

Much of what has been learned about tornadoes in recent years has come from scientists at the National Severe Storms Laboratory (NSSL) in the heart of Tornado Alley in Norman, Oklahoma. Every spring since 1972 researchers from the lab, often in cooperation with teams from the University of Oklahoma, have driven vehicles into the teeth of violent thunderstorms to gather information unavailable anywhere else.

One of their goals has been to drop a barrel of instruments in a tornado's path. The 400-pound barrel, dubbed TOTO (Totable Tornado Observatory) for Dorothy's spunky little dog in *The Wizard of Oz*, is fortified to measure temperature, wind speed and direction, and atmospheric pressure inside a tornado's core. So far, no tornado has directly hit TOTO, though a small one sideswiped it in April 1985.

From their encounters with tornadoes, NSSL teams have made some important observations. They confirmed that strong tornadoes almost always appear on the rain-free rear sides of severe thunderstorms, which typically move from southwest to northeast. Such tornadoes usually descend from a wall cloud, which hangs like a great horizontal wheel from the flat base of the storm. This wall cloud, half a mile to six miles in diameter, is part of a huge, rotating cylinder of air called a mesocyclone, the true source of the tornado's power.

Every April and May NSSL researchers spend hundreds of hours racing across western Oklahoma roads. It is far more difficult

Wasting no time, an NSSL team practices putting TOTO in the path of an approaching tornado. Carried into storms on the back of a pickup truck, the 400-pound Totable Tornado Observatory (named for Dorothy's dog in The Wizard of Oz*) is instrumented to collect data inside a twister.*

than you might imagine to catch a fast-moving thunderstorm in the act of spinning out a tornado. In a two-month season tornadoes may touch down within the 200-mile range of the lab's vehicles on only half a dozen days, and chasers must guess hours ahead of time where they might appear.

All of which adds to the excitement when a team succeeds in catching a tornado—or when, as happened when I joined them last year, a tornado nearly catches them.

MAY 14, 1986, 11:30 a.m. At NSSL headquarters in Norman, meteorologist Carl Hane tells a dozen or so members of the tornado intercept team that the day's outlook is mixed. The National Severe Storms Forecast Center in Kansas City has issued a tornado watch for the Texas Panhandle and western Oklahoma, and a band of storms is already moving across the area. "But winds are quite weak just off the surface," he says.

At the same time, balloon soundings show that the atmosphere is potentially very unstable. Warm, moist air at the surface is trapped beneath cooler dry air, threatening to explode upward into new thunderstorms if given the *(Continued on page 704)*

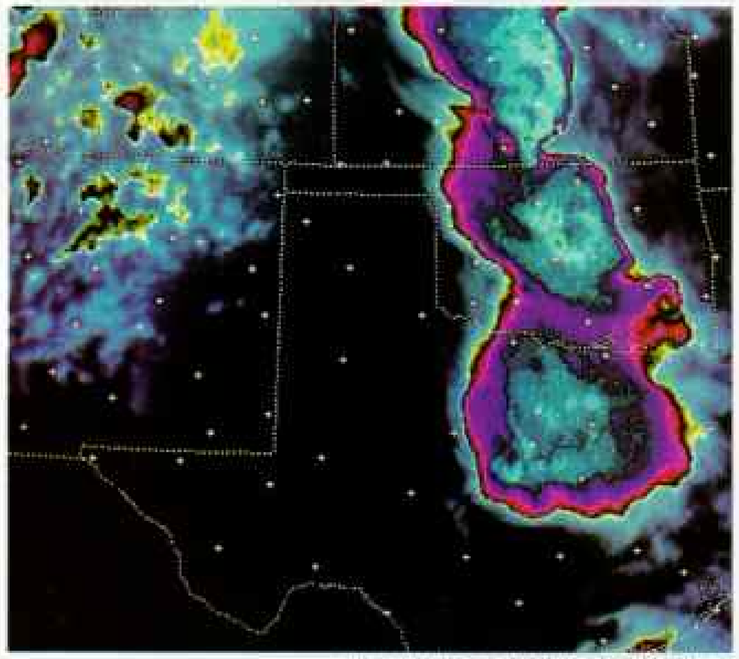
Early warning saves lives in Edmond, Oklahoma

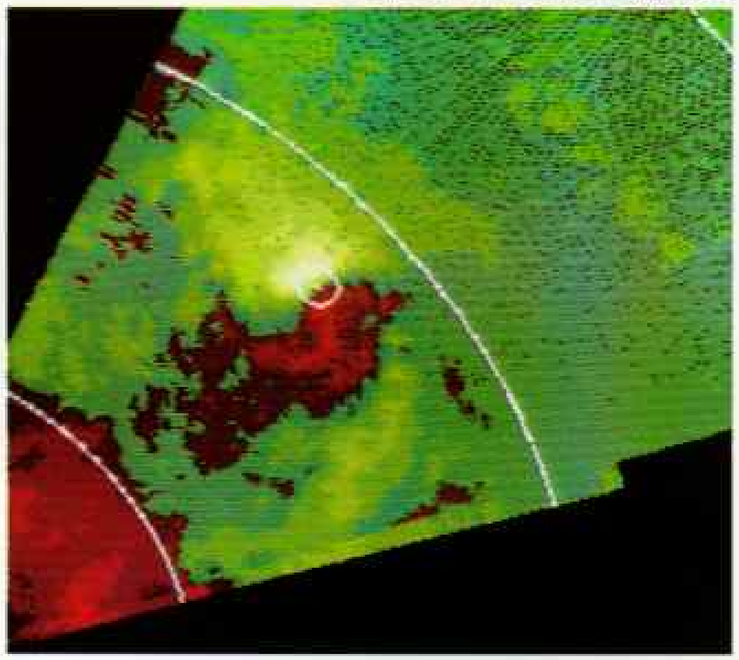
Just before sunset on May 8, 1986, a small tornado formed in the clouds over northern Oklahoma City and touched down in neighboring Edmond. Tearing through a new subdivision, it destroyed 30 houses and damaged 193. Yet no one was seriously injured. The reason: People were prepared.

A tornado watch had been issued for central Oklahoma that afternoon at 2:47. A line of severe thunderstorms stretched from Texas to Kansas, as seen in this infrared view (top right) from the GOES weather satellite.

At 6:40 a tornado warning went out from the National Weather Service when a wall cloud and large hail were reported. Several television stations broadcast live views of the funnel cloud as it approached Edmond. Tornado-wise residents hid beneath mattresses in their bathtubs.

The tornado hit at 7:18, sending a shower of sparks into the air (following page, center) when it struck a power transformer. Taking these photographs from his back door,





NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (ABOVE)

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With explosive force a tornado blasts through a mobile-home park near Cheyenne, Wyoming, propelling deadly debris outward at highway speeds. Watching from a quarter mile away, Peter Willing took this photograph just before rushing to his basement; he lived to tell the story.

Mike Pennington saw debris fill the air (below left) and worried about his neighbors.

At that moment, Doppler radar at NSSL showed the tornado on the ground at Edmond at the location marked by the circular cursor (foldout, lower). Here winds moving away from the radar (red) abruptly shifted to winds moving toward it (green), indicating rotation.

The twister sliced a narrow path through Edmond (right) before lifting back into the sky.

"I heard it roar through the chimney and felt it sucking things up," said Angie Brown (below). Taking shelter on the kitchen floor with her fiancé, Michael Parks, she felt the air suddenly turn cold. "When we stood up, there was no roof."

Shaken but uninjured, she and Michael began to pick up the pieces—grateful to be alive.

(Continued from page 697)

right push. This push might come from the afternoon sun, as air near the surface heats and becomes more buoyant. Or it might come from a disturbance in the high-flying jet stream, which could pull up air beneath it. A reading of minus 1 on the "lifted index," a measure of atmospheric instability, means storms are likely to be weak. A minus 5 indicates strong storms. Today's reading is minus 10.

1:15 p.m. The chase team's small caravan pulls away from the lab—two white Dodge vans, dubbed NSSL 1 and NSSL 2, filled with cameras and instruments to measure electrical activity; the tan Dodge pickup truck that carries TOTO; and finally the blue Bronco II in which photographer Chris Johns and I follow, aided by Travis Tull, a veteran storm chaser.

"We've got lots of storms in western Oklahoma, but none major," says Don Burgess, an NSSL tornado expert staying behind to coordinate the chase by radio. "I think we should opt for heading farther southwest and hope for a dominating storm later on."

So the caravan heads southwest, ignoring the thunderstorms closer by on a gamble that the day's worst weather is yet to come.

1:30 p.m. As we near Chickasha, Oklahoma, Burgess radios that the latest infrared satellite image shows an expanding storm near Hobart, 60 miles west. The storm's cloud top appears cold to the satellite's heat-sensitive eye, indicating that it has risen to perhaps 60,000 feet—high enough to be interesting. NSSL's Doppler radar also indicates that the updraft has begun to rotate, the first step in producing a tornado.

Like all radars, Doppler sends out electromagnetic signals and picks up echoes from objects in its path. But unlike others, it can measure the shift in frequency between the signal it sends out and the echoes that come back from rain, insects, or other airborne particles. That shift can reveal whether winds are moving toward the radar or away from it, and at what speed. The Doppler soon shows weakening rotation in the Hobart storm—a false alarm.

2:40 p.m. A tornado is reported on the ground near Amarillo, Texas, 200 miles away. Passing through Lawton, our caravan heads west on Route 62. The Doppler still shows no significant rotation in nearby storms. But the chase is heating up.

3:10 p.m. A tornado warning is issued for Jackson County to our west, telling residents to take shelter. We are driving under the leading edge of this storm, which hangs like a huge canopy over hundreds of square miles of flat farmland. The edge is bright white and sharp, a sign that the storm is still expanding and packs real punch.

"We have Doppler showing a mesocyclone in the storm near Duke," reports Lou Wicker, who is helping plan strategy in NSSL 2. We are only 30 miles away, approaching the storm from the east, a good position for intercepting a tornado.

3:30 p.m. "Tornado on the ground, people!" Lou shouts over the radio. "Get your cameras ready. Southwest of us!" I scan the cloud base but can't see a funnel. Hail bangs on our roof and windshield. NSSL 1 moves ahead on the main highway as the rest of us turn left onto a paved farm road and speed south, then west onto a dirt road toward where Lou had seen the tornado. The hail stops as suddenly as it started.

"This thing has two wall clouds," says Lou. "Let's give ourselves a bit of room. We may have to turn around fast."

Getting out of our vehicles, we study two lowered cloud bases, one to the west, the other to the southwest. The tornado apparently has dissipated. But another may soon take its place. The atmospheric pressure is dropping ominously.

"Look at the acceleration going on up there!" says Lou, pointing to the shreds of clouds dancing above us. "That's the old mesocyclone. It's hanging tough."

"It's so large, you could get a spin-up anywhere," says Mike Eilts, driving NSSL 2.

3:40 p.m. We jump back into our vehicles and turn around, driving east to keep in front of the wall clouds. A tornado suddenly touches down two miles behind us. There is a swirling on the ground, then a faint, thick funnel cloud forming around it. The funnel lasts less than a minute and disappears.

"Bust south!" Lou shouts over the radio.

Battle zones

VIOLENT STORMS often break out in central and Gulf Coast states in spring when waves of warm, moist air from the Gulf of Mexico clash with invasions of cooler, dry air from the north and west. May leads other months in numbers of tornadoes, though April twisters take more lives because they tend to be more severe. Only 2 percent of all tornadoes cause two-thirds of the deaths.

BACKGROUND PHOTO FROM NATIONAL SEVERE STORMS LABORATORY

Tornado activity 1950-1985

1.0 3.0 5.0 7.0 9.0

Average annual incidence per 10,000 square miles

206/6 Total number of deaths/ average annual number of deaths

"Be ready to deploy TOTO!" It normally takes the TOTO team less than a minute to roll the large canister down ramps on the back of the truck. But often there isn't even a minute to spare, as I was soon to learn.

3:47 p.m. A tornado reappears on our right, surrounded by a spinning wall of rain, and we race south to stay ahead of it. The winds around us are feeding it, sucking up dust and tumbleweeds. We turn east onto a dirt road to keep out of the tornado's grasp. But suddenly we run out of road.

The vehicles ahead of us hit their brakes, stopping in the yard of a farm where a man in overalls is watching us curiously. We spin around to head back toward the tornado and our only escape route—a small road heading north about a quarter mile away. Instantly it becomes clear that we are in real trouble.

"Geez, the rain curtain is wrapping around itself," says Travis, who has been busy driving the Bronco II and hasn't had a chance to take a good look until now.

"Go, go, go! Floor it!" yells Lou. "We got to get out of here!"

The TOTO pickup is first, the NSSL 2 van second, and we are last in turning the corner onto the northbound dirt road. The tornado races toward us across a wheat field. Debris explodes from the ground where the gray wall meets the earth as it rapidly eats up the distance between us.

The rain curtain catches us, splattering rain against our back window as we bounce down the road, but the tornado just misses us. If anything, its strong winds help shove us out of danger.

Behind us at the farm, the twister strikes, stripping roofing from the house, turning over farm equipment, plunging timbers into a shed's roof, and pushing the barn six inches off its foundation.

It wasn't a very powerful tornado. But it was strong enough to flip over a tractor or a vanful of tornado chasers.

"We were lucky," says Travis.

WE SAW four tornadoes in all from that same storm. Each formed rapidly from a low-hanging wall cloud and survived on the ground for a few minutes or less. As they demonstrated their power, they also revealed their vulnerability. Though tornadoes may seem indestructible, they are usually being unraveled by the same forces that create them.

Tornadoes result from a delicate set of circumstances. Assuming many shapes—from a long, thin rope to a fat, inverted bell—they may be as narrow as 50 yards or as wide as a mile. The strongest are spawned by a breed of thunderstorm called a supercell, the "atmosphere's equivalent of a rogue elephant,"

To protect the student body of rural Catherine, Kansas, all 32 children in the town's elementary school (left) huddle against an interior wall during a tornado drill. Survivors of a monstrous 1979 tornado, Phillip Malone and his family (right) show one of the fiberglass shelters he manufactures and buries in backyards of Wichita Falls, Texas.

in the words of Bob Davies-Jones of NSSL.

Like other thunderstorms, a supercell pulls in warm, humid air from the surrounding countryside and propels it aloft through a powerful updraft. The moisture in the updraft condenses into rain, causing a cool downdraft. In ordinary storms, the updraft turns into the downdraft, and the storm collapses. But in a supercell the updraft and downdraft are separated so that one reinforces the other, sometimes for hours.

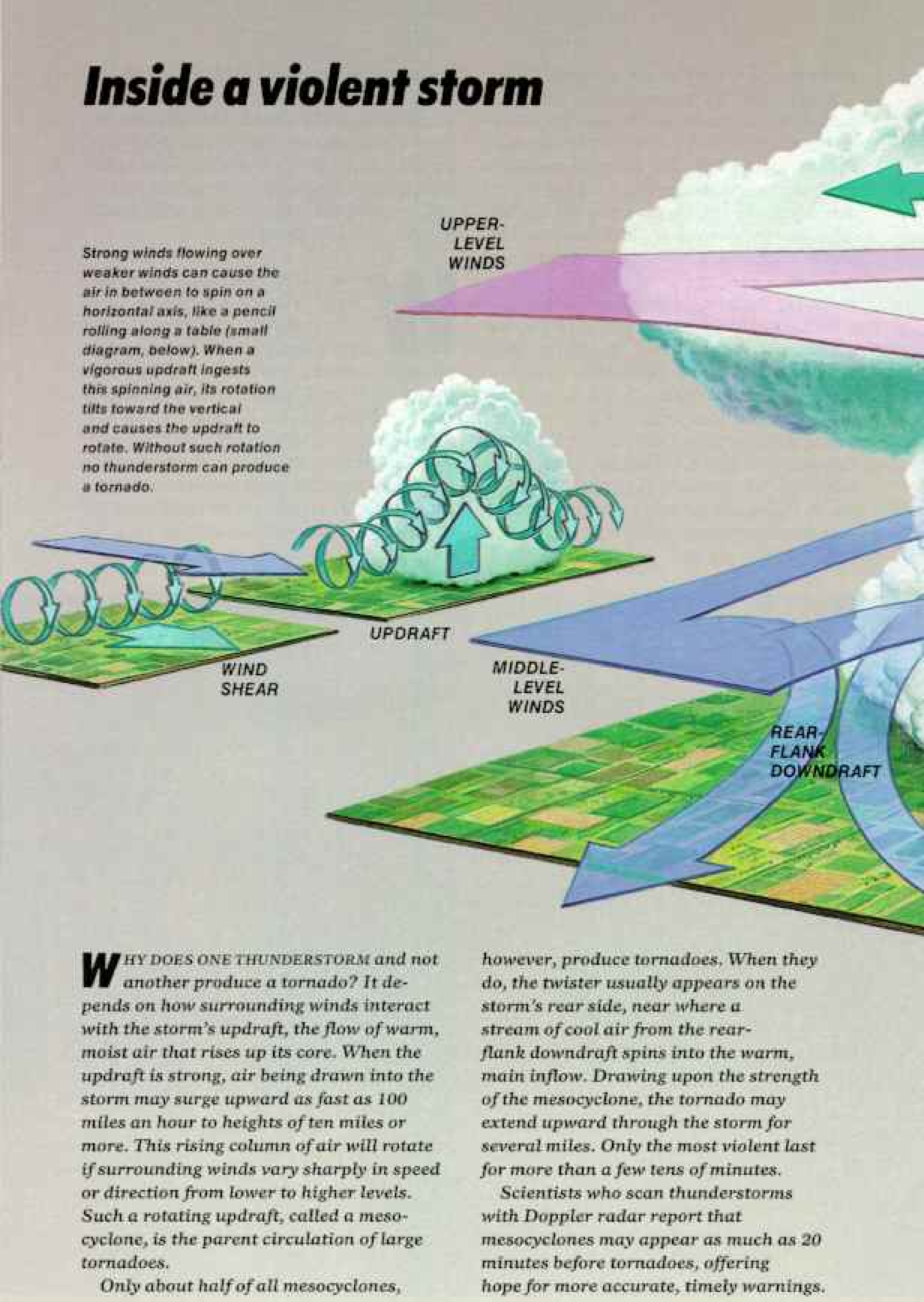
To make the updraft begin to rotate, the atmosphere surrounding the storm must contain substantial wind shear—change in the speed or direction of the wind with height. When this wind shear is present, strong upper-level winds cause weaker ones below to roll into a horizontal tube. As air rises into the updraft, the tube bends upward, tilting the storm's rotation toward a vertical axis (painting, next pages.)

When the updraft rotates rapidly, it becomes a mesocyclone, which narrows and intensifies as it stretches upward and downward through the storm. This massive column of swirling air may reach 60,000 feet, yet still not produce a tornado. "Only half of all mesocyclones result in tornadoes, and we can't explain yet why one does and another doesn't," said Davies-Jones.

WHAT GIVES developing tornadoes their crucial, last-minute spin? To pursue this question, Joseph Klemp and Richard Rotunno simulated a working supercell in a powerful computer at the National Center for Atmospheric Research in Boulder, Colorado. They focused on reports from storm chasers that a tornado usually does not occur until a small downdraft appears on the rear flank of the storm. "Our models show that the downdraft is pulled toward the earth by a sudden increase in the rotation of surface winds,"

Inside a violent storm

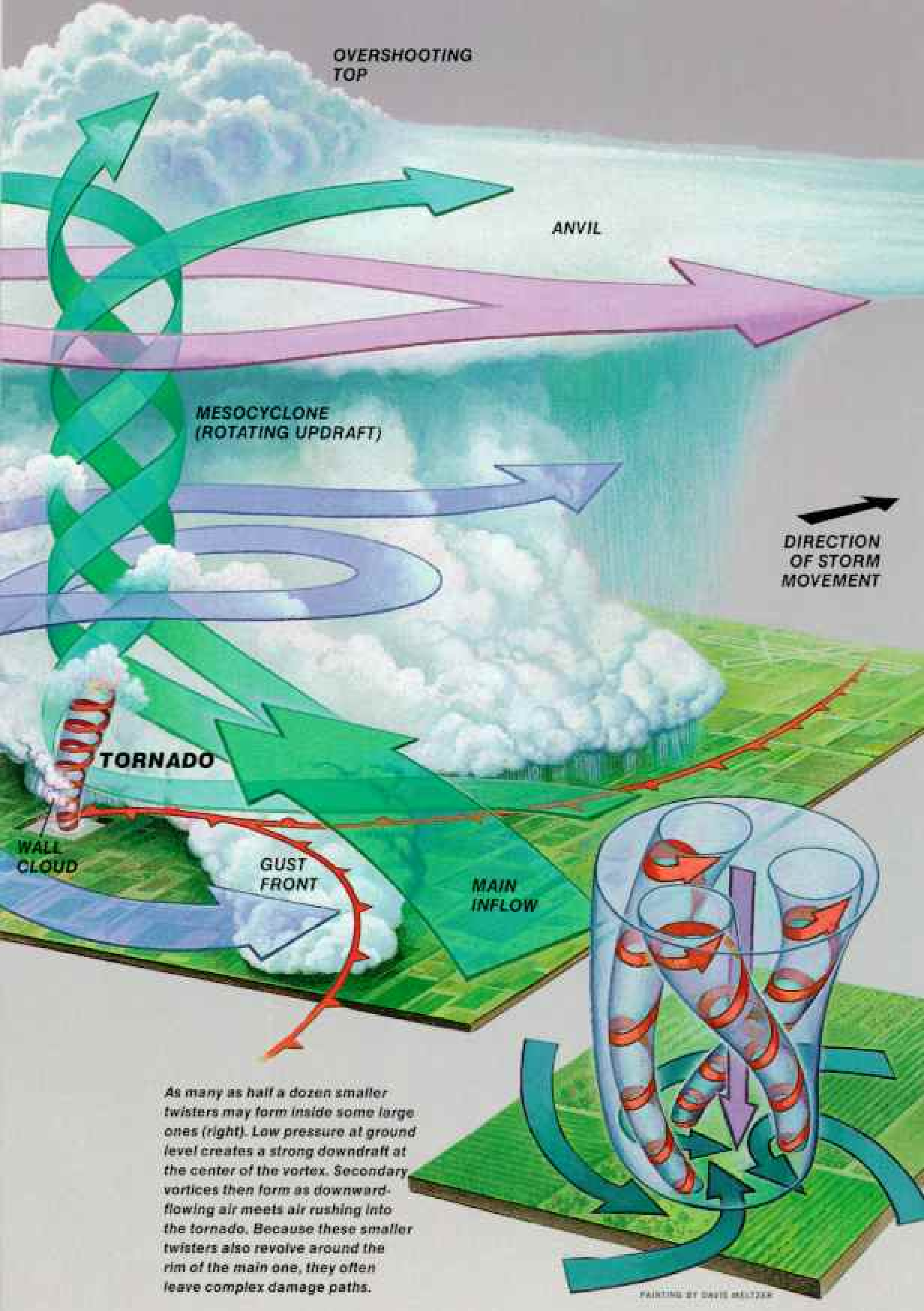
Strong winds flowing over weaker winds can cause the air in between to spin on a horizontal axis, like a pencil rolling along a table (small diagram, below). When a vigorous updraft ingests this spinning air, its rotation tilts toward the vertical and causes the updraft to rotate. Without such rotation no thunderstorm can produce a tornado.



WHY DOES ONE THUNDERSTORM and not another produce a tornado? It depends on how surrounding winds interact with the storm's updraft, the flow of warm, moist air that rises up its core. When the updraft is strong, air being drawn into the storm may surge upward as fast as 100 miles an hour to heights of ten miles or more. This rising column of air will rotate if surrounding winds vary sharply in speed or direction from lower to higher levels. Such a rotating updraft, called a mesocyclone, is the parent circulation of large tornadoes.

Only about half of all mesocyclones, however, produce tornadoes. When they do, the twister usually appears on the storm's rear side, near where a stream of cool air from the rear-flank downdraft spins into the warm, main inflow. Drawing upon the strength of the mesocyclone, the tornado may extend upward through the storm for several miles. Only the most violent last for more than a few tens of minutes.

Scientists who scan thunderstorms with Doppler radar report that mesocyclones may appear as much as 20 minutes before tornadoes, offering hope for more accurate, timely warnings.



As many as half a dozen smaller twisters may form inside some large ones (right). Low pressure at ground level creates a strong downdraft at the center of the vortex. Secondary vortices then form as downward-flowing air meets air rushing into the tornado. Because these smaller twisters also revolve around the rim of the main one, they often leave complex damage paths.

PAINTING BY DAVID MEUTZNER

said Klemp. But what causes the added rotation?

The two scientists think it comes from winds flowing into the storm along a boundary between warm and cool air. On one side, warm air rises, on the other, cool air sinks, making the winds passing between spin like a corkscrew. "As these winds swing around the back of the mesocyclone, their rotation is turned up into the updraft," said Klemp. "This extra spinning may trigger a tornado."

Once established, the strongest tornadoes can grow large enough to form smaller ones within them—a discovery made by T. Theodore Fujita of the University of Chicago. These suction vortices, as he calls them, concentrate the twister's power into even more deadly engines of destruction.

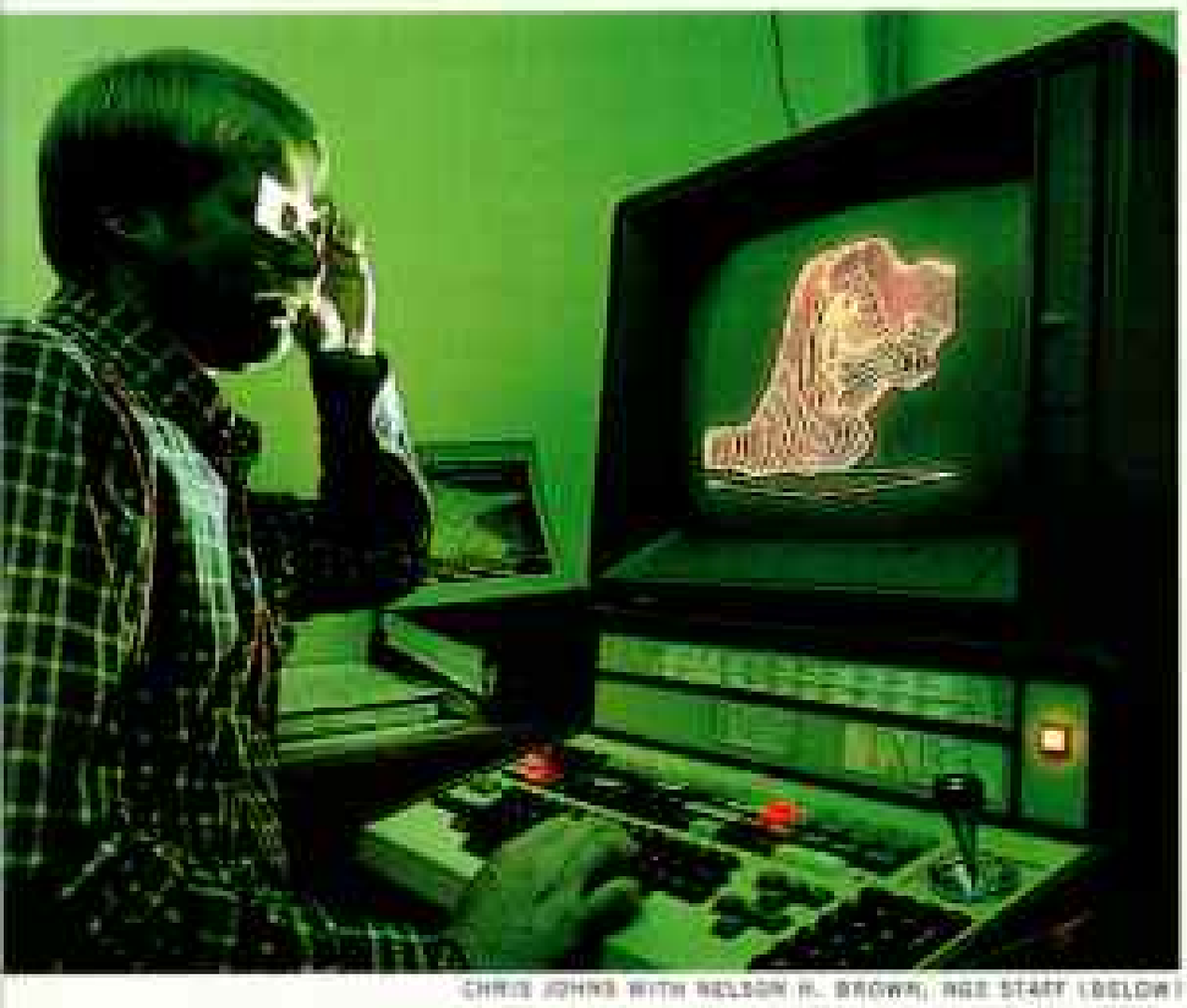
Most tornadoes don't survive that long, as I saw during our chase last May. For even as the funnel cloud descends, cool air from the downdraft may wrap around it. If that cool air completely surrounds the tornado, it can choke off the warm air rushing into it. Then the funnel runs out of fuel.

DURING THE BRIEF TIME that most tornadoes are on the ground, they can perform bizarre feats, leaving chickens featherless, or driving fragile straws into telephone poles. The brute force of the wind may manage this trick by prying open the wood grain, which then slams shut after the straw has entered.

But more often than not, tornadoes are simply terrifying. On April 27, 1986, an Iowa tornado sucked a four-year-old girl out of the pickup truck in which her family was fleeing. On May 31, 1985, a six-year-old boy in Pennsylvania was crushed in his mother's embrace as she tried to shield him beneath a collapsing cellar wall. He was one of 12 people killed when a monstrous tornado nearly wiped their town clean. Seven people died this past February 28, when a twister ripped through southeastern Mississippi.

Lightning illuminates the breathtaking architecture of a 58,000-foot thunderstorm over Ardmore, Oklahoma. Blown by upper-level winds, the anvil extends like a canopy from the main tower.

To see the unseen, Joseph Klemp of the National Center for Atmospheric Research (below) uses 3-D glasses while viewing a computer-drawn diagram of a simulated tornado. A two-by-four shot from a cannon into a cinder-block wall at Texas Tech University (bottom) inflicts damage typical of flying debris in a tornado.



CHRIS JOHNS WITH NELSON H. BROWN, NGS STAFF (BELOW)

Such heartbreaking stories fill the chronicles of tornadoes in this country. During the afternoon and evening of April 3 and the early morning of April 4, 1974, a super outbreak of 148 tornadoes descended on 13 states, killing 315 people (map, page 705). The single most deadly tornado on record claimed 689 lives in three midwestern states on March 18, 1925, 234 of them in the town of Murphysboro, Illinois.

CAN WE DO ANYTHING to protect ourselves and our homes from such terrors?

"If you're talking about houses, I really don't believe we can—anything that is economically feasible—to prevent the kind of damage we saw at Sweetwater. That tornado was too intense," said James McDonald, a civil engineer at the Institute for Disaster Research at Texas Tech in Lubbock. "But there are a few things we can do to minimize damage from weaker tornadoes, and that's the vast majority of them."

Inexpensive strap anchors over the rafters, for example, can help keep a roof from lifting off, he said. For less than $100,

such anchors can provide three to four times the strength of nails alone. And keeping the roof attached is crucial, because without it walls are more likely to collapse.

The greatest threat to individuals comes from flying objects such as broken glass, pipes, and lumber. "Hundreds of pieces of two-by-fours were scattered all over at Sweetwater," said McDonald. "If you got caught in the open with those things flying around, it would be disastrous."

To test the strength of building materials against such missiles, McDonald shot two-by-fours out of a cannon at various types of walls. The red-barreled cannon, housed in the basement of the university's Civil Engineering Building, used compressed air to propel a 12-foot two-by-four at 100 mph.

"We found that the two-by-four will perforate most wall coverings—timber, lapboard, aluminum siding, and the like," he said. "But not a wall with a brick veneer—only a single brick thick."

Such tests helped McDonald design a low-cost inhouse shelter for homes without basements. "We recommend a reinforced concrete masonry wall that is well anchored to the foundation and has a good solid roof, usually a reinforced concrete slab. The idea is that the rest of the house can blow away and that little module will still be there."

In the absence of a basement or shelter, families should go to a small room, such as a closet or bathroom, at the center of the house on the lowest floor. "You want to put as many walls as possible between you and the outside," said McDonald.

Don't bother opening windows to keep your house from exploding, he said. "That's a myth as far as we are concerned. Houses have enough natural openings to keep pressure from building up rapidly. They don't explode. If you opened a window in the windward wall—and you never know where that will be—you could make the situation worse."

THE BEST PROTECTION, of course, comes from being forewarned. In today's war against tornadoes, the first alerts come from the 17th floor of the Federal Building in Kansas City, Missouri. Here meteorologists at the National Severe Storms Forecast Center keep a watchful eye

Tornado machine: A vortex chamber at Purdue University makes a mini-twister with kerosene vapors. To study what happens when a tornado passes over an irregular surface such as a city, graduate student Rick Rostek studded the chamber floor with pegs. Result: The rough surface delayed formation of the twister.

on atmospheric conditions across the lower 48 states, using a unique, five-year-old computer system called the Centralized Storm Information System (CSIS). It gathers information from satellites, balloons, radar, and hundreds of weather stations, organizes it, and displays it on video terminals.

If forecasters are concerned about how the weather is developing in, say, southern Kansas, they ask the computer for a fresh satellite image of the area. They may call up a rapid display of images made over several hours, to spot developing weather patterns.

Computer-generated weather maps can be superimposed onto the satellite image, as can data from local weather stations on temperature, humidity, precipitation, and wind speed and direction. To determine the stability of the atmosphere, graphs of upper air data from balloons can be displayed.

If the forecasters suspect that severe thunderstorms or tornadoes will hit southern Kansas within six hours, they issue the appropriate weather watch to local weather offices, the media, and spotter networks, including amateur radio groups.

DESPITE THE TECHNOLOGY at their fingertips, the decision to issue a tornado watch always falls on human beings. "There comes a time when numbers don't tell you enough and you have to make a judgment call," said Bob Johns, a lead forecaster at the center. With the safety of large populations resting on his shoulders, Johns describes his job as one of the highest pressured in the Weather Service. "On a typical spring afternoon when I start my shift, the war is going on all around me. I have to get into gear fast. I have to distinguish very quickly situations that are life threatening from those that are marginal."

The center's record for predicting tornadoes is steadily improving. During the past few years, almost all the most violent tornadoes have occurred within watch areas. But many smaller, less damaging tornadoes still elude the forecasters.

"We get about 100,000 thunderstorms a year in the U. S.," said Frederick P. Ostby, director of the forecast center. "Only one percent spawn tornadoes, and two percent of the tornadoes claim 70 percent of the fatalities. What we're trying to do is get a handle on where those 20 or so killer tornadoes will appear and put a watch out two to six hours ahead of time. That's a tough job."

To help local forecasters do their part, the Environmental Research Laboratory in Boulder, Colorado, has been developing a computerized work station under the Program for Regional Observing and Forecasting Services (PROFS). The work station is a prototype of equipment the government plans to install at weather offices across the nation during the 1990s.

Besides providing many of the rapid sources of information available with CSIS—satellite images, radar, surface observations, and balloon data—the PROFS system also takes advantage of two new advances in weather technology.

One is the wind profiler, an automated radar unit intended to complement balloon soundings in reporting wind direction and speed at different altitudes.

The other advance is Next Generation Weather Radar (NEXRAD), a computerized Doppler system that tracks and analyzes storms, especially those with mesocyclones, better than conventional radars.

From the time a mesocyclone is detected on the Doppler radar screen, 20 minutes or more may pass before a strong tornado touches down. That should give local forecasters a crucial head start in warning communities to take shelter.

Armed with such advanced technology, local forecasters will be better prepared for all sorts of local weather problems, from flash floods to heavy snows. But the speed and accuracy of these computerized systems will help them most in their lifesaving fight to sound an accurate alarm—when skies turn black and clouds begin to swirl—that a killer tornado is on its way. □

Magnificent but deadly, a tornado in its final phase of life "ropes out" over Cordell, Oklahoma, as surface winds push the bottom ahead of the top. Survivors compare a tornado's low roar to that of a freight train, a jet engine, or a million bees: "The bigger the animal, the deeper the growl." DAVE RUST, NATIONAL SEVERE STORMS LABORATORY

Waterway That Led to the Constitution

George Washington's

Canal history buffs pole a reproduction of an 18th-century
Patowmack Canal. The brainchild of George Washington,
a cooperative effort that started the newly united states on a

By WILBUR E. GARRETT EDITOR Photographs by KENNETH GARRETT

Patowmack Canal

riverboat through Virginia's Seneca Bypass, a remnant of the the canal linking tidewater settlements with the frontier required path toward the framing of the Constitution.

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

THE KAYAKERS who are bobbing, darting, and dancing down the Potomac rapids paddle into an eddy and stare downstream. Out of the morning mists a ponderous, gondola-like boat slowly materializes. In eerie quiet it moves toward them up the narrow rapids against a fast current. The crew, wearing clothes of a time long gone and using poles, not paddles, maneuver the strange craft with an easy skill.

An apparition? Not quite. For the first time in more than a century a 50-foot-long riverboat—as out of place among the colorful little kayaks as a dulcimer at a rock concert—was passing up the Seneca Bypass of George Washington's Patowmack Canal. In an earlier time this channel had provided passage around the seven-foot drop of Seneca Falls for thousands of such boats. Five quite modern men in colonial costumes made up the crew of the 1,500-pound workboat. Dr. William Trout, scholarly president of the American Canal Society, manned the steering sweep. In the bow, fending off rocks, was headman Joe Ayers, the bearded and stocky president of the Virginia Canals and Navigations Society. Three polemen propelled the boat by jamming their poles against the canal bottom and walking the planks that ran on both sides from bow to stern.

Joe, who built the boat, had trailered it up from Columbia, Virginia, to run this historic waterway. He invited me to take passage. The night before, he had put us in the mood with foot-tapping Early American tunes on his five-string fretless banjo.

More than a boat was emerging from the mists. A little-known historical scenario was becoming clear. This canal had been part of a major project conceived by George Washington to make the Potomac River more navigable. The idea, spawned in his youth, grew into a lifelong obsession. Eventually a navigable Potomac, with improved channels and five bypass canals, would connect the Atlantic seaboard to upriver ports and—via a road portage—to the Ohio country and lands far to the west that few white men had yet seen.

In solving the political problems that blocked the waterway, Washington started a chain of events that led to the writing of the Constitution of the United States. And he went from president of his Patowmack Company to President of the United States and the permanent rank of Father of His Country.

When I tell this story, knowledgeable friends usually interrupt politely about this point. "Don't you mean the Chesapeake and Ohio Canal?" No. That was a war later and in Maryland.

Washington and Richard Henry ("Light-Horse" Harry) Lee had been authorized by the Virginia Legislature in 1772 to form a Potomac navigation company, but Baltimore merchants—knowing the project would help competing towns on the Potomac—opposed it. Maryland support was required: It owned the Potomac River. War came and the project died.

When the Revolution was over, the "times that try men's souls" weren't. In many ways the troubles were just beginning, and Washington wanted out. Like a lot of other GIs after a long war, facing an uncertain future, he was sure of only one thing—he would never go back in the Army or to any other government work. He wrote: "I am not only *(Continued on page 726)*

Love of land and dreams of greatness for the Potomac River ran like threads through Washington's life. Born on its banks, he first tasted the colonial frontier near the Potomac's headwaters when, barely out of boyhood, he helped survey the northern boundaries of the enormous Virginia holdings of Thomas, Lord Fairfax. A 1924 painting by Frank Schoonover depicts a youthful Washington with his assistants and a surveyor's compass ***(facing page)****.*

Until the era of the American Revolution, the Appalachians served as an effective barrier to large-scale settlement of the Ohio country. Washington's early travels convinced him that the Potomac offered the best route west—if only the waterway could be made navigable. This conviction led him in later years to spearhead the founding of the Patowmack Company, whose seal is shown above.

Negotiations over navigation rights between Maryland and Virginia, neighbors on the waterway, set in motion a train of events that led in 1787 to the Constitutional Convention.

SUPERINTENDENT'S HOUSE

WORKERS' QUARTERS

LOCK 1

LOCK 2

LOCK 3

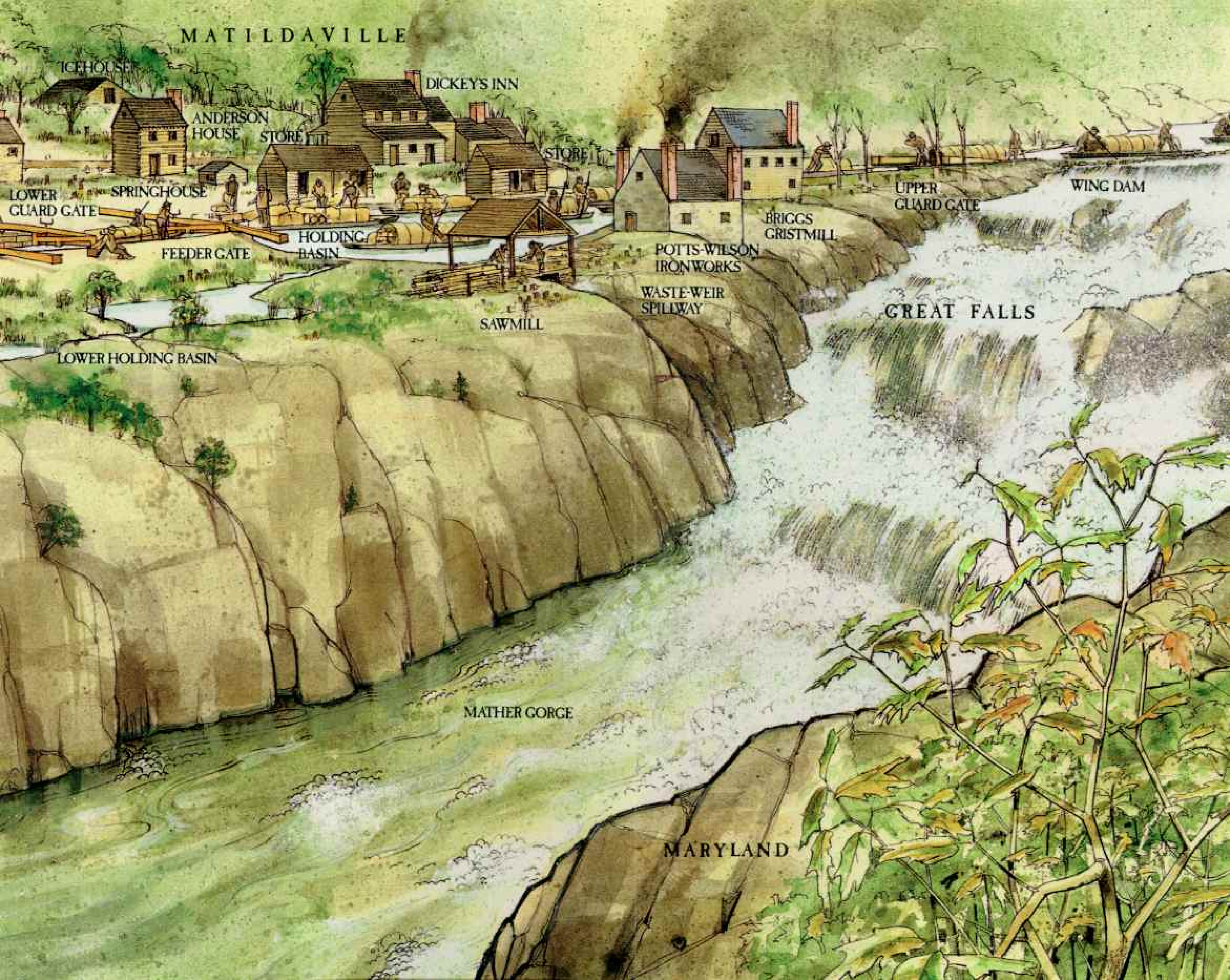
LOCK 4

LOCK 5

VIRGINIA

WING DAM

PAINTING BY NATIONAL GEOGRAPHIC ARTIST WILLIAM H. BOND


MATILDAVILLE
ICEHOUSE
ANDERSON HOUSE
DICKEY'S INN
STORE
STORE
LOWER GUARD GATE
SPRINGHOUSE
FEEDER GATE
HOLDING BASIN
SAWMILL
LOWER HOLDING BASIN
POTTS-WILSON IRONWORKS
BRIGGS GRISTMILL
WASTE-WEIR SPILLWAY
UPPER GUARD GATE
WING DAM
GREAT FALLS
MATHER GORGE
MARYLAND

"The navigation of this river is equal, if not superior to any in the Union.... this will become the great avenue into the Western Country."

—George Washington

KY.

Southernmost point reached by canoe Nov. 2, 1770

Kanawha

Big Bent 4,470 acres

2,448 acres

2,343 acres

Ohio

Little Kanawha

Great Kanawha 23,216 acres

209 acres

NORTHWEST TERRITORY 1787

The Ordinance of 1784 called for the eventual formation of 14 states in the Northwest Territory, a vast area from the forks of the Ohio to the Mississippi's headwaters. Thomas Jefferson proposed state names, hybrids of Greek, Latin, English, and Indian roots, including Sylvania (Woodland), Pelisipia (Country of Skins), and Metropotamia (Head of the Rivers). Michigan and Illinois were adapted from his list.

In October 1770 Washington, after traveling from Mount Vernon to Fort Pitt, canoed down the Ohio to select land to be given to Virginia veterans of the French and Indian War.

1,293 acres

In 1755 Washington assisted General Braddock in the disastrous campaign to march from Alexandria to the forks of the Ohio and push the French out of Fort Duquesne. Braddock was killed, but Washington distinguished himself in the defeat.

Ohio

Fort Duquesne ,1754

Fort Pitt ,1758 (Pittsburgh)

2,813 acres

2 lots

1,656 acres

PENNSYLVANIA

VIRGINIA

Monongahela

Youghiogheny

234 acres

In 1752 Thomas Cresap, who helped form the Ohio Company of Virginia to carry on fur trade with the Indians and speculate in land, marked a 65-mile portage that linked the Potomac with the Ohio.

Fort Necessity

Fort Cumberland (Cumberland)

North Branch Potomac

Will's Cr.

Produce flowing down the Potomac totaled some 200,000 tons during the 40 years the Patowmack Company operated the navigation system (dark blue). In 1828 the C & O Canal Company took over the operation until 1830, when the locks were closed.

South Branch Potomac

Oldtown

Paw Paw

249 acres

2 lots

Potomac

Cacapon

APPALACHIAN MOUNTAINS

Winchester

Washington surveyed in this area in 1748 for Lord Fairfax and set up headquarters here in 1756-58 during the French and Indian War. In 1758 he became burgess from Frederick County, his first elected office.

2 lots

House Falls

This 150-foot bypass dropped three feet and was the smallest of the five canals.

Big Spring

Harrisonburg

Work on opening up the Shenandoah lagged behind that on the Potomac because of a lower priority and lack of funds, but most of the river was eventually opened to navigation. In 1815 a separate company was formed to take over the project.

Harpers Ferry

Shepherdstown

Shenandoah Falls

One-mile-long bypass dropped 15 feet.

3,022 acres

Shenandoah

3,753 acres

Great Falls

A total of five locks were needed to overcome a 77-foot drop in the river.

Seneca Falls

Completed in 1790, it was one of the first Patowmack canals to be operational, bypassing nearly a mile of rapids and dropping seven feet.

W. VA.

MD.

519 acres

Matildaville

300 acres

Seneca Cr.

Little Falls

Longest canal employed three locks to overcome a 58-foot drop over two miles.

1,200 acres

2 lots

After seven years of debate Congress chose a Potomac site for the capital in 1790.

BLUE RIDGE

Charlottesville

James

Mount Vernon 8,077 acres

A Maryland-Virginia commission met at Mount Vernon in 1785 to resolve navigation disputes on the Chesapeake Bay and the Potomac. This led to the Annapolis Convention in 1786.

In 1784 Washington returned to Mount Vernon from an aborted trip to the Ohio, where he had hoped to visit lands he owned. An Indian uprising diverted him from his goal, but the trip rekindled his prewar interest in opening up the Potomac to navigation.

280 acres

669 acres

Alexandria

Georgetown

This major port on the Potomac supported the growth of the City of Washington, which became the federal capital in 1800.

VIRGINIA

MARYLAND

Potomac

Chesapeake Bay

Annapolis

The Annapolis Convention of 1786 met to discuss interstate commerce and issued a call for the 1787 meeting in Philadelphia that became the Constitutional Convention.

The James River Company was organized in 1785, in the same year and with the same purpose as the Patowmack Company—to open navigation to the West. Its first canal-and-lock system was in operation in 1789, the start of a southern route for goods from the Ohio and the West.

State Capitol

1 lot

5 lots

Richmond

James

NORTH

Map covers approximate time frame of 1752-1830

- French fort
- British fort
- Canal site
- Washington's lands, not to scale

Map shows present shorelines and drainage

Scale varies in perspective view

NGS CARTOGRAPHIC DIVISION
DESIGN: DAVID E. CHANDLER
RESEARCH: MARDEN J. FLYNN, ROBIN W. EMERSON
PRODUCTION: BARBARA CARRIGAN, ELLEN J. LANGEMAN
MAP EDITOR: GUS PLATIS

PAINTINGS BY WILLIAM H. BOND

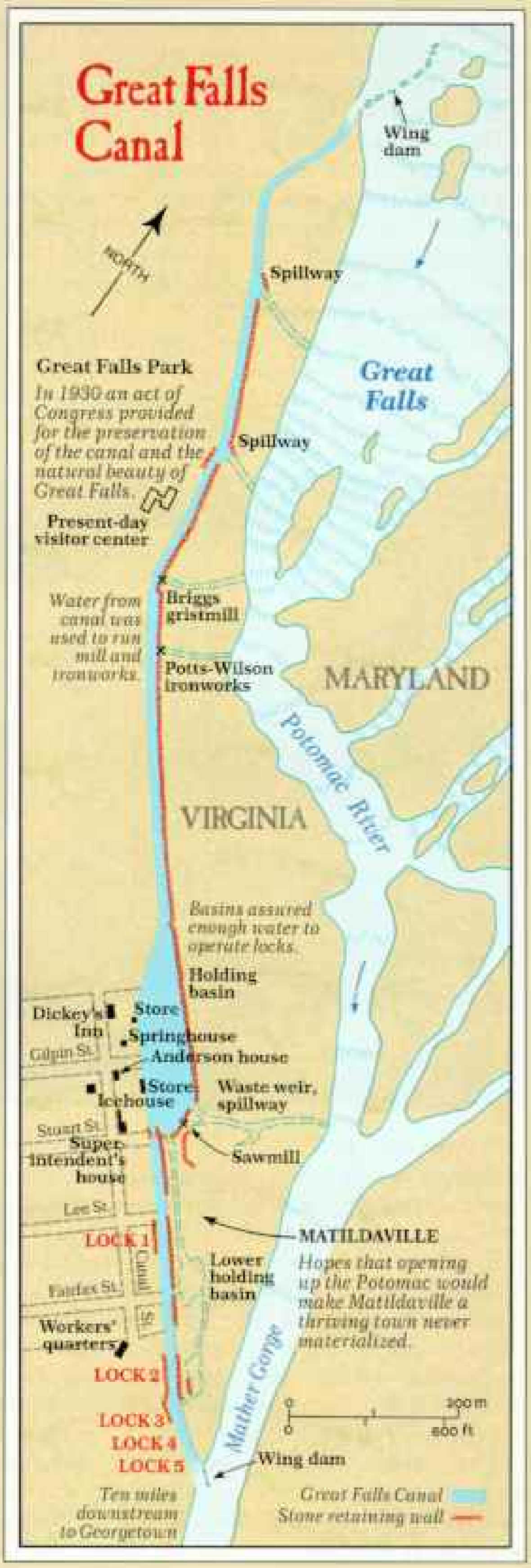
Patowmack: Route to the West

"ARISING EMPIRE" was Washington's vision of the lands and vital river highways beyond the mountains, and he invested both time and money in that empire's future. For his service in the French and Indian War (***map, left***) Washington was given extensive claims in the Ohio Valley and purchased others from fellow veterans.

Already a major landholder in the Potomac Valley, he traveled down the Ohio to the Great Kanawha River in 1770 to select and survey the new properties. After the Revolution he advertised for lease 30,000 acres that "by laying on the So. East side of the Ohio can give no jealousy to the Indians" and promised that "a great deal of it may be converted into the finest mowing ground imaginable, with little or no labour."

In 1784 he investigated means of linking the Potomac with tributaries of the Ohio. Greatly alarmed by separatist sentiments and foreign threats on the frontier, he pushed for the creation of the Patowmack Company, charged with making the river navigable from the seagoing port of Georgetown to Cumberland, near a pass through the Appalachians.

The company's strategy was to skirt five areas of falls. Traffic would follow the riverbed for most of the route. The greatest obstacle and engineering feat was faced at Great Falls. Side routes around other unnavigable points were completed long before the Great Falls locks opened in February 1802 (***right***), two years after Washington's death. Shown in full operation (***foldout, preceding pages***), five locks, three of which stairstep through a rock cut, raise and lower boats past the falls. Workmen heave at levers to open the gates. Stores, barracks, and other buildings near the holding basin constitute the settlement of Matildaville, envisioned as a manufacturing center and entrepôt for Potomac and Ohio Valley produce. Water powers a sawmill, foundry, and gristmill beside the river.



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retired from all public employments, but I am retiring within myself; and shall be able to view the solitary walk, and tread the paths of private life with heartfelt satisfaction. . . . I will move gently down the stream of life, until I sleep with my Fathers."

How wrong he was! He still had a country to father. Retirement to gentleman farmer was brief. The tall, vibrant, 52-year-old veteran, rested and raring to go, wrote to Thomas Jefferson in March 1784: "Respecting the practicability of an easy, and short communication between the Waters of the Ohio and Potomac. . . . I am satisfied that not a moment ought to be lost in recommencing this business."

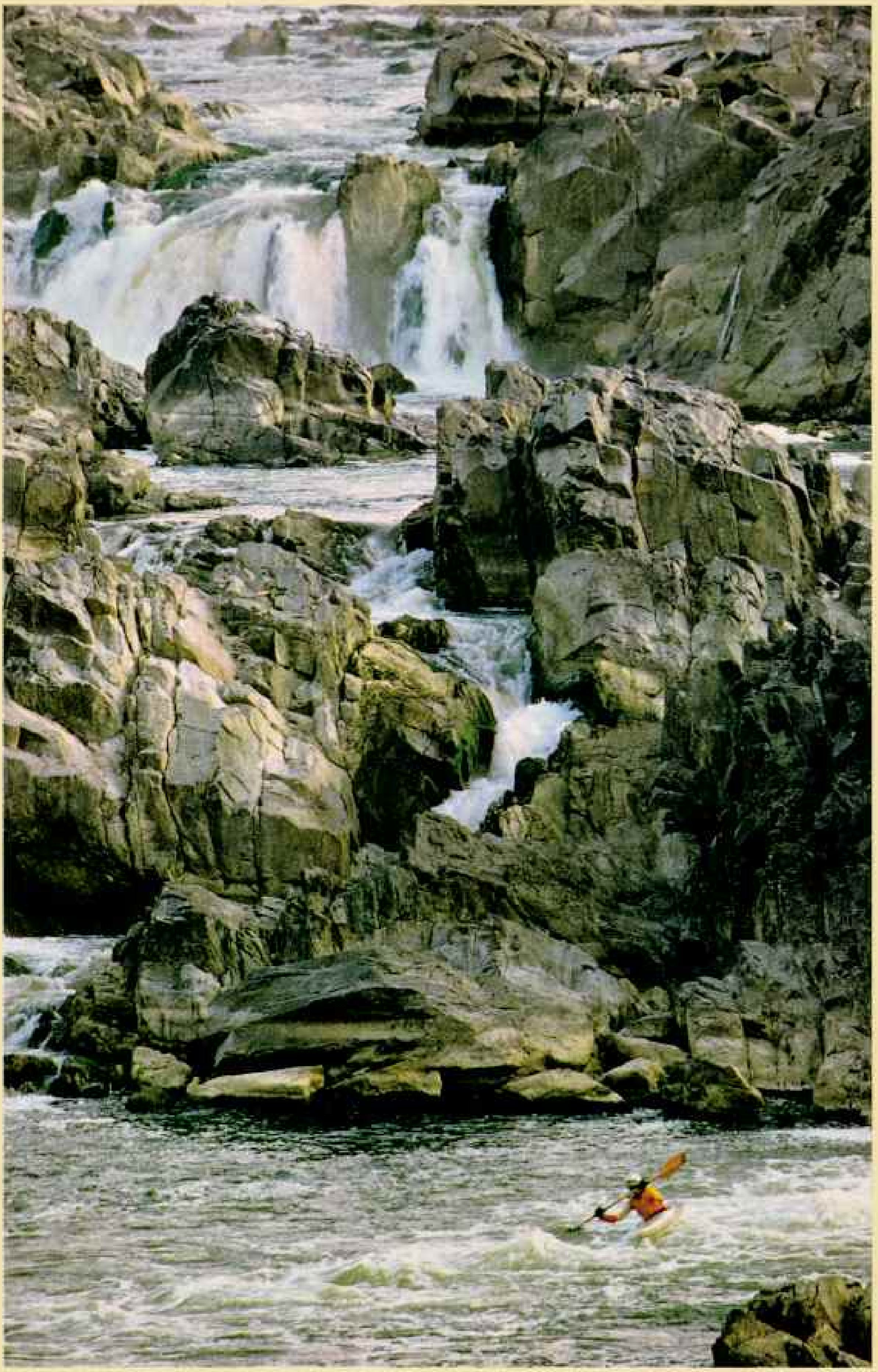
By 1785 Washington, now a national hero and a skilled politician, had lobbied the legislators of both Virginia and Maryland into formalizing his dream by chartering the Patowmack Company. "The choice of a President . . . ," he noted in his diary, "fell upon me." But before the canal could work, Virginia and Maryland had to resolve differences and distrust and agree to free trade on Potomac waters. At a congenial meeting of leaders from both states in March 1785 at Mount Vernon—probably graciously enhanced by Madeira from its well-stocked wine cellar—Washington started the ball rolling: perhaps a bigger roll than even he expected. The delegates recommended compromising on state waterway rights. Both legislatures ratified the resulting Mount Vernon Compact—an illegal act, since the Articles of Confederation forbade treaties between the states without approval of the Congress.

The legislators quickly called for another meeting in Annapolis in September 1786 to discuss other interstate problems, with all 13 states invited to send delegates. With commercial interests in several states eyeing the Ohio country, Washington

*Falls and floods wrote the history of the Patowmack Company. At normal flow the river cascades through Great Falls (**right**), ten miles above Washington, D. C., dropping 77 feet in three-quarters of a mile. A flood in November 1985 (**below**) gathered water from the Potomac's upper drainage into a torrent that hid the falls and filled part of the old canal bed, visible beside National Park Service buildings.*

WILBUR E. GARRETT (ABOVE)

High water often hampered the Patowmack Company's construction work and inundated its operations. But low water proved the more intractable problem. A boat with one-foot draft would find enough water to float the length of the waterway on an average of only a few weeks a year. This unreliability sent trade via other routes, sealing the company's ultimate demise.



clearly needed more than just Maryland and Virginia support.

The Annapolis Convention was a failure, but delegates approved a resolution drafted by Alexander Hamilton calling for another meeting: "at Philadelphia on the second Monday in May next, to take into consideration the situation of the United States . . . to render the constitution of the Federal Government adequate to the exigencies of the Union."

Though it was Washington's lobbying for his canal that led to Philadelphia, it was obvious there was much more at stake. The Confederation wasn't working. The ship of state was sinking. In Philadelphia, Washington was elected president of what became the Constitutional Convention. The delegates wrote a document that even former British Prime Minister Gladstone declared "is the most wonderful work ever struck off at a given time by the brain and purpose of man."

U. S. FLAGLER COLLECTION

OUR STORY BEGINS on the Potomac River where Washington's dream was born. Ten miles above Washington, D. C., at the Great Falls of the Potomac, the river bashes itself down, over, and through a gantlet of cascades in a crashing tumble toward tidewater, creating one of the most scenically dramatic obstacles to navigation in the United States.

Alongside Great Falls in Virginia 185 years ago, a series of five locks on the Patowmack Canal began gently lowering boats around the falls, and they continued until 1830, when a successor across the river in Maryland—the Chesapeake and Ohio Canal—took over the job.

For a century and a half after the locks shut down, they were ignored and virtually forgotten. For the past quarter of a century they've been the derelict, deteriorating wards of the National Park Service. They go unnoticed by most visitors, who have to walk over the ruins to reach the falls. To add insult to George's dream, the film shown in the Great Falls Park visitors center is titled "The Magnificent Failure" and refers to the canal as "Washington's folly."

Washington certainly would have disagreed. His company built five bypass canals to skirt rapids and waterfalls and improved miles of riverbed that did indeed make the Potomac navigable. The waterway operated in various stages of completion and competence from 1788 until 1830 and brought more than ten million dollars' worth of produce (perhaps 15 times that at today's prices) from the upper Potomac and the Ohio country to Georgetown. At least one shipment of furs from Fort Osage

on the Missouri River used his waterway around 1810 as the last leg of a 2,000-mile trip—all of it except 130 miles by water.

Washington's scheme was to draw the people and lands west of the original 13 Colonies into the United States. He feared that the rapidly growing population beyond the foothills of the Appalachians would take their business and loyalties to the Spanish via the Mississippi or north to the British through the Great Lakes.

He warned all who would listen: "The Western Inhabitants . . . composed in a great degree of Foreigners . . . can have no predilection for us; and a Commercial connexion is the only tie we can have upon them." "We shall . . . bind those people to us by a chain which never can be broken." "The flanks and rear of the United States are possessed by other powers, and formidable ones too. . . . The Western settlers . . . stand as it were upon a pivot; the touch of a feather, would turn them any way."

Dick Stanton, canal historian and superintendent of the C & O Canal National Historical Park, feels Washington's project succeeded and invited me upriver to see why. A one-man public relations team for the Potomac and its old canals, Dick may know as much about them as any man alive.

"I've been on this river most of my life. As a boy in Washington I begged rides in any canoe I could get into. I've logged 8,000 miles on the river since. I'm rabid at the charge that the Patowmack and C & O Canals were follies or failures. The Patowmack Canal probably did save the Ohio country. Sure, neither one made money for stockholders, but for more than a hundred years people up here made a living off these canals."

*Prominent and wealthy shareholders of the Patowmack Company, founded in 1785, gathered at Wise's Tavern in Alexandria on August 7, 1786, to review the corporation's progress under its president, George Washington. In the same building, now called Gadsby's Tavern, a re-creation (**below**) places Washington at left with other Maryland and Virginia gentlemen.*

It's easy to say now that Washington's waterway should have included more flat water channels, but locks were expensive. In the new nation optimism was sometimes all the leaders had to work with, and bad river travel was better than forest trails.

From the first Europeans to see the Potomac through Washington himself, the river was looked upon as an avenue to someplace else. Capt. John Smith, in his search for the elusive Northwest Passage, was stopped by Little Falls just above the present site of Washington.

But the river was navigable for the Indians, who apparently came from great distances on it and other rivers to trade—starting almost 10,000 years ago. The Indians Smith met in 1608 had steel knives and hatchets traded from the French in Canada.

A European traveler in 1712 watched Indians make a boat "in less than half a day . . . of the bark of trees" and marveled at

*A roster of original shareholders (**facing page**) records Washington's purchase of five shares, at 100 pounds sterling apiece. Virginia gave him 50 additional shares, which he placed in public trust for the advancement of education. But all shares ultimately proved valueless as the company failed to turn profits, despite hopes reported from the 1786 meeting that "the great national Work . . . is prosecuted with an Industry and Ardor, truly characteristic of the illustrious President."*

their use of it: "The turns they had to make, and what inexpressible skill was needed to steer this canoe or boat, we almost thought there was some magic in the act, especially when we heard the Indians singing as they passed at great speed, almost striking against a great stone or rock."

WASHINGTON studied various routes to the West and selected the Potomac River through Fort Cumberland, up Will's Creek, and across a 65-mile land route to Ohio River waters (map, pages 723-4). He knew the Cumberland area well enough to have been invited in 1755 to assist Maj. Gen. Edward Braddock in a planned attack on Fort Duquesne—now Pittsburgh.

In an ambush en route to the fort, George had two horses shot from under him and took four bullets through his coat, but he escaped injury. Many historians attribute the disastrous loss to the stupidity of General Braddock. As one of the dead, he couldn't defend himself, but Virginians' zeal for a westward route through their own lands may well have been more to blame. There was already a Pennsylvania road to Fort Duquesne. The wilderness trek—where guerrilla-like Indian tactics were so effective—was probably unnecessary.

Washington's men buried Braddock in the road and drove wagons over the grave so Indians wouldn't find it. In 1824 a road-repair crew came across remains with insignia indicating they might have been the general's.

The first Europeans to reach the Cumberland site, about 1728, had found a stockaded Shawnee Indian village in place. Over the years it evolved into a storehouse town for the Ohio Company, a fort, a canal town, a railhead, a coal depot, and the start of Thomas Jefferson's National Road. At times it was the most important town on the frontier. Then the frontier moved on, canals died, and, eventually, railroads faded in importance.

The four-man boat crews that left Cumberland for the three-to five-day dash to Georgetown supplied themselves with 30 pounds of bacon, some bread, tea, and sugar, four tin cups, 20 feet of rope, and two gallons of whiskey. The first boats to reach Georgetown could demand top prices for their cargoes. Those rivermen were working hard to stay alive. If they were lucky, they might make a few extra shillings, buy some land, and conquer a piece of western wilderness for themselves—if the Indians didn't get them first.

At first the Patowmack Company accepted only gold and

The clink of metal was the only sure sound of money after the Revolution. The Patowmack Company initially required that tolls be paid in foreign coins, the major hard currency in circulation. Coins of the canal era, arrayed below, are (clockwise from top left): French six-livre and five-centime pieces; Spanish-American two-real and one-escudo pieces; Welsh privately minted copper halfpenny; Virginia halfpenny; English shilling and guinea; and Portuguese 400-rei piece.

ARTIFACTS COURTESY NATIONAL NUMISMATIC COLLECTION, SMITHSONIAN INSTITUTION

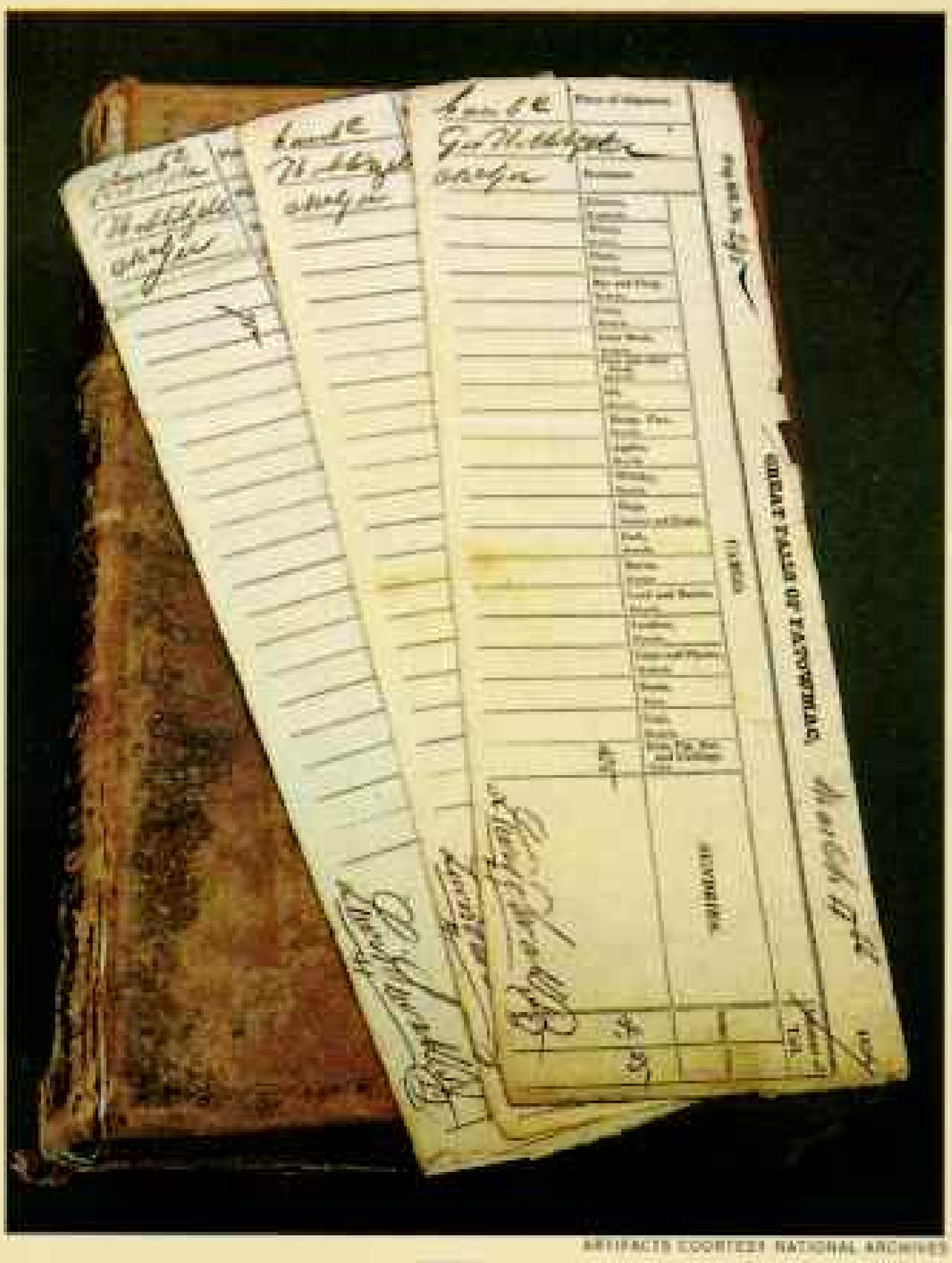
Paper dollars were issued by state-chartered banks and varied in value according to a bank's soundness and proximity. The loose alliance under the Articles of Confederation, predecessor to the Constitution, failed to establish a national currency or to regulate interstate commerce.

Continental dollars printed in Philadelphia from 1775 to 1779 were officially valued at 1/100 face value when redeemed in 1790—giving rise to the phrase "not worth a continental."

silver coins for tolls. Since there were few U. S. coins, Spanish, French, British, Portuguese, and even Arab specie was accepted. With not enough trusted money in circulation, barter was common and whiskey a favorite trade item. Wheat, corn, and rye, being bulky, were usually converted to flour and whiskey for shipping. Boats also carried pig iron, pork, beef, tobacco, ginseng, linseed oil, and even cast-iron stoves and walnut gunstocks.

Practicality and Patowmack Company rules narrowed the choices to two basic boat designs. The sharpers—such as Joe Ayers's replica—were better built, with both ends tapered. They were as much as 70 feet long and seven wide. The others, about the same size but little more than rafts, were usually sold at the end of the trip for lumber or firewood. A tarpaulin was sometimes stretched over bent poles—like a Conestoga wagon—to keep the cargo dry.

The sharpers, lightly loaded for the return trip, carried a variety of manufactured goods to the frontier. Polemen walked the planks as if on a treadmill. In some rapids, ropes or chains were fixed to the walls to help them. One boatman complained that getting a boat back to Cumberland was "the hardest work ever done by man." Nevertheless, they often raced back to Cumberland. Townspeople cheered the winner.



ARTIFACTS COURTESY NATIONAL ARCHIVES

Frontier wealth was measured in barrels, hogsheads, and tons and duly recorded for toll as it passed the locks at Matildaville. Flour, the greatest bulk item, was followed in value by whiskey and pig iron. Three toll cards from the same day in 1827 list cargoes from Cumberland. After the downriver trip—three to five days from Cumberland to Georgetown—many boats were broken up for lumber rather than used for an arduous ten- to twelve-day return upstream.

TO SEE THE WATERWAY from a boatman's level, I canoed the river from Cumberland, Maryland, to Washington, D. C. Since I lacked the Indian's magic with a canoe, son Kenneth—veteran of several thousand miles of river running—joined me as photographer and number one paddle.

Downriver from Cumberland at Oldtown, Maryland, the site of a privately owned toll bridge, we visited the Michael Cresap house. Maybe the toughest man ever to part these waters was his father, Thomas Cresap, a Yorkshireman who spent some 70 years on the leading edge of the frontier. After a clash with Pennsylvania authorities over a land title in 1736, he was captured and cuffed in irons because he was so dangerous. As soon as the smithy finished applying them, Cresap raised his shackled hands and decked him for his trouble. When Cresap was released nearly two years later, he moved to Maryland and never forgave the Pennsylvanians. Maybe they weren't all wrong. A Braddock aide referred to him as a "Rattle Snake Colonel, and a D——d Rascal, calls himself a Frontiersman."

Washington had found his deceased father's surveying

"George was a farmer," says Dr. John Augustine Washington at his West Virginia estate, Harewood, originally the home of George's brother Samuel. "He realized that the fertility of lands here was something they didn't have in Tidewater," where tobacco had leeched the fields.

Completed in 1770, Harewood came to the now retired Washington, D. C., pediatrician by descent via six generations. When George first surveyed the Virginia uplands, he and half brother Lawrence bought tracts here. On Lawrence's death three of Washington's brothers each inherited part of his holdings. Always drawn to the area, George might have joined them had he not inherited Mount Vernon.

instruments when he was 14 and quickly learned to use them. This led to an invitation to join George William Fairfax in 1748 on a trip to survey part of the five-million-acre holdings of Thomas, Lord Fairfax. Torrential rains forced the party to stay at Cresap's fortified house for four days.

It was there that George probably had his first contact with Indians—at least an Indian war party. Thirty young warriors stopped to see their friend Cresap on the way home after a disappointing trip—they had only one scalp to show for their fighting. Nevertheless, the Indians agreed to dance for the surveying party. They stretched a deerskin over a pot to make a drum, built a large fire, and soon were performing.

The tenderfoot learned both the rigors and the joys of sleeping on the ground, especially when straw beds proved to be full of lice. The young aristocrat noted in his journal that another host provided "neither a Cloth upon the Table nor a knife to eat with." The river as a highway looked good to young Washington, who found that the road to Cresap's place was "the worst Road that ever was trod by Man or Beast."

It was then, too, that George sensed not only the value of the Potomac as a waterway but also the potential land values in the West. He saved enough money to buy his first piece of Shenandoah land when he was only 18. From then on the navigation project and Washington's craving for land were two sides of the same coin. He admitted in one letter that his plan to develop the Potomac could seem to be self-interest. Though no one ever questioned his honesty or loyalty to state and

country, today he would probably be accused of insider trading.

In 1767 he wrote to William Crawford, his old friend and partner in land speculation: "By this time it may be easy for you to discover, that my Plan is to secure a good deal of Land. . . . I would recommend it to you to keep this whole matter a profound Secret." Of circumventing a restriction on buying western lands, he wrote to Crawford, "I can never look upon that Proclamation in any other light (but this I say between ourselves) than as a temporary expedient to quiet the Minds of the Indians and [it] must fall of course in a few years especially when those Indians are consenting to our Occupying the Lands."

In 1784 he advertised 30,000 acres for lease: "The So. East side of the Ohio can give no jealousy to the Indians, the proprietors of it . . . may cultivate their Farms in peace, and fish, fowl and hunt without fear or molestation." Maybe. There was no Federal Trade Commission to regulate land promotions, but the Indians could be even tougher regulators. His partner didn't live to see these lands rented or sold. Crawford was tortured and burned at the stake by Indians near Upper Sandusky, Ohio. On hearing the news Washington was "excited to tears."

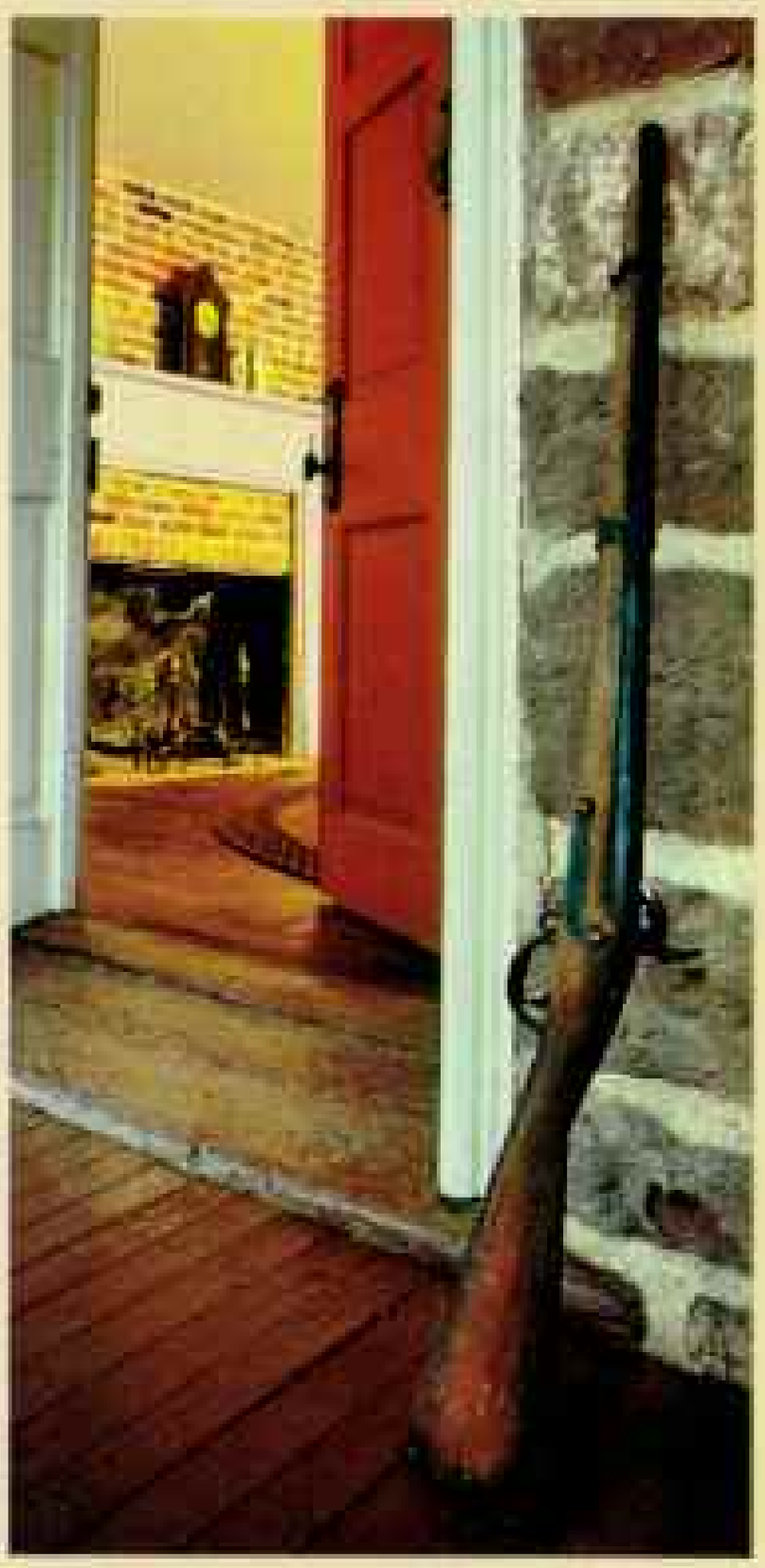
BELOW OLDTOWN we swam where the Potomac's South Branch joins the North. At the campfire that night my Geographic associate Ralph Gray reminded us that there was a time when we wouldn't have dared.* "Forty years ago parts of this river smelled so bad you didn't even want to canoe it." In 1965 President Johnson called the Potomac "disgraceful."

The only pollution we suffered from that night was noise. We had camped too close to the railroad tracks. There's almost no place along the upper river where you can't hear the lonesome wail of trains in the night, but it seemed every train on the East Coast wailed, rattled, and roared through our tents. When I beefed about the noise, Ralph said: "That's the sweet sound of money up here. The railroads move more goods through here in one night than moved on George's canal in a year."

Washington lived along the river, traveled its waters, and even fished it commercially. He wrote of its potential often. I hope he also felt its lulling charm when you ship your paddles on a summer afternoon and drift with a lazy current. The world slows until the panorama of fields and forests seems to float by while you and time stand still. Stately herons feed and fly in slow motion. The river seduces with a deceptive gentleness as it licks at the banks and gurgles past rocks and logs.

It was this Potomac Washington wanted to develop. But then there's that other river, the rabid animal, flushed with red earth and swollen with snowmelt or frog-strangling rains. It leaps its banks, brutally sweeping all before it, leaving gouged fields and splintered forests. Such floods—which can push a million gallons a second over Great Falls—followed by frustrating drought, plagued construction and use of his river-canal. Extremes of high and low water made it dangerous or impassable all but 30 to 45 days a year. Even then it took skill and courage to

*See "Down the Potomac by Canoe" in the August 1948 issue.



Muster was held at Michael Cresap's house in Oldtown, Maryland, to meet George Washington's call to arms at the outset of revolution. From here a troop under Captain Cresap marched off to Boston. A later era musket, made at the Harpers Ferry armory, stands by the door.

Cresap's father, Thomas, built the outermost house in Oldtown around 1740, after an earlier home was attacked by Pennsylvanians, Cresap's longtime enemies. The cantankerous frontiersman lobbied for Potomac-Ohio development and helped bring about formation of the Ohio Company, a pre-Revolutionary trading concern dedicated to opening the Potomac route west.

Water was power on the threshold of the industrial revolution. The Charles Mill, as it is called today, was situated on a stream suitable for a mill-race on the Potomac's Maryland side. Mills have been on the site since at least 1750.

*Stone walls and a waterwheel stand where a photograph from early in this century shows the millhouse (**above,** right foreground), put out of business by a flood in 1924. Defunct mill machinery includes a wooden bearing (**right**) that was adjusted as it wore by tamping*

CHARLES MILL PHOTOGRAPH COURTESY BERNARD CHARLES COLLECTION

the spike to tighten the block in its center.

The mill's flour was probably shipped via the Patowmack Canal. A later enterprise, the Chesapeake and Ohio Canal, is visible at far right in the old photograph. The C & O acquired the Patowmack Company's rights and property in 1828 and functioned for nearly a century.

*Flour is still ground at the renovated Burwell-Morgan Mill (**left**) on a tributary of the Shenandoah, a route to the Potomac for 18th-century produce.*

ride a 20-ton load through the rapids at the water level required to make the 220-mile run.

We found Paw Paw, West Virginia, still hurting from the record-breaking November 1985 flood. Water had swept through at second-floor level, 29 feet above flood stage. At bends in the river uprooted trees still lay in disarray like weeds snatched from a garden. We canoed under one railroad bridge from which a huge tree hung, its branches jammed among the steel girders. With its roots now dangling in the river, it was trying to survive hydroponically—sucking nourishment from the Potomac.

Around the bend from Beanpatch Hollow—or "Holler"—we pass Doe Gully below Purslane Mountain. Washington once owned 249 acres here. It's a rugged and remote area little disturbed by roads. Unless we come too close, deer and birds ignore us. A mallard mother near the bank scurries and flaps around to divert our attention from her four ducklings, who—not seeming to understand the ploy—paddle frantically after her. Hunters on shore break the spell—blasting ducks out of season and out of sight of game wardens.

We go to sleep that night at the mouth of the Cacapon River to the chirping of tree frogs and the harrumphs of bullfrogs. We awake to an unexpected mid-June frost. A band of fog blankets the river. We warm up soon enough, paddling against a headwind that shoves us back upstream whenever we pause. No matter which direction the river snakes, the wind comes head on. Dick Stanton said that when he is tired he canoes the river: "It's a source of power." I can assure him it's also a consumer.

AFTER HUNDREDS OF MILES of lip-chapping, arm-wearying wind and only 32 miles of river we reach Big Spring, Maryland—site of the Charles Mill, reputed to have been milling flour long before Washington built his canal. Owner Bernhard Charles is installing pieces of a broken grinding stone into a patio. "This buhrstone came from France. My father was the last man in this area who could sharpen one." This one—broken many years ago—was the same kind Washington used to mill his own brand of flour at Mount Vernon. The 1924 flood that ended C & O Canal operations also washed out the Charles Mill.

Charles showed us around the three-story ruins. The once grand waterwheel—now slumped and rusting—transferred power for grinding through a huge steel cogwheel with maple teeth. Charles could remember the living mill: "When the wheel was working, you could hear the teeth meshing all over the valley. As a kid I used to grab hold and ride the vertical shaft round and round. We didn't grind just flour. Ships from Europe carried chalk as ballast. It was brought up here and ground into plaster."

He fished a wooden gadget out of the weeds. It was a near-perfect shaft bearing with grease still in the three-inch hole (page 734). One half slid neatly in grooves so that by tapping a wedge the miller could take up slack from wear. I grimaced when he tossed the beautifully made artifact back in the weeds.

An ancient pastime lures Ben Schley and his fly rod to the remains of a fish weir in the Potomac below his home in Shepherdstown, West Virginia. The funnel-shaped rock walls, plugged with a net or basket, were constructed over centuries by Indians and settlers. The river's numerous weirs posed a major hazard to Potomac shipping. Perhaps as long

*as 1,300 years ago Indians carved a petroglyph (**bottom**) that may have marked a prime prehistoric fishing spot.*

Once badly polluted, the Potomac benefited from a major cleanup after President Lyndon B. Johnson called it to national attention in 1965. "The smallmouth bass fishing is just as good now as it was 50 years ago," Ben Schley reports.

"Don't know what to do with it," he said. "Hate to burn it."

Like Washington, Charles is a licensed surveyor. Near the spring, beside a patch of wild strawberries, he cleared away weeds to reveal an "A" carved in a rock. "Nobody knows what it means, but we think it was the surveyor's mark from the original survey of 1745. My father showed it to me, as his father did to him, and as I did to my kids. But they don't care."

Every spot along this river has its own page in our history. Shepherdstown, West Virginia, has several. It was considered for the site of the nation's capital by George Washington himself. To any resident of Shepherdstown, "Who invented the steamboat?" is more than a question in a trivia game. They

THE FISH petroglyph found on the Potomac is similar to others along the Susquehanna River. Carved into the stone, two concentric lines surround a diamond-shaped stylized fish. Three concavities in the center represent its eyes and a mouth.

DRAWING BY GEORGE E. STUART

damn well know and are quick to tell you that it wasn't Robert Fulton—his came 20 years later—and it sure wasn't that "impostor" John Fitch of Philadelphia, who claimed *he* was first.

Two hundred years ago on December 3, 1787, James Rumsey took several ladies and a little girl named Ann on the first (according to Rumsey fans) steamboat ride in history. It was a beautiful day, and at an early hour hundreds of people began arriving to see a boat that would move without oars, sails, paddles, or poles. It was said that "the crazy man was going to run his canoe with a steam kettle."

Witnesses testified that when the boat shoved off "she paused for a moment and then, by a sudden impulse steamed off up the stream, against the current of the river amid the shouts of the excited multitude upon the shore. General [Horatio] Gates removed his hat and exclaimed, 'My God, she moves.'" And she did—for two hours—up and down the river. Jay Hurley of

The coming age of steam, which would unlock upriver travel throughout the nation, had a preview in 1787 when two American inventors, James Rumsey and John Fitch, demonstrated steamboats they had invented. The two wrangled over the precedence of their inventions in one of the nation's first patent disputes; both eventually received patents.

In Shepherdstown, where Rumsey demonstrated his boat on the Potomac, Jay Hurley **(above)** *and fellow members of the Rumseian Society are building a half-size working model of the 48-foot craft, drawing on patent-case depositions, a treatise by Rumsey, and a drawing submitted for a Pennsylvania patent. Rumsey's revolutionary water-tube boiler, the iron box beside Hurley, required far less space and weight than conventional steam engines. It powered a piston that drove water through the box keel in a prototype of jet propulsion.*

Shepherdstown told me that was because Rumsey hadn't included a stop valve. She ran until the steam died down.

Hurley, who played Rumsey in the town's celebration last year, does more than dress and act the part. Like Rumsey, a jack-of-all-trades, he's building a half-scale model of Rumsey's steamboat, with one improvement: a stop valve. "People still refer to him as Crazy Rumsey," Hurley told me, "but anyone who had the ear of George Washington, Thomas Jefferson, and Ben Franklin couldn't be a buffoon. I play him as a gentleman."

In 1785 Washington had hired Rumsey to build his canal, but he quit in less than a year to get back to his boat. Washington, also impatient for the invention that would help his navigation project, urged Rumsey to hurry. After his success at Shepherdstown, while in London to raise money, Rumsey had a stroke and died. His boat never succeeded commercially, but his impact on the industrial revolution is incalculable. His water-tube boiler design eventually became the world standard for all steam engines—from power plants to ocean liners. Today a 75-foot granite column on the riverbank at Shepherdstown memorializes the inventor of the steamboat—the not-so-crazy Rumsey.

Soon after Rumsey was hired by the Patowmack Company, he joined Washington and numerous directors and shareholders to inspect the river. All agreed locks were not needed at Shenandoah Falls at Harpers Ferry. Instead they'd dig a mile-long sluice to smooth the 15-foot drop. Across the river at House Falls another bypass would help navigate a three-foot fall.

Washington cautioned Rumsey that if he had to hire more than a hundred hands, he should "give information to the President least any disappointment should happen in the ready payment of the company's debts, which by all means is to be avoided." Optimism ran high, but from the beginning money

was a problem. Many stockholders never paid what was due. Like most such projects, costs exceeded funds, and there was no federal money to bail them out.

KENNY AND LAGREE: Locks are still not needed at Shenandoah Falls, but we study the run carefully. Between Washington and Cumberland seven dams were eventually built to feed river water into C & O Canal locks. All but numbers four and five have been removed by man or floods, but here at the ruins of number three, steel spikes stand waiting in rapids like dull can openers for unsuspecting canoeists.

We emerge from the rapids at the point where the Shenandoah merges with the Potomac; our canoe is scarred but unopened. The Patowmack Company undertook navigational improvements on the Shenandoah as well as the Potomac but—over its head and budget—surrendered the job to another company.

Washington built the national armory at Harpers Ferry because of its access to water power. Thomas Jefferson, more romantic, was smitten by the view: "On your right comes up the Shenandoah, having ranged along the foot of the mountain an hundred miles to seek a vent. On your left approaches the Patowmac, in quest of a passage also. In the moment of their junction, they rush together against the mountain, rend it asunder, and pass off to the sea. . . . This scene is worth a voyage across the Atlantic."

All this sundering was long over when we arrived at Harpers Ferry, which embraces its view and its history with a warm, economic affection. Washington's inspection party boated on to Great Falls, probably in a canoe hollowed out of a poplar tree.

Washington left the party at Seneca Falls. At Seneca Creek on the Maryland side, the red sandstone used in much of the canal construction was quarried. The Smithsonian Castle, the Renwick Gallery, and parts of Georgetown University were built with the same stone. Many of the mason's marks incised in the canal locks are also found in the Capitol and the White House. Capt. George Pointer, in charge of carrying stone to Great Falls, became impatient because of a jam of boats in the Seneca Bypass "with marble for the capitol. . . . I had to run outside . . . my boat Struck, I was precipitated out of her, and a broken Leg was the issue of it. . . ." His report indicates the canal was well used and was needed.

Today, though little known and seldom seen, the Seneca Bypass is the only section of the canal where water still flows as it did when the canal was operating—and sometimes that flow is as violent as in the falls it was built to avoid. The best surviving canal section runs for 150 feet and is 20 feet wide and seven feet deep. Even though I live just above these ruins—kayaking the cut when the waters are running and skating on the pool below it when winter freezes it—until recently I was not fully aware of the canal's starring role in American history.

Usually seen only by canoeists and kayakers, it lies hidden in a roadless forest only a few miles from the nation's capital. The area provides habitat for dozens of varieties of birds from the

FRED SCHRAUDER COLLECTION

"The ingenious Mr. Rumsey" was George Washington's description of the Virginia inventor who, in 1784, demonstrated for him a model of a boat that moved upstream by mechanically driven poles. Washington grasped its usefulness at once: "Rumsey's discovery [is] one of those circumstances which have combined to render the present epocha favorable above all others for securing . . . a large portion of the produce of the Western Settlements."

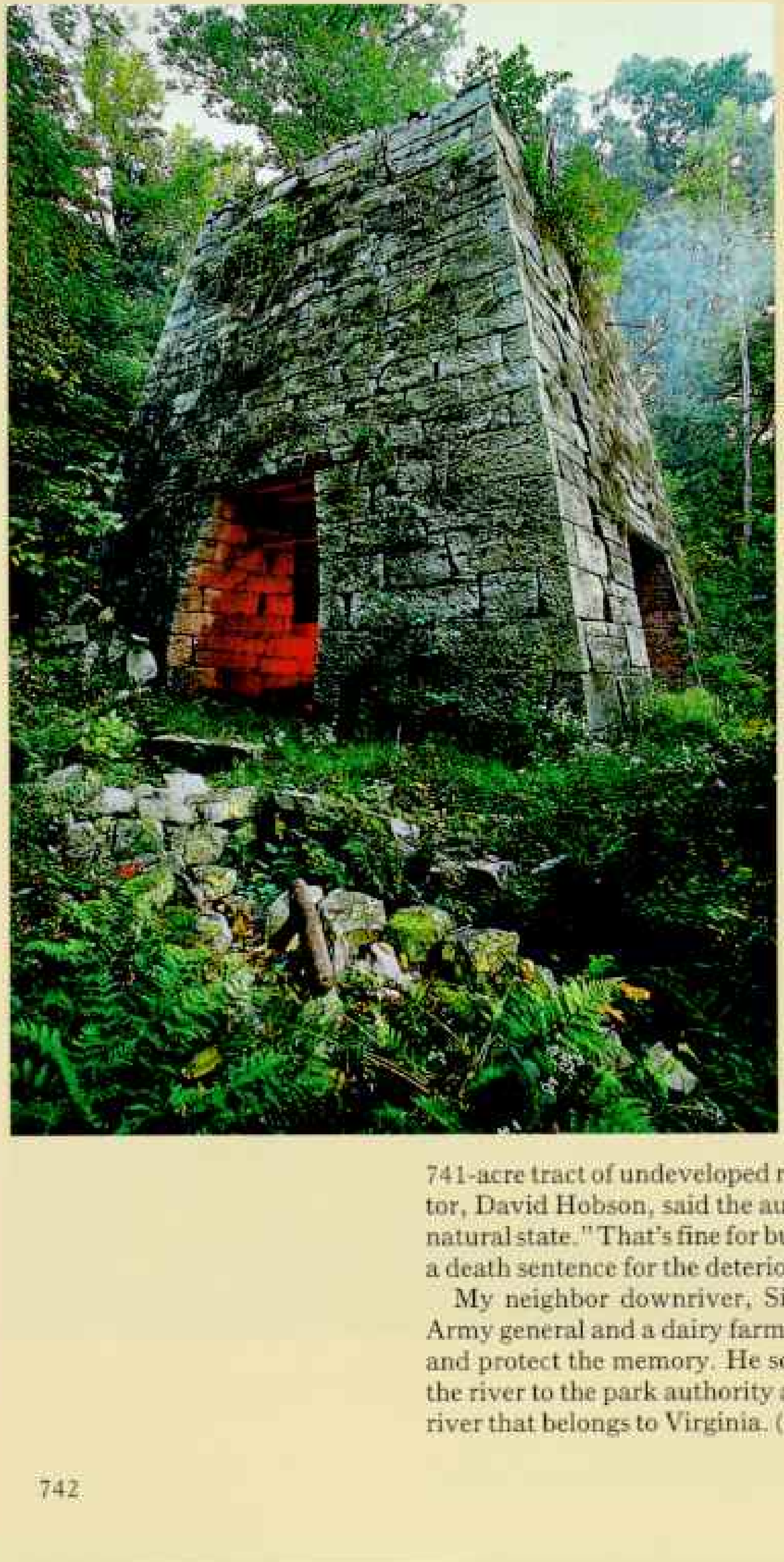
Rumsey abandoned his pole boat to concentrate on creating a steam-driven boat. Impressed by Rumsey's engineering, Washington engaged him as the Patowmack Company's first superintendent. The job went poorly, and Rumsey left to pursue his steamboat. After his demonstration on the Potomac he continued his work in England. There he died unexpectedly while completing a new craft, which admirers successfully demonstrated on the Thames in 1793.

Sister rivers join at Harpers Ferry, where the Shenandoah, at right, loses itself in the Potomac. A Patowmack Company canal on the Potomac's Maryland shore bypassed the junction rapids, carrying boats through a 15-foot drop over

1,760 yards. Locks and canals were also built on the Shenandoah, opening it to commerce with the Potomac; 220 miles were eventually navigable, at a time when the long, fertile Shenandoah Valley was among the nation's richest farming regions.

wild turkey to the pileated woodpecker—that chicken-size role model for Woody Woodpecker. I've seen fox, deer, possum, and muskrat here and followed beaver tracks in fresh snow beside the stone canal walls.

A ten-year-old study reports that Virginia's Seneca area qualifies for the National Register of Historic Places. Hundreds of spearpoints, stone axes, and arrowheads suggest that it has been occupied for at least 8,000 years. Indians farmed the fertile riverbanks after A. D. 700. European history dates from the grant to two Culpepers and five companions in 1649. My own property title traces back to 1709. By 1740 there was an inn nearby offering haven to travelers. One entrepreneur, John Ballendine, started a canal here two years before the Revolution but went bust.



Here, too, on the moonless night of June 27, 1863, Maj. Gen. J.E.B. Stuart forded the river with 3,000 Confederate cavalry in a belated attempt to help Lee at Gettysburg.

And then there's the canal itself, which rates several wows from friends when I convince them Washington really did build those walls they're standing on. It's tempting to try to keep the area a secret among the few of us who use it as a private retreat, but it deserves better. Certainly there's no push to preserve or dignify it with historic-register status by the present landlord of this riverside wilderness—the Northern Virginia Regional Park Authority. The authority inherited the artifact as part of a 741-acre tract of undeveloped riverbank. Its capital-area director, David Hobson, said the authority "intends to leave it in its natural state." That's fine for budgets and us bird-watchers, but a death sentence for the deteriorating canal.

My neighbor downriver, Sidney Spalding, a retired U. S. Army general and a dairy farmer, has done his part to preserve and protect the memory. He sold his very valuable land along the river to the park authority and gave it the only island in the river that belongs to Virginia. (All natural islands were granted

to Maryland, but Patowmack Island was sliced off the Virginia shore by the Seneca cut.)

NINE MILES below Spalding's Patowmack Farm, Ken and I reach Great Falls after polishing our canoe on a lot of hidden rocks. Summer drought makes the area unnavigable, with not enough current to create ripples. Like riverboats of old and all reasonable and cautious people today, we leave the river above the falls. An average of seven people a year drown between Great Falls and Little Falls.

We see the ruins of the only business to survive the closing of the locks here. Myers' Tavern—which became Dickey's Inn—was reputed to have served every President from Washington to Teddy Roosevelt. It closed in 1935 after 130 years. General Spalding—now 97—told me he ate there around 1914. "The food wasn't very good," he remembered.

In its heyday it had been the social center of Matildaville, one of the first planned towns in the United States. Entrepreneurs believed the available water power and the canal would spawn an industrial center. Light-Horse Harry Lee, father of Robert E. Lee, leased a site along the canal from Bryan, Lord Fairfax, and planned the town, which he named for his beautiful young wife, Matilda Lee, who had just died.

Only a few stones remain to show for all that 18th-century optimism. The vast majority of visitors to Great Falls Park walk past the ruins and over the canal without knowing they exist. Sadly, the whole project seems to have slipped from our national memory like a bad dream. Over the years token efforts to preserve the canal have popped up like mushrooms after a rain and lasted about as long. Though the canal locks still stand—or teeter—the whole complex needs friends as optimistic as those founding pioneers to preserve the site.

Park Superintendent John Byrne feels a personal and professional obligation to be one of those friends. He agreed the park needs a new film. "I don't know who labeled the project a 'folly.' We sure didn't."

Byrne, an engineer who also holds a law degree, will need a lot of bureaucratic skills, a bit of luck, and maybe a degree in psychology to succeed. In the heat of celebrating Washington's 200th birthday, Congress passed the 1930 Capper-Crampton Act that set up the park, with orders to look to the "preservation of the historic Patowmac Canal." And then Congress, the National Park Service, and everyone else forgot about it.

Even now, with the 200th anniversary of the Constitution

Wrecks were not infrequent in the swift current of the canal that skirted Seneca Falls, the only Patowmack Company canal section where water still flows. Today it is a popular run for kayakers and canoeists.

*Along its banks, Gen. Sidney Spalding (**below**) displays an iron "pig" found on his land at Seneca. It may have been part of a lost cargo from upstream iron furnaces, like one whose walls still stand near the Cacapon River (**facing page**). The same casting is shown resting on rubble of the millrace that powered the furnace's bellows.*

Smelting local ore, such furnaces produced crude, or pig iron, so called for the typical shape of the castings: "The main mold was the sow," says General Spalding, who worked for a pig-iron foundry in his youth in Lowell, Massachusetts, "with the piglets coming off to the sides."

stirring interest in history again, not everyone wants the canal restored. Bird-watchers man the barricades against history buffs who would clear the site of overgrowth. At a spirited public meeting to air differences, one canal buff shouted, "You're ignorant!" at a naturalist who had said the canal was a disaster. The naturalist countered with eyewitness proof that Byrne's clearing operations had destroyed an Acadian flycatcher's nest.

"I'm in business to save birds," pleaded the superintendent, "but I have a mandate."

Some canal buffs will settle for stabilization. Others insist the canal be rebuilt, rewatered, restored to its glory days. Since dissension can paralyze park aspirations and congressional appropriations, progress will be slow. And birders can be tough. Last year, at the urging of one group, National Park Service Director William Mott ordered stabilization work halted until a plan is approved.

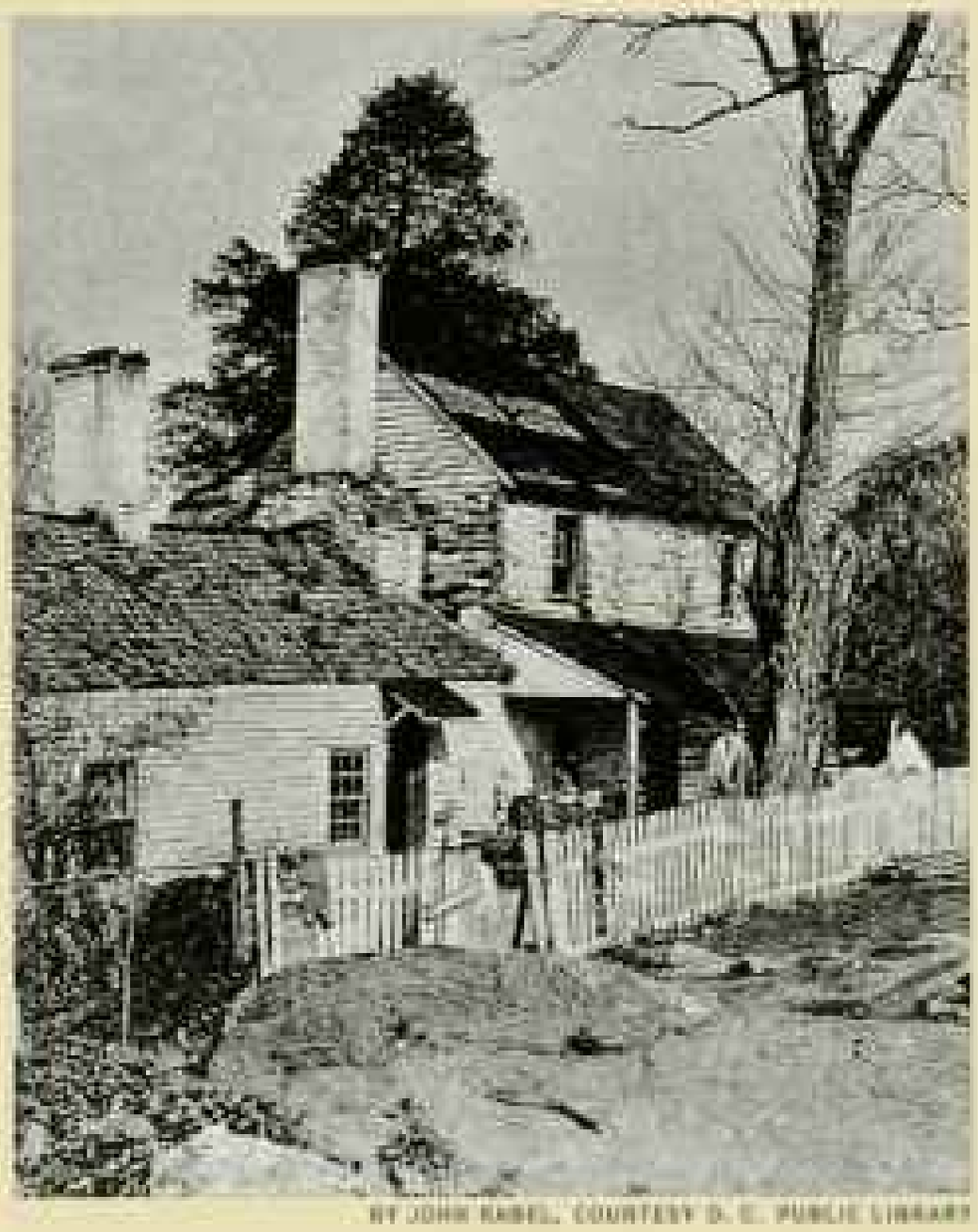
To help me understand the Park Service's preservation plans, Byrne takes me on a tour of the Great Falls canal site. To his educated eye, a string of rocks in the river is the "massive wing wall" funneling water and boats into the canal. Beside the path John sees a vague depression as the upper canal—clogged with boats and impatient crews. Just beyond the visitors center I see a jumble of old foundation walls, partly held together by tree stumps. John reconstructs the Samuel Briggs gristmill. More stones and a ditch are the John Potts-William Wilson forge and foundry.

My imagination needed little help with the five lock ruins that stretch the last half mile. Though some of the walls have been held up for ten years by ugly "temporary" props, they are impressive. Using a lot of sweat and black powder, workers hacked a notch in the wall of Mather Gorge for the last three locks by removing 4,300 cubic yards of rock. For 28 years the locks lowered thousands of boats 76 feet and 9 inches to slack water below the falls (pages 720-22).

WASHINGTON, ever the optimist, didn't think locks would be needed. (A sluice here like that at Seneca would have been a world-class amusement-park ride!) Rumsey convinced him locks were essential and proceeded to design them even though he had never seen one. Engineers have since said they were brilliantly conceived.

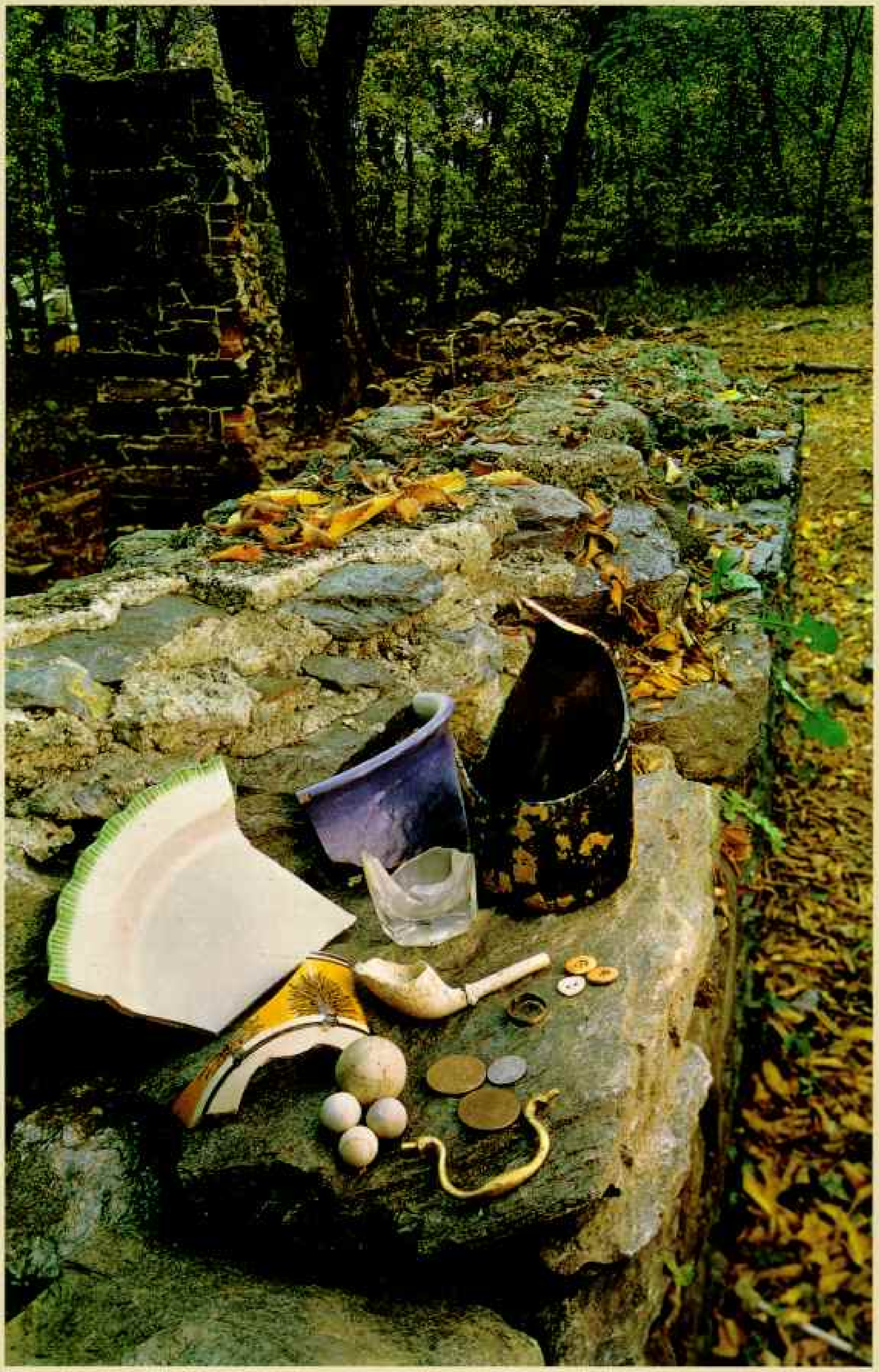
But troubles abounded. There was never enough money to pay bills. Workers were hard to find. To keep them happy, wages included three-quarters of a pint of rum every day. Rumsey wrote often of his labor problems: "Every time that they get a little Drunk, I am cursed and abused about their money in such a manner that contrary to my wish, I am obliged to turn abuser." Since the use of black powder in construction was not yet perfected, accidents occurred often: "We have Been much Imposed upon the last Two weeks in the powder way—we had our Blowers, One Run off the other Blown up. We therefore was Obliged to have two new hands put to Blowing."

*Founded for laborers and boatmen, Dickey's Inn (**below**, in a 1925 photograph) grew traditions of hospitality that lasted into this century. The only Matildaville business to survive long past the locks' 1830 closing, the log-cabin public house catered to weekend Washingtonians when Great Falls became a popular escape from the city. Presidents from George Washington to Theodore Roosevelt are said to have dined here. A turn-of-the-century rail line brought visitors to Great Falls Amusement Park, where an all-girl orchestra played in a lantern-lit dance pavilion.*

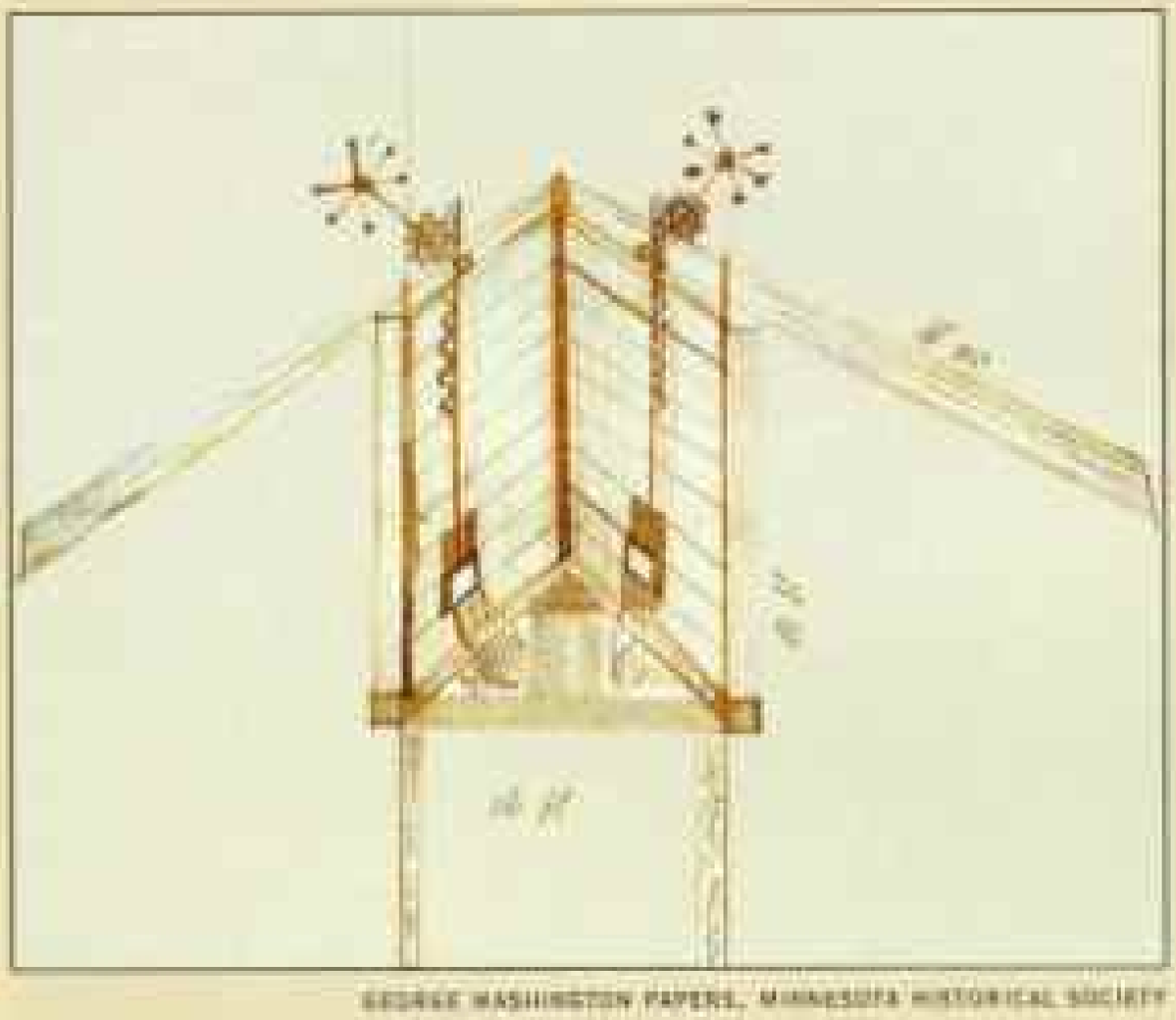


BY JOHN RABEL, COURTESY D. C. PUBLIC LIBRARY

*Long neglected, other ruins in Matildaville have recently received archaeological attention. Artifacts displayed on the foundation of the Patowmack superintendent's house (**facing page**) include parts of a wine bottle, tumbler, and other housewares, along with a clay pipe, marbles, coins, buttons, a ring, and a drawer pull.*



The challenge of lock building found no engineers in the United States with hands-on experience. Washington and Thomas Jefferson, a Patowmack Canal booster, first considered engaging an engineer from Britain or the Continent, where lock building had reached an advanced state. Then the decision was made to hire Rumsey. Visiting British engineers lent expertise at critical junctures.



GEORGE WASHINGTON PAPERS, MINNESOTA HISTORICAL SOCIETY

Rumsey designed lock gates but failed to build any during his one-year tenure at Great Falls, and his plans have not survived. This gate sketch shows guillotine-style sluices at the base for filling and emptying the locks while the main gates were shut. It was sent to Washington by Thomas Johnson, a prominent Marylander and an early ally of Washington for Potomac navigation. Evidence indicates that similar gates were built at Matildaville and later modified with butterfly-type sluices.

By the turn of the century there were still no working locks, but an incline had been built to lower boats and goods around Great Falls. A visitor in 1801 reported the holding basin crowded with boats and the hoisting machine working day and night. Flour came so plentifully that warehouses had to be built to store it. By 1802 the best of the superintendents, Leonard Harbaugh, finished the locks. The biggest obstacle behind them, boatmen still faced hazards—some man-made.

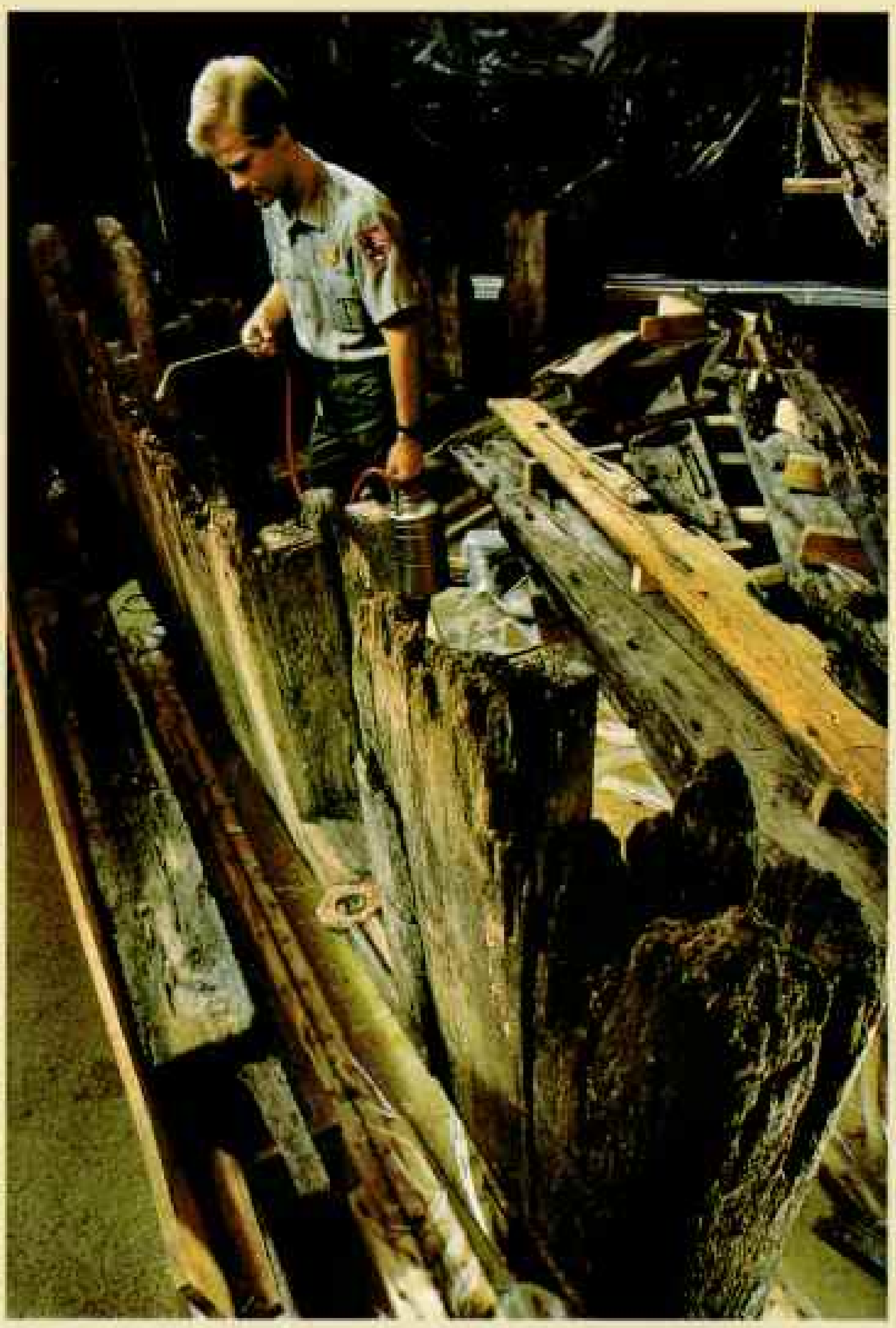
All along the river Ken and I found remains of V-shaped stone dams. Some were built as aids to navigation: By raising the water level at rapids, boats could scoot through the V as they would the tongue of a rapid. Others were built by Indians and settlers to trap fish by putting a basket at the V.

Washington declared that the "Fish Pots, of which there are many . . . clog the navigation." The same Capt. George Pointer who suffered a broken leg was assigned to remove them. Over many protests he ripped out 44 traps he deemed hazardous—at "the Risk of loosing my life by the inhabitants."

Pointer, born a slave, was permitted to buy his freedom for $300 while working on the canal. He became a supervisor and a company pilot leading boats down the river. Ironically, in 1829 he made a plaintive appeal to the directors of the C & O Canal because one of their men tore out *his* fish trap at Little Falls. He wrote that the new canal was also "drawing near my Little Cottage that I have occupied for 43 years, unmolested With an aged Wife and Some offspring. . . . I do trust in God, the giver of all things, that if the new Company does dispossess us . . . they will give me Some Little Place. God has prospered the old Canal that the father of his Country First brought into escistence and may he favour the new one." There is a record of a check to a Captain Pointer from the "old" company but no indication his plea was answered by the "new" one.

The last obstruction before Georgetown—the Little Falls that stopped John Smith and all who followed—had been defeated by Harbaugh with three locks by 1795, among the first locks built in America. Ken and I found only a token few rocks that can claim Patowmack Canal heritage. The C & O Canal was built over the old locks and over the dream.

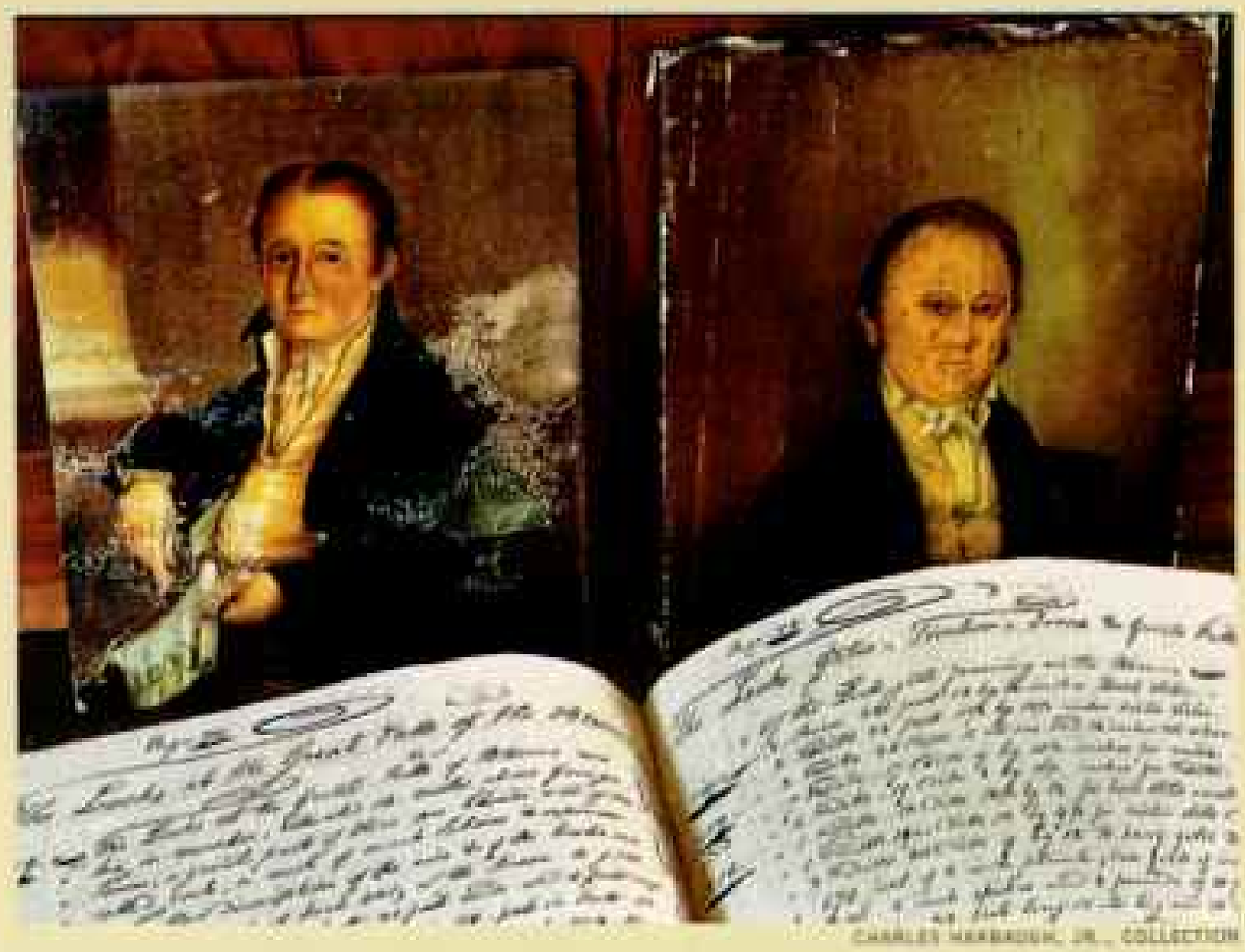
WASHINGTON'S WATERWAY was perhaps the last work of such scale attempted without federal support. It died in bankruptcy with all of its assets and liabilities turned over to the C & O Canal Company, launched on July 4, 1828. But events were moving fast. The new canal was doomed from its first day to disappoint stockholders. At almost the same moment that President John Quincy Adams turned its first shovel of dirt, 40 miles to the north Charles Carroll of Carrollton—the last surviving signatory to the Declaration of Independence— *(Continued on page 752)*



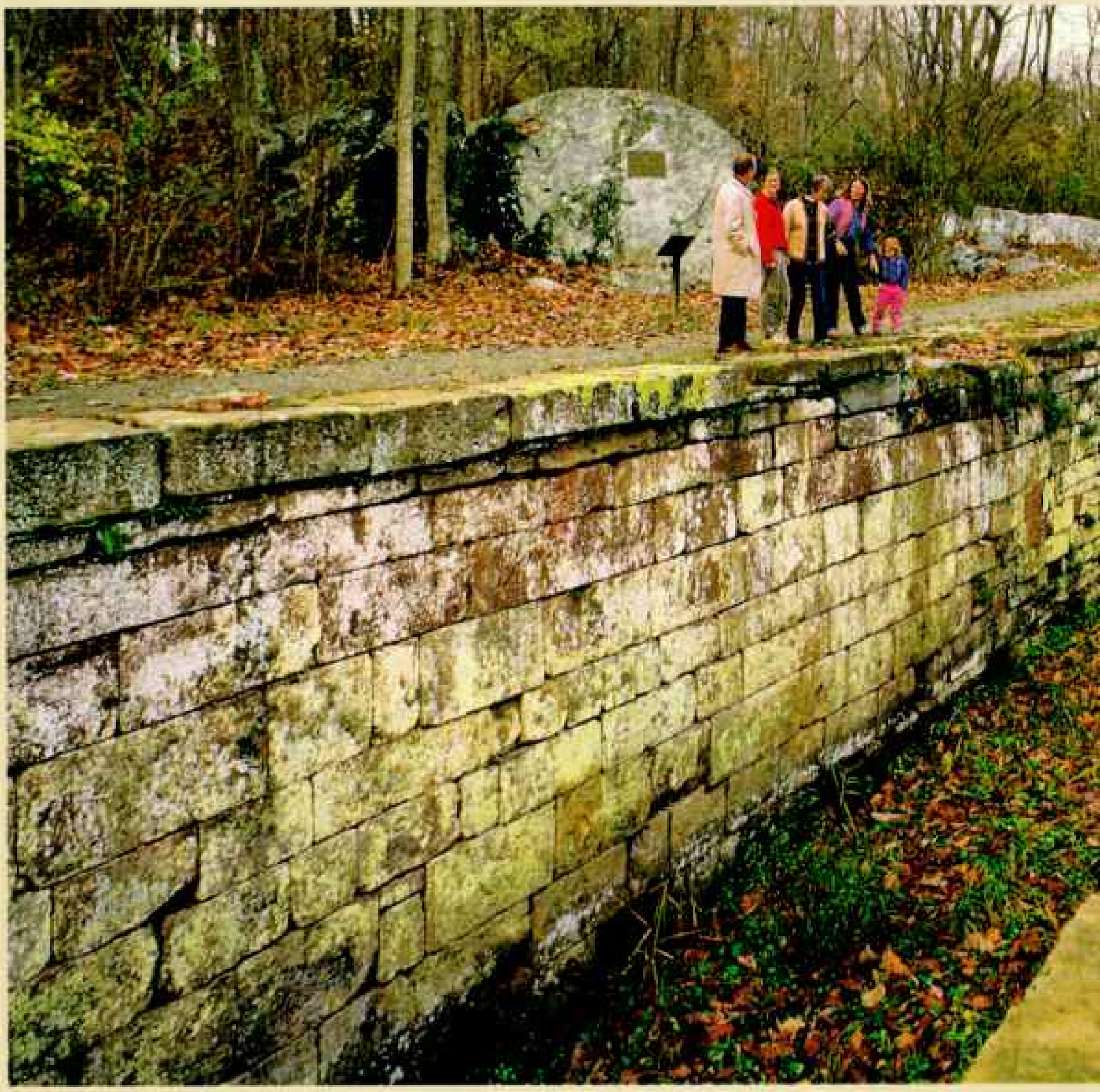
Mud was the savior of wooden beams and fragments from the base of a gate at lock one in Matildaville, found in 1982 excavations. Moved to an exhibit room at the Great Falls park facility, the gate section and miter sill—against which the gate fit when closed—are treated with polyethylene-glycol preservative ***(above left)*** *to protect against exposure to air. Attached to the gate, an iron ring* ***(above)****—possibly made at Matildaville's forge—served as a center pivot in a butterfly sluice at the base of the gate.*

At the foot of the massive concave quoin stones of a guard gate that protected the locks, National Park Service conservation specialist John Barrow studies a miter beam ***(left)*** *that will be left in place to protect it from decay.*

*The key to building the locks around Great Falls was finally found in the person of Leonard Harbaugh (**right,** at left). Work had been under way at Great Falls under a series of superintendents since 1786, but no locks had been completed there when Harbaugh took charge in 1797 after his success in circumventing Little Falls lower on the river. Harbaugh opened Great Falls' five locks in 1802. His son, Thomas, at right, also worked for the Patowmack Company, keeping this log of its operations.*



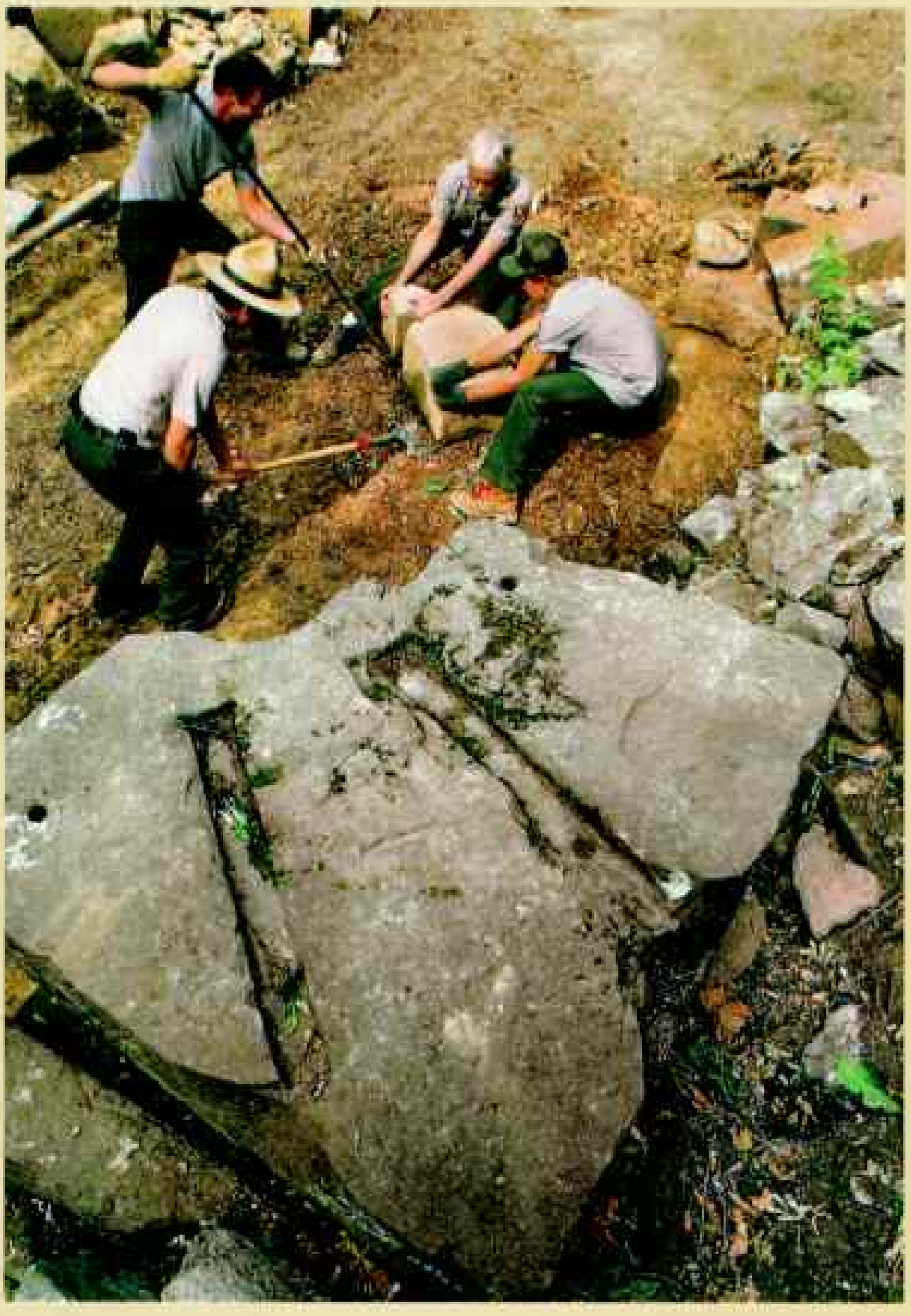
CHARLES HARBAUGH, JR., COLLECTION



*Built to last, the tightly crafted stones of lock one (**below left**) belie the pitfalls faced by superintendents during its construction. Labor was a major headache. Indentured servants showed a penchant for running away. Recalcitrants' heads and eyebrows were shaved on recapture. Finally, black slaves were rented from nearby plantations.*

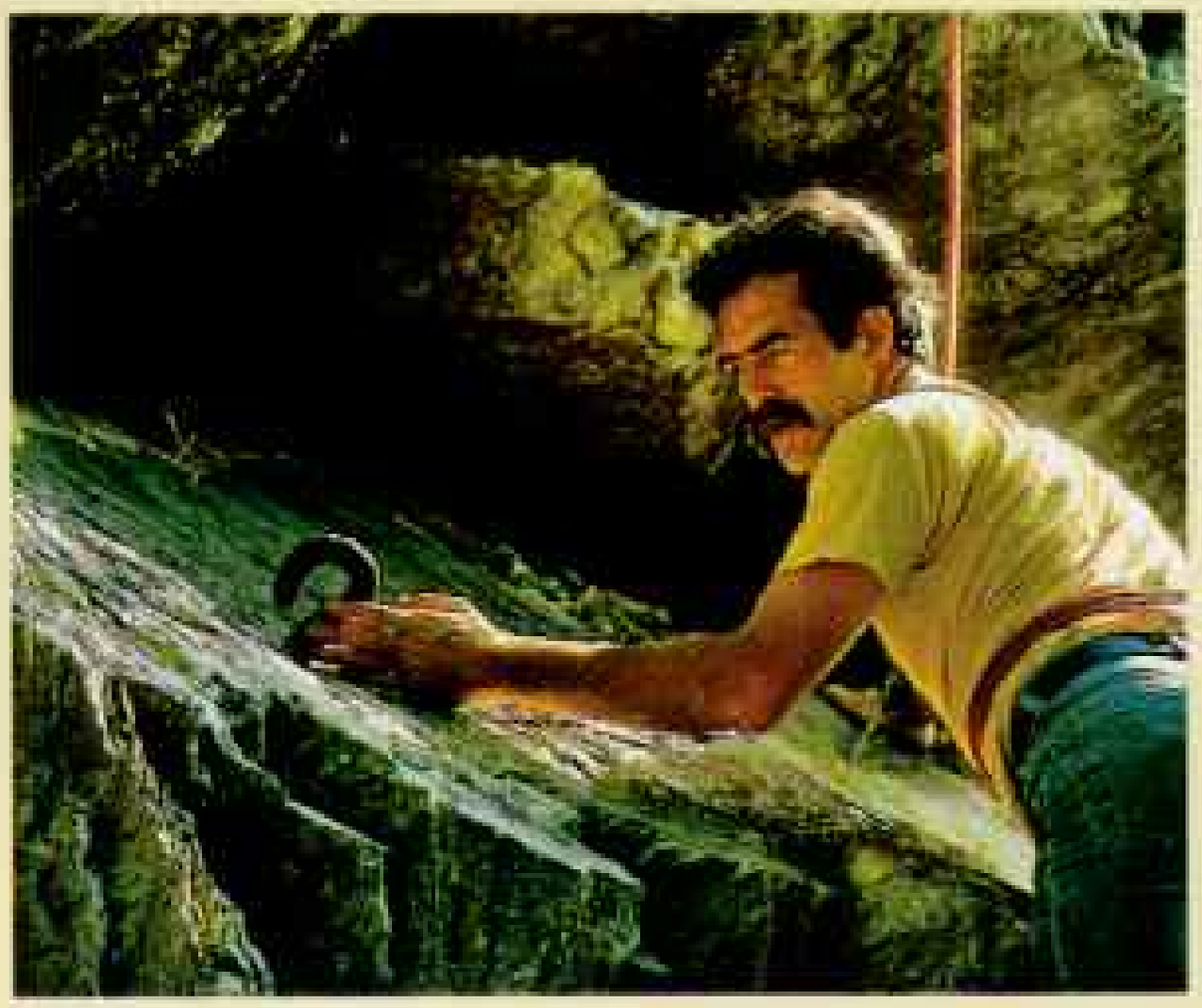
*Professional masons left their individual marks (**left**) on the locks' stones. Their skill is exhibited also at the Capitol, the White House, and the federal fort in New York Harbor on which the Statue of Liberty was erected—all bear some of the same mason's marks.*

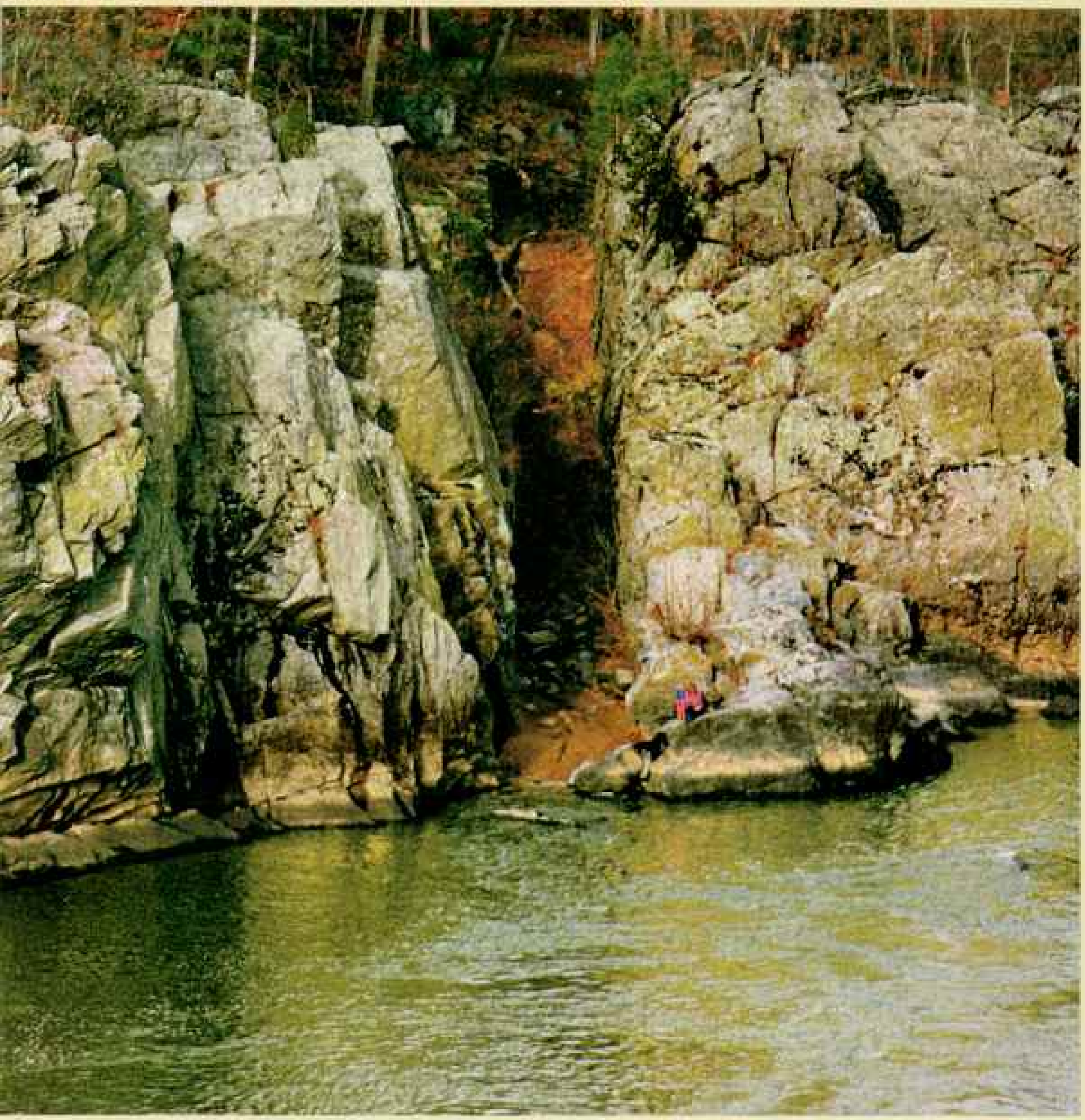
*Years of neglect allowed the erosion of most of the Great Falls canal-and-lock complex. A park cultural-preservation team wrestles with a stone displaced by tree roots (**below**). A mandate to preserve the park's historic structures has led to protests from local bird-watchers, who object to the removal of trees in a prime birding site on the outskirts of Washington.*



Rising to the greatest engineering challenge undertaken in 18th-century America, Harbaugh blasted a cut through a bulwark of stone **(above)** *to link Matildaville's canal with the river below Great Falls and complete Cumberland-to-Georgetown navigation. Three locks in the defile carried boats up and down the precipitous drop.*

The project involved an early use of black blasting powder for





construction in North America. Blastholes are still visible in rock around the cut. Workers drilled holes with mallets and augers, then tamped and exploded the powder in work costly to life and limb. But such names on the payroll as "Hercules," "Bob the Blaster," and "Monster Manley" suggest the élan that went with the job of dealing with black powder.

Laborers at Matildaville were so roughhewn a lot that neighbors in the countryside complained of their threats and depredations—but received little sympathy from hard-pressed company overseers.

Iron hooks set in the cut (**left**) *may have been used to control boats in the locks. Before the locks' completion, tolls were charged on boats and cargoes transported around the falls by wagon or hauled up and down an inclined plane that led from the canal to the river.*

did the same for the nation's first major railroad, the Baltimore and Ohio. And that was the day the fates decided that Georgetown would eventually be absorbed by Washington, D. C., and Alexandria would become a quaint bedroom community of the capital, while Baltimore would become a major East Coast railhead and seaport. The B & O's success earned it a lot of money and a square on the Monopoly board.

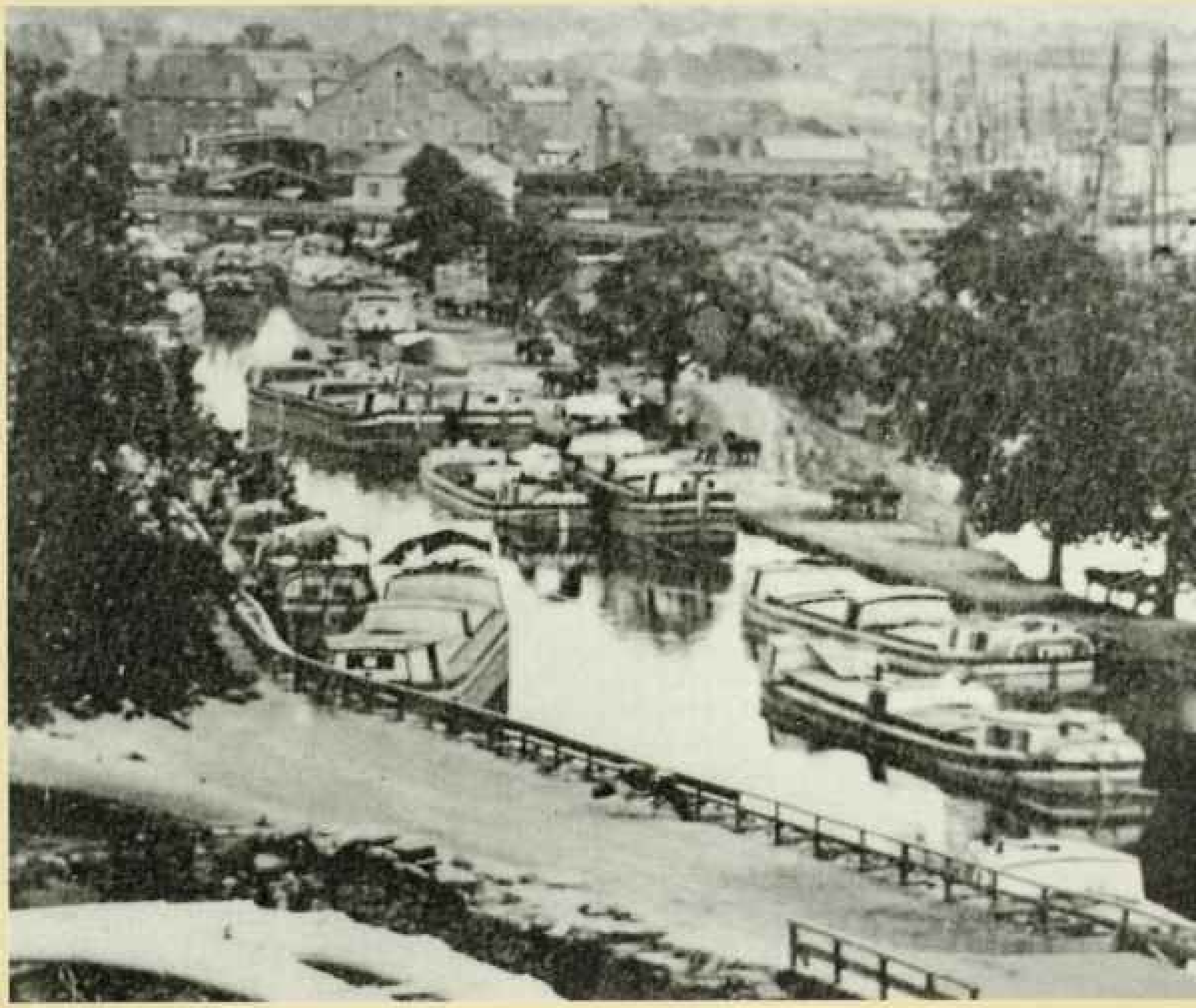
Washington's canal project had made the Potomac navigable long enough. It had helped bring the western lands into the United States, when they might have evolved into a gaggle of separate countries as unneighborly as the nations of Europe or Africa. By the time the company died, the nation had more than doubled in size and 11 new states had been added to the Union.

Washington's interest in the project never flagged. On December 10, 1799, he was not able to attend the company meeting but voted his 73 shares by proxy. Four days later he died, after a full life. His last words: " 'Tis well."

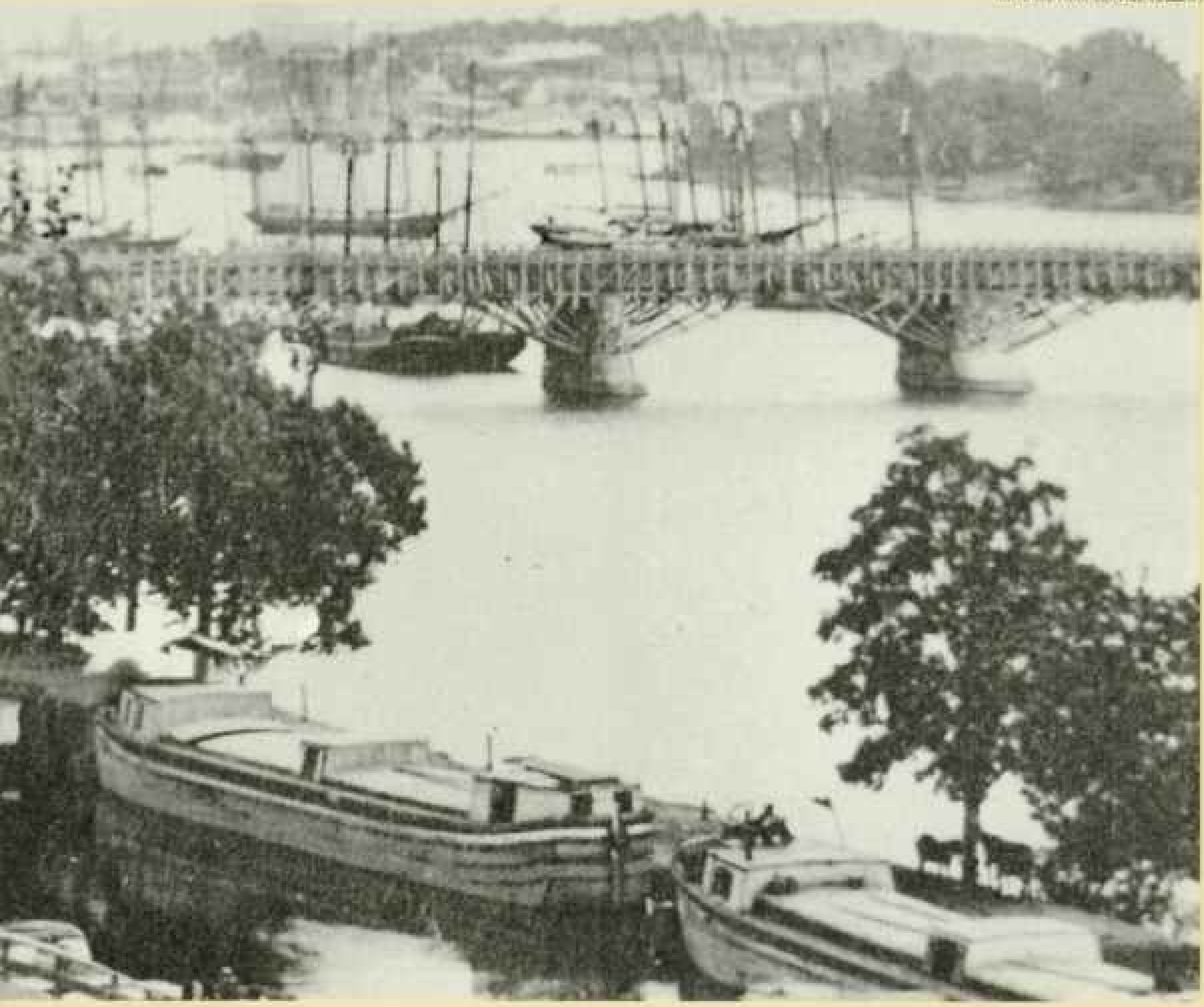
If he could return for an inspection tour, Washington would have ample reason to be proud of the country he fathered. But he would be justified were he to scold us for our indifference to his great dream: a waterway west that did indeed help unify the nation. □

*Never the industrial and trade center envisioned by Washington and his peers, Washington, D. C. (**right**, with Georgetown in foreground), shows the low profile of a city built on government and tourism. Railroads and other canal routes ended the bid for a Potomac gateway to the West.*

*Georgetown remained a busy port through the Civil War. Oceangoing vessels and C & O canalboats called at the waterfront (**below**) in the mid-19th century, and—where Key Bridge stands today—an aqueduct carried boats across the river to connect with a canal to Alexandria. By then the Patowmack canal builders' contributions to nation building were bound into the republic's foundations.*



NATIONAL PARK SERVICE (BELOW)



Gray Whales

At Play in Baja's San Ignacio Lagoon

By STEVEN L. SWARTZ
and MARY LOU JONES

Photographs by
FRANÇOIS GOHIER

There, less than an arm's length away, above the gape of the mouth, was the large brown eye of the whale, staring directly back at me and following my every move.

THUS BEGINS Mary Lou's journal for February 15, 1977, during the first of six winters we were to spend studying the gray whales of San Ignacio Lagoon in Mexico's Baja California. It was a thrilling entry, for it recorded the first truly close contact we had with these giant mammals, which remarkably have returned from severe depletion to become the best known and probably the best loved among all the world's species of great whales.

A RESEARCH PROJECT SUPPORTED IN PART BY YOUR SOCIETY

Mary Lou's whale was promptly dubbed Amazing Grace, for her friendly behavior at the time was somewhat amazing and her movements underwater, like those of all her species, were graceful beyond description.

Until recently gray whales were considered anything but friendly, though one can hardly blame that on the whales themselves. Beginning in the 1840s, commercial whalers hunted the gray giants in their breeding lagoons along the Baja California coast and later in

Tenderly a gray whale calf, top, presses close to its mother in late March, nearly two months after its birth in this winter haven for their kind, off Mexico.

Close encounter of a lifetime for whale-watchers, a cow and her calf inspect an inflatable craft. Such tour-company skiffs are restricted to the lower lagoon by the Mexican government. Not all grays are as curious as these, probably attracted by outboard-motor sounds.

their northern range, reducing the eastern Pacific stock, which once may have numbered 24,000 animals, to a nearly fatal level of only a few thousand.

CHARLES SCAMMON, a 19th-century whaling captain turned naturalist for whom one of the lagoons was named, relates that some whalers harpooned calves first in order to lure the mothers within killing range. In reaction, Scammon wrote, the mother whale, "in her frenzy, will chase the boats, and . . . overturn them with her head, or dash them in pieces with a stroke of her ponderous flukes."

Such attacks earned the gray whale nicknames like "devilfish" and "hardhead"—images that endured long after the species received belated partial

protection from commercial whaling in 1937. Even in 1977 we were not certain what type of reception we would get from the whales of San Ignacio. It was Amazing Grace, doubtless moved more by curiosity than by friendliness in the human sense, who first indicated we would be welcome as long as we came in peace.

Our six-year study of whales was supported by half a dozen organizations, among them the National Geographic Society and World Wildlife Fund-U. S. At best, live whales are difficult to study. As with icebergs, one sees only the surface, and the rest must be inferred. In general the dense concentrations of whales in the shallows of the lagoons allow one to see more, and therein lies the advantage of San Ignacio.

Each autumn gray whales leave their summer grounds in the Bering and Chukchi Seas and migrate southward 5,000 miles along the Pacific coast to

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Steven L. Swartz and ***Mary Lou Jones,*** both recognized authorities on the California gray whale, direct Cetacean Research Associates, an organization devoted to the study of whales and dolphins. Photographer ***François Gohier*** is a French free lance based in California.

the sheltered bays and lagoons of Baja California. Here the whales gather by the thousands to court and mate and to give birth to calves conceived the previous winter.

IN LATE JANUARY the gray whales begin the migration northward, completing a 10,000-mile round-trip in the space of six to nine months.

Although gray whales are a familiar sight to Californians, much of their behavior remains a mystery. Do the whales feed in winter grounds, and do individual animals return to the same spot year after year? How many gray whales migrate to specific lagoons, and how long do they remain there? Such questions are vital to the preservation of a species that man in his greed and ignorance very nearly destroyed.

In the sheltered and relatively shallow waters of San Ignacio Lagoon we hoped to find some of the answers.

From our very first encounter with Amazing Grace, she readily adopted us along with our 14-foot inflatable outboard as her personal toys. She would roll under the boat, turn belly up with her flippers sticking three to four feet out of the water on either side of the craft, then lift us clear off the surface of the lagoon, perched high and dry on her chest between her massive flippers.

When she tired of the bench-press technique, Grace would do the same thing with her head, lifting us out of the water and letting us slide off to swirl around her in circles, like a big rubber duck in the bathtub with a ten-ton playmate. At other times Grace would submerge beneath us and release a tremendous blast of air that boiled to the surface in a giant Jacuzzi of white water that engulfed us and the boat.

After such gymnastics Grace would often lie quietly alongside the boat to be rubbed. We would oblige her with a vigorous massage along her back, head, and ribs, while she opened her mouth to display huge fringed curtains of creamy white baleen plates (page 764).

From her length of 30 feet and the mammary slits along the after part of her belly, we judged Grace to be a two-year-old juvenile female. She would begin to mate and calve at puberty, about six years later.

Our first winter's observations taught us that Grace was the exception rather than the rule among gray whales. The majority of whales either ignore or avoid human observers; "friendly" whales find you, you don't find them. Moreover, friendly whales soon lose their timid ways and grow rambunctious. With a 35-ton creature, play can be hard on both boat and observer. More than one friendly whale has nudged a boat with such enthusiasm that passengers have been knocked overboard.

ESCHRICHTIUS ROBUSTUS. ADULTS AVERAGE 40 FEET, 35 TONS

AS WEEKS and months passed, we came to identify individual whales by the distinctive colors and markings on their bodies. Eventually we assembled a photographic identification file of more than 500 different whales. Individuals that we recognized season after season were given nicknames such as Peanut, Rosebud, Cabrillo, Haleakala, and Pinto. Over the years this constantly expanding file proved invaluable in tracing the movements of groups and individuals alike.

From our camp at Punta Piedra near the mouth of the lagoon, we could explore the entire 60-square-mile body of water, which could contain 600 or more whales at the height of the breeding season (map, right). Courting and mating, we discovered, take place near the entrance to the lagoon, an area resembling a turnstile. From our 18-foot observation tower we watched as many as 500 whales a day entering and leaving. Here amorous giants lunge through the water, trailing

The gray whale's annual odyssey

WITH A RINGSIDE seat to observe their diving quarry (facing page), the authors camped at Punta Piedra for six seasons. In fall the whales depart their summer Arctic waters, migrating 5,000 miles south. In bays and lagoons of Baja California (below right), thousands mate or give birth to calves conceived the previous winter. They leave for the Arctic from late January through April.

From the 1840s to the 1940s waves of whalers preyed upon the "devilfish," feared for its ferocity, and the eastern Pacific grays were reduced from 24,000 to a few thousand. The species finally received full protection from commercial whaling in 1946, and today the population has rebounded to about 18,000.

San Ignacio Lagoon

0 5 km 0 5 mi

Soundings in feet

The nursery
Most females give birth in the relatively shallow upper lagoon, which averages 15 feet in depth. Each season about a hundred cows and their calves find solitude here from males.

Mapping effort
Five researchers, including authors Steven L. Swartz and Mary Lou Jones, spent three years mapping the lagoon. They plotted depth contours and used satellite imagery to redraw the shoreline.

Tour-boat area
Each year commercial vessels make about 30 trips with whale-watchers, usually during the January and February calving season, when boats are restricted to the lower lagoon.

North end
Isla Garzas
Isla Pelicano
Upper lagoon
Middle lagoon
Lower lagoon
Isla Ana
Black lagoon
Isla Abreojos
MUD FLAT
MANGROVE SWAMP
La Laguna
Punta Piedra (Authors' camp)
Northern limit of tour-boat access

NGS CARTOGRAPHIC DIVISION
DESIGN: JOHN W. LOTHERS
RESEARCH: DAVID B. MILLER, LISA R. RITTER
PRODUCTION: C. MARK CONNELL, SARAH RAMSEY MURRAY
MAP EDITOR: GUS PLATIS

plumes of vapor from their blowholes like geysers.

Since gray whale cows normally calve every other year, only half of the mature females are available for mating each season. Courting bulls thus outnumber females two to one, leading to the belief of a ménage à trois mating system envisioned by early naturalists. In fact, we learned that gray whale mating is a far more complex and uninhibited affair, with males and females copulating with an assortment of partners. This promiscuous activity sometimes blossoms into giant free-for-alls involving as many as 18 to 20 individuals at a time.

Who actually sires a given female's offspring is therefore anybody's guess.

Gray whale mothers with their calves prefer to remain separate from the courting groups for a month or two following birth. They concentrate in what we call the nursery, the sheltered upper lagoon where the depth averages only 15 feet. Here each February about a hundred mothers congregate with their calves, resting, nursing, and moving with the tides. On calm days the blows of the females and their calves hang in the morning air like down feathers caught in a breeze.

Gray whale calves at birth measure 14 to 16 feet in length and weigh between 1,500 and 2,000 pounds. They grow quickly on milk that contains 53 percent fat, one of the richest in the world. By winter's end, when it is time to leave the lagoon, the calves have added three or four feet to their length and have doubled their weight to two tons.

By spring each year a twofold shift takes place in the lagoon.

Seeking out a soft touch, an adult proffers a snout laden with barnacles and whale lice (facing page). The authors identified more than 500 whales by distinctive body markings, including a cow and her calf, blowholes exposed (above). The calf was one of three young they sighted with this female during six consecutive seasons.

Impassive island in a roiling sea, a cow surfaces and blows on a rough, windy day (above) as her calf—a growing butterball nursed on milk containing 53 percent fat—lolls nearby.

Life may be tranquil once the calf is born, but producing it entails wholesale mating. Because most cows calve every other year, courting males outnumber available females by two to one. Thus, boisterous foreplay scenes are typical (right). Here two males, one showing its head, the other its flukes, close in on a female, at center. Often both suitors succeed. And although such tempestuous triangles have been well documented, the authors also observed mating bouts of what they call "truly herculean proportions," lasting for hours and involving as many as 20 individuals, changing partners at will.

Some cows, they also found, consistently return to San Ignacio, while others visit a different lagoon each year, and still other females circulate through the lagoons during the same season.

A calf's gaping maw trails eelgrass (facing page), habitat for fish and other morsels—possible food sources. Grays strain meals through horny baleen plates, displayed by a whale in San Ignacio (above). But do they feed in the lagoons? Many marine biologists believe that grays eat only in northern waters. Yet the authors saw bottom grubbing in San Ignacio, although its floor is poor in prey. However, lagoon waters teem with zooplankton, which the whales appeared to strain.

Adult mating pairs and groups have become fewer and fewer since they are the first to start the return migration north toward the Arctic.

At the same time, the cows and calves abandon the nursery and move toward the mouth of the lagoon. Here under the watchful eyes of their mothers the calves go into rigorous spring training for the long swim to come. Most will start north in March or April. In company with the cows the calves position themselves in the main channel of the lagoon, facing into the strong incoming or outgoing tidal current. They swim strenuously as though on a treadmill, going nowhere but getting a valuable workout.

With strength comes confidence and the urge to explore. Increasingly the calves leave their mothers for short periods to investigate all manner of objects. We watched one little fellow entertain himself (or herself) with a ball of kelp, lifting the plaything onto its head, pushing it underwater, straining it against the baleen plates, then releasing it to pop to the surface. When mother decided to move on, the calf followed obediently—with the kelp securely perched atop its head.

During this same period the calves train in other ways. Within the lagoon they are exposed to other whales in what we call "play groups." These may involve 20 or more pairs of cows and calves, rolling and rubbing against one another, wheeling and diving and blowing blasts of bubbles.

We believe that this activity represents more than idle play. In the absence of aggressive courting adults, young whales meet their peers in gatherings that appear to serve as socializing functions. Here the calves begin to learn what it is to be a whale and, perhaps even more important, to discover that there are other whales out there besides mom.

At this stage the cows are still highly protective of the calves. During our third season we witnessed a striking example. From our observation tower on Punta Piedra next to a deep channel, we saw a calf thrashing as it left the channel and tried to cross a shallow sandbar.

Instantly an adult whale we took to be the calf's mother surged out of the channel and beached itself beside the calf. Seconds later another whale beached itself on the other side, sandwiching the calf between two adults. Both adults thereupon raised their heads and flukes, pivoted with the calf between them, and slid smoothly back into the channel.

The next year we saw the same thing happen again. In each case the entire incident lasted only 15 or 20 seconds and appeared to be a deliberate, well-coordinated act. Presumably one of the adults was the calf's mother, but we have no idea what relationship, if any, the other adult had to the mother-calf pair.

BY THE SPRING OF 1982 we had a large enough photographic ID file to compare it with other collections. We met with Shirley Lawson, Susan Lafferty, and Peter Bryant, all of the University of California at Irvine, who had a file on gray whales from areas north and south of San Ignacio Lagoon. Other photographs were contributed by Dave Withrow and his colleagues from the National Marine Mammal Laboratory in Seattle, Washington, and by a team from Mexico's Secretaria de Pesca, or Ministry of Fisheries. Both groups had worked in Laguna Ojo de

Trusting eye of a calf takes in all around it. About 15 feet long and weighing nearly a ton at birth, calves must mature quickly for the long migration two months later, doubling their weight by then. Cows gradually lead their calves into the lower lagoon,

where the youngsters gain strength by swimming against strong currents. Twice the authors witnessed remarkable adult cooperation when a calf was stranded on a sandbar. Two adults, one likely the mother, sandwiched the victim and freed it.

Liebre (Scammon Lagoon) north of San Ignacio.

To our delight the files contained a number of matching portraits that provided valuable new data. The first fact to emerge was that although some gray whale cows return to the same lagoon each year, others circulate from one area to the next, mating and rearing their calves in different lagoons. The same cows may also visit different lagoons in the same season.

The matching portraits also confirmed that most cows give birth to a calf in alternate years. Some cows may rest two or more years between calves, and one of 30 cows produces a calf two years running. Cows that are courting arrive in the lagoons in January and remain for periods ranging from a few days to a few weeks. Cows carrying calves arrive at the same time but may remain for as long as 13 weeks.

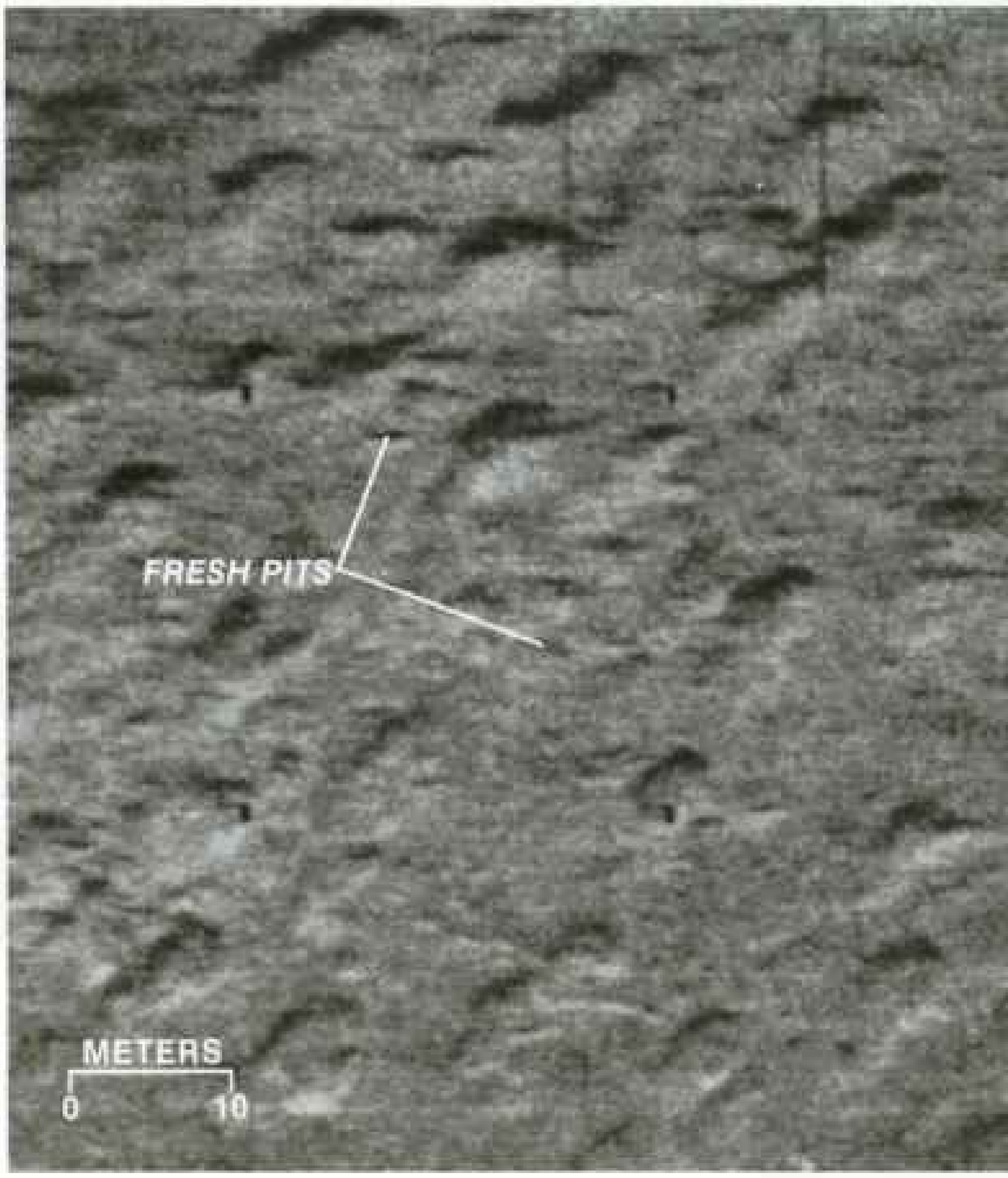
Whether cows with calves feed during winter in the lagoons remains a question. Some observers believe that gray whales fast from the time they leave the Arctic in autumn until their return there the following spring. Dr. Theodore J. Walker, a noted authority on gray whales, believes the animals feed wherever and whenever they find food.

IN 1984 photographer Flip Nicklin, working with cetologist Dr. Jim Darling, managed to photograph a juvenile gray whale bottom-feeding off Vancouver Island in British Columbia (facing page). The historic photograph demonstrates that gray whales feed by a suction technique, using their massive tongues as plungers, first to vacuum up bottom sediment and then to force it through their baleen. The baleen allows the sediment to pass through, while trapping small crustaceans on which the whales feed.

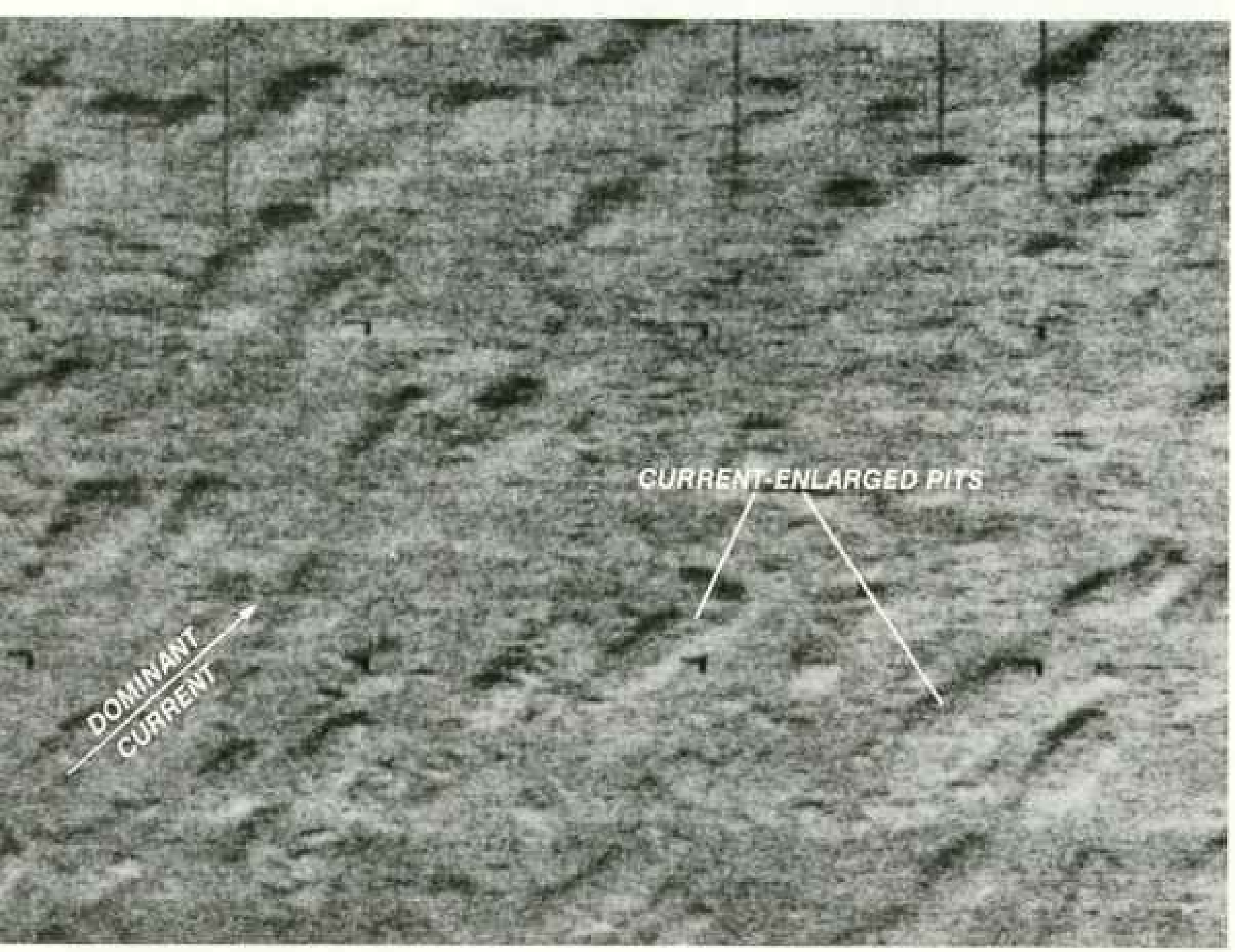
Like Dr. Walker, we had witnessed gray whales grubbing along the lagoon floor, but whether they were actually feeding we could not tell. In 1981, with assistants Mike Bursk and Dr. Jim Sumich, we returned to San Ignacio Lagoon with scuba gear to try to answer the question. In two months we collected no less than 60 samples of bottom sediment from every area of the lagoon. Each time we surfaced, we would hand a sample to Mike in the boat for inspection, and each time the verdict was the same: "Mud," Mike would announce.

"Just mud?" we'd ask, and Mike would smile. "Well, no, there's some sand and a few shells too."

Massive undersea dredge, a gray vacuums the bottom off Vancouver Island (right). Seeking shrimp-like crustaceans, a whale presses one side of its mouth to the mud and uses its tongue to create suction. Recently researchers made a key discovery on the floor of the Bering Sea. Pocked as if by a barrage of meteorites, one section shows dozens of pits left by feeding grays (below); the image, called a side-scan sonograph, was created from acoustic signals reflected off the bottom. Fresh pits measure about eight feet long, close to the length of a gray's mouth. Many pits have been enlarged, probably by a prevailing current.



FLIP NICKLIN (ABOVE) © MARK NELSON AND KIRK R. JOHNSON, U. S. GEOLOGICAL SURVEY



Breaching near breakers, a gray displays still unfathomed behavior that may serve several purposes, such as communication, the authors feel. Like a boisterous steam engine, another emits blasts of bubbles (facing page), perhaps stimulated by the boat motor of photographer Gohier, who felt "as if I were in a Jacuzzi." Playful grays lift boats with their snouts. As the harpoon era fades, these creatures seem to find delight in human contact.

In short, the floor of San Ignacio Lagoon offers gray whales little in the way of food—probably less than 5 percent of what the Bering Sea floor provides. Thus the bottom grubbing at San Ignacio seems unrelated to feeding, though why the whales strip-mine the lagoon floor we have yet to understand.

Gray whales have two additional feeding techniques and appear to use both at San Ignacio. One method consists of swimming with mouth open against tidal currents, sieving huge quantities of water through the baleen to trap the rich plankton that blooms within the warm lagoon shallows.

The second technique involves skimming "salads" of eelgrass at the lagoon's surface for the various small creatures the grass contains. One afternoon in the boat, Mary Lou encountered a long strip of floating eelgrass.

"One after another," she recalls, "the eelgrass patties were mysteriously vanishing before my eyes. Moving closer, I caught sight of a whale moving slowly on its side with its head just beneath the plants. It was sucking them down one by one, just like a gopher pulling turnips underground."

The gray whale's varied feeding techniques allow it to utilize a wide variety of foods and may have contributed to its recovery from a century of slaughter by commercial whalers. Today there are an estimated 18,000 gray whales—a far more hopeful figure than that of several other large species.

THE GOVERNMENT of Mexico has taken a leading role in preservation of the gray whale. In 1972 it declared both Laguna Ojo de Liebre and Laguna Guerrero Negro refuges for gray whales—the first such sanctuaries ever established in the world. In 1979 Mexico added Laguna San Ignacio to the list, further ensuring the gray whale's survival.

Our studies at San Ignacio Lagoon have contributed a measure of new knowledge on gray whale behavior, and we hope to continue our research. The growing body of knowledge inspires us as never before to strive to understand these remarkable mammals. □

LAOS

HE CERTAINLY GAVE ME a surprise, this smiling farmer on the Bolovens Plateau in southern Laos, harvesting coffee so ingeniously from a tree that was three times taller than he.

First he'd reach up with a hooked bamboo pole and pull down a branch. Then he put a foot into a canvas loop at the bottom of the pole, so that the branch was held down while his hands were free to pull off the little pods—greenish, yellow, red. After letting his crop dry in the sun, he'd sell it to a government cooperative; six kilos of every hundred would go for tax.

Getting ready to leave, I expressed polite wishes: health for his family, a crop bigger than ever, and tax lower. Then it came, with his biggest smile yet: "The government has nothing, only empty hands, so we the people must help the government."

Amazing—who'd ever heard of a farmer so full of understanding about taxes?

But then of course I hadn't come alone. Escorting me were an official from the capital, a provincial security officer, and a militiaman with an automatic rifle. And so I wondered: Had I indeed come face-to-face with that "new man, new in spirit, determined to construct socialism," as envisioned by the Communist regime that had displaced the Royal Lao government? Or was this farmer simply doing what people in Laos had always done: telling rulers what they wanted to hear, while doing pretty much what they themselves wanted to do?

It was a big question, transcending Laos. To most of the world this thinly populated,

Biding its time, *a beached boat in the Mekong River at Vientiane patiently awaits the monsoon season. In a land long beset by changing regimes, the adaptable Lao survive on a philosophy of fatalistic optimism.*

By PETER T. WHITE Photographs by SENY NORASINGH

ASSISTANT EDITOR

The former Kingdom of a Million Elephants has spent the past decade coming to terms with Communist rule.

mountainous country the size of Great Britain had long been a remote Southeast Asian backwater. True, for a dozen years Laos had attracted international attention as a battleground of political factions armed by the United States and the Soviet Union. But now it was once more a backwater.

And yet I was to find here a remarkable manifestation, in a quiet way, of what may be the most momentous confrontation of our time: on one hand, tradition-conscious people, mindful of their personal interest; on the other, modern government of the most intrusive kind—the Marxist-Leninist state, which in the name of the common good claims control over nearly every aspect of human life.

I was back in Laos 25 years after my first visit. The Communists had now been in power for a decade. What had happened here? How had life changed for these buoyant, easygoing people who had long impressed foreigners with their proclivity for having *muan*—for enjoying themselves, for having fun?

ON MY FIRST DAY in Vientiane, the capital stretching along the wide Mekong River, a stroll through the main market brings striking reminders of the recent past.

Amid stalls with succulent vegetables, frogs in plastic bags, and assorted spices and Lao tobacco, I see a display of stationery and schoolbooks and pick up an arithmetic primer with pictures. For 3 + 1 = 4, it's three bunnies, plus one more; for 6 − 1 = 5, six U. S. warplanes, minus one shot down

by soldiers in bulbous floppy caps. That was the headgear of the Pathet Lao, the revolutionary forces that opposed the royal government with support from North Vietnamese troops. A middle-aged man wearing such a cap limps by on a wooden leg.

Clothing stalls offer blue jeans made in Thailand—*song kaboi*, or cowboy trousers. Those were taboo early in the new regime. Now they're typical of what young men wear if they can afford them. A clothes seller says her husband just returned after ten years in a political reeducation camp; one of her sons is in Rochester, New York, another in Iowa. I'm told that's typical too.

A noisy procession winds through the market with drums, bamboo pipes, and a silver bowl, collecting money for a Buddhist festival. Such get-togethers at a monastery, or *wat*—with dancing, fireworks, and men and women singers teasing one another with wittily improvised allusions to sex—used to be frequent opportunities for gaining religious merit while having fun. Apparently they still are.

Something else seems basically unchanged. By the measurements that international economists apply—industry, transportation, per capita income—Laos still is one of the least developed, poorest countries in the world. And alas, poor Laos remains beset by officious foreigners trying their best to make the country go as they think it should.

It used to be the French colonial overlords and the Vietnamese they brought here to be lower-level officials. Next came the Americans—administrators dispensing massive amounts of foreign aid, military advisers, assorted technical experts—who built on the outskirts of Vientiane a little California-style suburb of their own that became known as Kilometer 6.

Now is the heyday of the Communist advisers: Hundreds from the Socialist Republic of Vietnam, said to be ensconced in virtually every government department; hundreds more come directly from the Soviet Union. The big bookshop in the center of town, formerly run by the U. S. Information Service, now stocks Russian folktales in Lao and week-old copies of *Pravda*.

And Kilometer 6? It was there, in the abandoned U. S. high-school gymnasium—in December 1975, after King Savang Vatthana had abdicated—that 264 delegates selected by the Pathet Lao proclaimed the Lao People's Democratic Republic. It's still a busy place, heavily guarded, home to the top echelon of the LPRP, the Lao People's Revolutionary Party.

A vice minister of foreign affairs tells me he's angry at Western news media; they say the results of the new regime are very bad. "But we are very proud. Ten years ago we

Twice the rice *is the goal in the paddy fields near Vientiane; expanded irrigation permits two annual crops. Glutinous sticky rice forms the basis of the Lao diet, supplemented with fish and vegetables.*

had to import rice, but now we have reached self-sufficiency." Most of the people were illiterate, he says; now, he claims, they aren't.

And now for the first time it can be told how many people there are in Laos—there's been a census! The total is 3,618,000. About half are Lao Lum, or Lao of the valleys; these are the ethnic Lao, the Buddhists, with Lao as their mother tongue. Roughly a third are Lao Theung, or Lao of the mountainsides, once contemptuously called Kha, or slaves. The rest are Lao Soung, or Lao of the mountaintops. These last include the Mien, formerly known to outsiders as Yao, and also the Hmong, formerly known as Meo. There are 68 ethnic groups in all; equality among them, says the census report, "is being gradually put into practice."

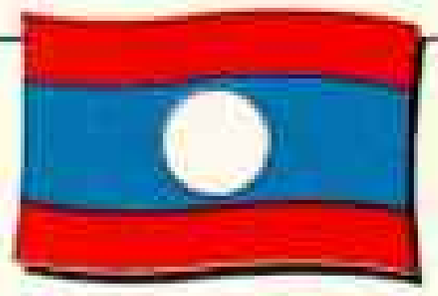
I'M OFF TO SEE what's new north of Vientiane along Route 13. This is the dry season, three months after the big rains stopped and five more to go before the next monsoon. I pass stubbly brown rice fields, just harvested; a car-repair shop established by Sweden; an Australian project

Scarred by war, *both land and people suffer the legacy of heavy U. S. bombing during the 1960s and '70s. Gaping craters in the Plain of Jars now serve as fishponds. Nine-year-old Viengsamone Nounhasone was wounded and partially blinded when an antipersonnel bomblet exploded belatedly in 1983, killing her brother and two other children.*

for livestock improvement. Some houses reflect a new prosperity—they're still on stilts, in the Lao tradition, but the pillars are of concrete, not wood; in a few houses the open space is bricked in. And here are fields with foot-high rice shoots, light green—a second crop in the annual cycle, thanks in great part to newly expanded irrigation, with Australian advice and water from the lake impounded by the Nam Ngum dam.

After a drive of an hour and a half I'm at this hydroelectric dam itself, guarded by blue-helmeted militia. The manager, just back from advanced training in Sweden, explains enthusiastically: five generators, 150 megawatts! Equipment from Japan, West Germany, and India, expertise from Switzerland, money from the World Bank, the Asian Development Bank, OPEC.

As yet, relatively little electricity is required for Lao factories: cigarettes, beer, detergent powder, furniture—altogether they employ no more than 5,000 workers. And so the Nam Ngum turbines light up Vientiane, but 80 percent of their output passes via high-tension lines across the Mekong to



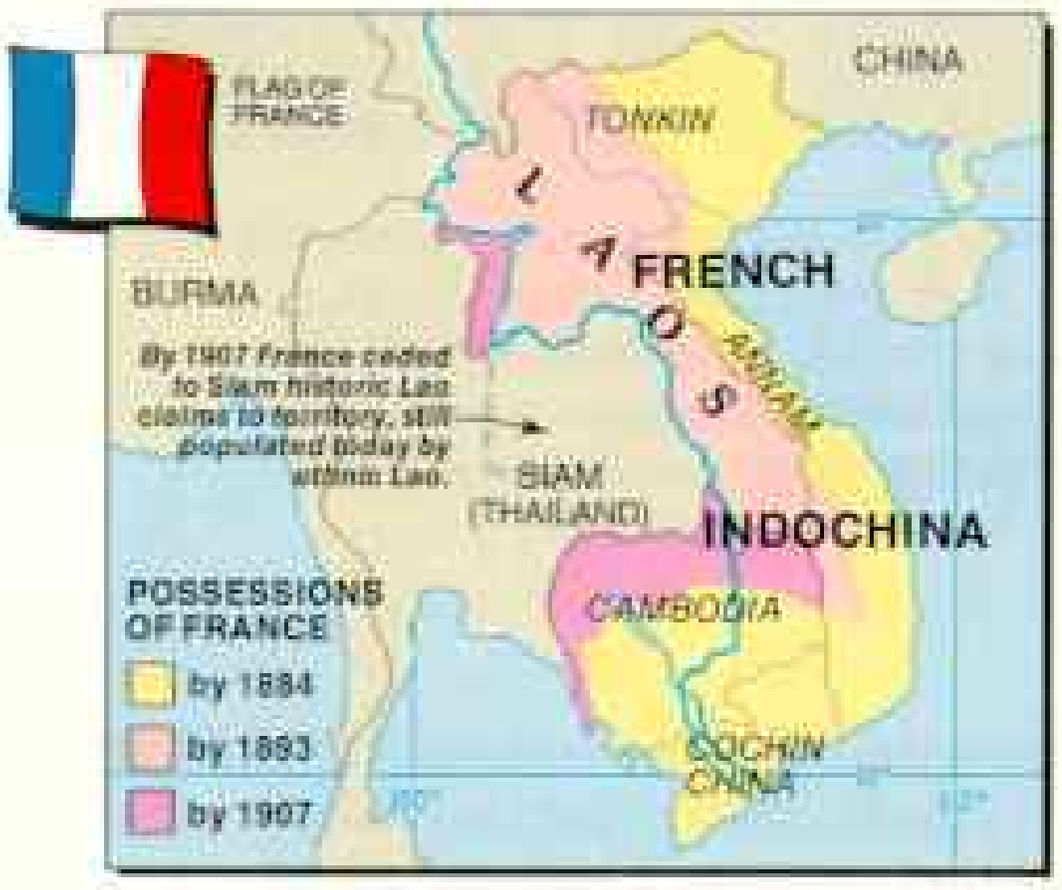
LAOS 1987

STRATEGICALLY LOCATED, Laos forms a buffer zone between China, Thailand, and Vietnam. During the Vietnam War, U. S. planes routinely bombed the Ho Chi Minh Trail (top map, **right**), a vital route south through Laos for North Vietnamese troops and supplies. Plane-crash sites, marked below, indicate areas of the most intensive bombing.

The population of Laos, spread thinly and unevenly across the country, consists of three main ethnic groups: the Lao Theung, highlanders; the Lao Soung, mountain tribes; and the valley-dwelling Lao Lum—half the population—whose ancestors had migrated from China by the 13th century. Approximately five times as many Lao Lum live in northeastern Thailand. Border clashes between the two nations have erupted periodically, disrupting trade.

POPULATION: 3.6 million. **AREA:** 236,800 sq km (91,430 sq mi). **CAPITAL:** Vientiane. **MAIN CITIES:** Savannakhet, Luang Prabang (former royal capital), Pakxe. **RELIGION:** Buddhism, traditional animist beliefs. **AGRICULTURE:** rice, corn, tobacco, coffee, cotton.

1953-1975 *Periodic fighting between the Royal Lao government and pro-Communist, Vietnamese-supported Pathet Lao lasted until 1973. In 1975 the present regime abolished a short-lived coalition government and the monarchy.*



1893-1953 *A victim of expansionist Thai and Vietnamese neighbors, Laos was little more than a collection of Thai vassal states when the French began to take over in 1893. Laos gained independence in 1953.*

1353-1707 *Scattered principalities were first unified in 1353 by King Fa Ngum, who established Buddhism as the state religion of the kingdom of Lan Xang, a powerful feudal state in Indochina for some 350 years.*

MAIN SOURCE: "LAOS: KEYSTONE OF INDOCHINA," BY A. J. DOMMEN

Missing in Action

THE LAO SOLDIER above and the U. S. Army man in civilian clothes in the background participate in a joint U. S./Lao crash-site excavation in the jungle east of Savannakhet, where a U. S. Air Force AC-130 gunship went down on March 29, 1972 (map, facing page).* From remains found here, five of the plane's crew of 14 have been identified by the Army's Central Identification Laboratory in Honolulu. A previous excavation, in February 1985, has so far produced ten identifications. This leaves 552 Americans, mostly USAF and Navy fliers, still unaccounted for in Laos—out of 2,417 such cases in all of Vietnam, Laos, and Kampuchea. Each one means a family left in dreadful uncertainty.

Could any of these Americans still be alive and held against their will? Privately, experts say no. Faced with persistent reports to the contrary, the U. S. government maintains that although no conclusive evidence has been produced thus far, the possibility cannot be ruled out. President Reagan has pledged that if it can be confirmed that a single American serviceman is still held prisoner, the U. S. will "take decisive action."

The Lao government also has promised to help resolve this issue so close to American hearts. Another joint U. S./Lao crash-site excavation is under discussion.

*A complete account of the excavation was published in the November 1986 NATIONAL GEOGRAPHIC.

*"**Uncle Kaysone**" to his fellow Communists, Kaysone Phomvihane, General Secretary of the Lao People's Revolutionary Party, receives traditional good-luck bracelets at a ceremony in Luang Prabang. The reclusive leader is rarely photographed informally. After many years at Pathet Lao headquarters in the caves of Samneua, he emerged into the limelight in 1975. A Vietnamese soldier (**facing page**), one of some 50,000 in Laos, sells salt in Phonsavan; a 25-year treaty binds both countries.*

Thailand. That brings in some 30 million dollars a year, more than half the country's hard-currency income.

We stand on the roadway atop the 1,200-foot-long dam and look northeast to the mountains beyond the great greenish lake—it's 180 feet deep, I hear, yielding ten varieties of fish, up to ten tons a day. Look, there's Peace Island, Boy Island, Girl Island.

Why those names?

"After liberation, prostitutes, robbers, hippies, young city delinquents infected with foreign ideas were rounded up in Vientiane and brought here for reeducation." Males on one island, females on another. After release, many ran away to Thailand, part of the early waves of refugees from Laos that eventually added up to some 400,000.

Those hazy mountains rising to 9,245-foot Phou Bia, the country's highest peak, also symbolize some stark recent history. A lot of the Hmong highlanders in Laos had been organized by Americans into a fighting force to engage the Pathet Lao and North Vietnamese. After the Communist takeover in 1975 many fighters and their families also made their way to Thailand, quite a few eventually winding up in the U. S. But others retreated to those mountains and fought on. By late 1979 bombs and hunger had put an end to large-scale resistance.

Headed back to the capital, at Kilometer 52, I see ducks, pigs, men in wide black trousers, kids pulling homemade toys—it's a farming settlement of some 900 displaced Hmong families making a new life in the hot lowlands. Fairly often a notice comes from the post office in Vientiane, and a young man will hop on his motorcycle and dash off to pick up a package with clothes and money from relatives in Montana or Minnesota.

WHEN YOU GO on a trip in Laos, you take something along for your friends—and when I fly to Luang Prabang, the former royal capital, with Sangkhom, my guide assigned by the Foreign Ministry, he takes a

plastic shopping bag stuffed with French-style bread. It's a specialty of Vientiane, each morning fresh and crispy.

The Soviet-made passenger plane heads north across the Vientiane plain, then over forested hills and mountains that seem carpeted with green broadloom. They look unpopulated, but no, here and there in the green emptiness rises bluish haze, a sign of Lao Theung and Lao Soung using fire to clear new little patches for dry upland rice. After 30 minutes there's the confluence of the Mekong and the Xeng Rivers, and I'm once more in quiet Luang Prabang, where cars are still scarce and monasteries plentiful. I see some gloriously maintained in red and gold: Wat Xieng Thong, Wat Aphay, Wat Vixun.

The former royal palace can be visited too, by appointment only. The private quarters are Spartan, but the reception rooms glisten in gold and brocade. Presents are on display, teacups from Mao Zedong, a medal from Lyndon Johnson, a shotgun from Leonid Brezhnev. As to the whereabouts of the former king, nothing is said officially, but it is widely believed that he was taken away to a remote province in 1977. Should he still be alive, he'd now be 79.

In the market turbaned Hmong women from villages a day's walk away are shopping for cooking pots and salt, having sold their season's yield of mountain-grown opium. At the cinema the film is Bulgarian and gets the same treatment foreign films used to get—one Lao translator takes all the parts. It's about a peasant who gets lots of money and loses all. The audience laughs a lot.

One cool morning we take a boat upstream on the Mekong. The river is low, and on the exposed banks—quite steep, exceedingly fertile—women carry up buckets to water vegetables. Some grow right in the river, and I see yellow mats spread out for *phak nam*, a kind of watercress, to dry. That's a specialty of Luang Prabang, says Sangkhom; he'll take a big bag of the stuff back to Vientiane.

We stop on the left bank at Ban Xanghai, where a dozen thatched sheds are sheltering oil drums set over charcoal fires, distilling *lau lao*, liquor from rice. Would I like a taste? Hmm, smooth, powerful. And profitable, at 100 kip a liter—that's a day's pay for a city laborer—and no tax, no delivery costs. Customers in boats chug right up to the still.

Farther upstream people dig blackish sand from one of the islands that emerge in the dry season. They sift the sand in wooden pans and add mercury, which forms wiggly little blobs. These are squeezed in pieces of cotton cloth, leaving dry balls the size of a fingernail. What's been going on here?

The mercury has latched onto tiny gold

particles. Merchants come to buy those little balls, take them to town, and apply a blowtorch—the mercury evaporates, leaving 22-karat gold. On a very good day a woman can make 600 kip, gold from the Mekong.

No wonder things look good at the village of Pak-Ou, at the mouth of the Ou River, where limestone cliffs rise a thousand feet straight up, as in romantic Chinese paintings. Under nearly every house I see firewood and fish traps, chickens and pigs, big jars with fish paste or with salted bamboo shoots left to ferment. They'll go into sour bamboo soup. Under some houses I see a sewing machine, an outboard motor. On seeing me, little children stop dead in their tracks, then run to their mothers. Bigger children squeal "Soviet, Soviet." They think I must be a Russian.

Pak-Ou ladies needn't trudge to the river for water; it's piped from a reservoir to taps in the village; these are set in concrete, with a date incised: 1974. Aha, built under the old regime, probably with money from U. S. AID. Another inscription can be seen on a long, pointed metal object nearby: Bomb MK 82 MOD IGP 500 LB. This bomb was a dud. But a lot of others were not, a woman tells me. American planes came in 1968 and 1969, she says, and the whole village was burned. But by then everyone had fled. . . .

A hundred years ago, too, the people of Pak-Ou had sought refuge in the mountains—Chinese "Black Flag" bandits, claiming to collect tribute due the emperor of China, were coming to pillage and burn. They went on to sack Luang Prabang. The

Chicken in a basket: *A Hmong tribesman proudly transports his stud rooster in a bamboo carrier (**left**) for loan to a nearby village.*

*At the That Luang market on the outskirts of the capital of Vientiane (**above**) people gather to breakfast on soup and noodles near the sprawling parade ground where Liberation Day was first celebrated on August 23, 1975. Goods imported from Vietnam and Thailand—medicines, vitamins, cassette players, and toys—appear in the markets; once taboo, blue jeans and other Western fashions are making a gradual comeback.*

desperate old king—under pressure also from Siam, as Thailand was then known—turned for help to a small French mission visiting him. France, already in control in neighboring Vietnam, exerted military power to establish a protectorate in Laos. It lasted half a century. Only in 1954 did the French, defeated at Dien Bien Phu by Ho Chi Minh's resurgent Vietnamese, at last let go of Laos and all Indochina.

NEXT I FLY to Pakxe, in Champasak Province, for sight-seeing in the romantic far south. From the air I see new bridges along Route 13, built with Soviet and East German aid. At Savannakhet, Route 9 branches east to Vietnam, to Da Nang on the South China Sea; Vietnamese are working to asphalt it by 1988. It brings gasoline from the U.S.S.R. Out goes Lao timber—teak, rosewood.

South of Pakxe the placid Mekong widens to a full mile. I'm in a boat again, passing floats of bamboo or Styrofoam that hold huge fishnets. Along the right bank grow tobacco, marijuana, reed to make thatch for roofs. The motor conks out, and I am glad. For a while we drift downstream, slowly and in silence, aware of sights that might have rushed by unappreciated. A girl rows her little boat standing up, her hair glistening down to her waist. A herd of brown

cattle comes racing down the bank; all drink and trudge up again. A ferry made up of old U. S. Army pontoons brings a truckful of water buffalo.

In the forest over there, says the boatman, you can hunt good things to eat: deer, wild pig, python. Not far to the southeast is Phapho village, notable for being in the elephant business. A dozen men may be away for a month to snatch a couple of little ones away from their mothers. When they are bigger and trained to drag logs out of the forest, they'll be worth a fortune. In Phapho nearly every family has one.

We stop on the right bank to visit Wat Phu, now in decay but still a marvel—the gigantic water basin; two exquisite pavilions; a 700-foot-long stone stairway flanked by flowering trees leading to the sanctuary—all built by the Khmer kings who ruled from Angkor 165 miles farther southwest. It's been said the Emerald Buddha enthroned in Bangkok is merely a copy, that the true Emerald Buddha is hidden away here at Wat Phu. . . .

FARTHER SOUTH we travel by road. The Mekong widens to five miles as water pushes past seemingly endless outcroppings of rocks—the 4,000 islands, as a Lao song has it. They make for a plethora of rapids. Close to the Kampuchean border, near the Khonephapheng waterfall, a new lookout pavilion offers a view of seven waterfalls—and there it is, on a tiny island amid the foam and spray, the object of my southern trip: the magic *manikhot* tree! It's not much to look at—spindly, almost leafless. But it looms large in the Lao imagination. A monkey eating its fruit would turn into a man. If a man ate it, who knows? It's said no human will ever reach it, the water is too swift.

In late afternoon a dozen birds come and sit on a branch, then more and more, a hundred are silhouetted in the dusk. . . .

It's a bumpy ride, six hours by night, back to Pakxe in a Soviet jeep. In the forest the villages are dark, but at one, a district headquarters, a couple of kerosene lamps burn. People are bringing contributions—ten kip

A time-honored pastime, *shooting down insects requires fierce concentration* ***(right)****. On a once thriving business street in the heart of Vientiane* ***(above)*** *a game of netless badminton unfolds against a backdrop of shuttered storefronts, sad reminders of the many tradesmen who have left the country.*

and two bowls of rice per family. For a festival? No, a conference. The Lao call it *sammana*. It's political education, and everyone must go, regularly, from ministers on down. Can I go? Certainly not.

Too bad, but then I've already had a whiff of the current political vocabulary, from published party pronouncements: "Enthusiastically support the special relationship with fraternal Vietnam!" "Be vigilant against the *patikan*, the reactionaries in collusion with the U. S. neocolonialists and imperialists, and the hegemonists [meaning the Chinese]." Those patikan, I learn, still hold up a bus, or blow up a bridge, or ambush an official now and then.

And, come to think of it, I have had an unsolicited private lecture on Lao socialism, or *sangkhom nyom*, the good society. That was shortly after my arrival in Pakxe, when I made a side trip to Pakxong, on the Bolovens Plateau. There Lao Theung minorities make up a majority—the Loven and Nha-Heun, the Sapuan, Kasseng, Oy.

The chairman of the Pakxong city committee told me he'd joined the Pathet Lao 38 years ago and could remember when his people were coolies under the French. They were forced to work on roads, he said, and to pay taxes when they were so poor that one's shirt would weigh kilos, meaning it was so heavily patched. Now, he said, life is improving under the farsighted LPRP and its three revolutions: Eradicate illiteracy! Eliminate private trade, create cooperatives! Introduce modern techniques, produce more! Here that means more coffee, for export to socialist countries.

Pakxong, lying close to the wartime Ho Chi Minh Trail—the North Vietnamese supply line through Laos to South Vietnam (map, page 779)—was flattened by U. S. bombs; even today I see only one masonry building, a new villa for East German coffee

From around the world *come gifts of clothes and checks for relatives back home. At Vientiane's main post office young Hmong men* ***(below)*** *gather to claim their packages, while customs officials search for contraband. Goods flow both ways; traditional embroidery and jewelry—such as adorn a Hmong girl* ***(left)****—fetch high prices overseas. Almost a third of Laos's 300,000 Hmong have escaped since 1975. Many of them fought in the CIA's secret war in Laos.*

experts. I asked, how's coffee production?

It's up, said the chairman—1,900 tons in 1980, this season 4,600! So far it's 40 percent private, but next season it'll all be cooperatives. That's the plan. "Of course, we don't force anyone; we educate, we tell people what's good and what's bad."

Later I heard that in fact coffee production is down; the German coffee experts are tearing their hair. People tell them yes, they'll plant more, the right way—but then they don't.

At a farewell dinner in Pakxe a top provincial committeeman also keeps invoking the party as he reminisces about the bad old days when U. S. planes dropped two million tons of bombs on Laos (more than the U. S. dropped in all of World War II). He'd spent those years at Pathet Lao headquarters in the limestone caves at Vieng Sai, in the far northeast. I'd heard about life in those caves—safe from bombing but noisy, cold, stuffy, never enough to eat. Provisions were a problem, the committeeman says—how could our people raise food when they had to hide?

"But under the clever leadership of the party, we knew when the planes would come and where. So where they came by day we'd work at night, and where they came at night we'd work in the morning. Where the planes could see smoke, or clothes drying, they'd drop bombs. So we lit fires and hung out clothes in far-off places."

He laughs and tells the story about a farmer who wanted a fishpond. So he built a flimsy little hut and lit a fire in it at night. Sure enough, a plane came and made him a fishpond. "This really happened, in Xiangkhoang Province. . . ."

Today, bomb craters remain plentiful on much of the Plain of Jars on the Xiangkhoang Plateau (pages 776-7), but a lot of the explosives dropped here have left no

Fragments of gold *lie buried in the sediment of the Mekong River upstream from Luang Prabang, awaiting panning by locals* ***(above)****. Mercury added directly to the pan bonds with the gold. The resulting amalgam is squeezed in a cotton cloth, leaving a small dry ball* ***(left)****. This is heated with a blowtorch; the mercury evaporates, and the gold remains. Local inhabitants can thus earn extra cash in the dry season—as much as 600 kip a day, or about six times a typical daily wage.*

visible impact. Down came thousands of containers, each releasing hundreds of fist-size bomblets filled with hundreds of steel pellets. Not all these little bombs went off. A lot still lie around in shallow dirt. They won't explode if a farmer should step on them. But if he swings his long-handled hoe from high overhead, as people here do—boom!

Thus belated casualties of the war still arrive once in a while in Phonsavan, the new provincial capital, at the hospital staffed by doctors and nurses from the Mongolian People's Republic. Some of the wounds leave ugly scars.

I'm glad to have also met Americans trying to help. They're from the Mennonite Central Committee in Akron, Pennsylvania, and have brought 1,200 shovels, reinforced for cultivating the tough, dry soil. Use one instead of a hard-hitting hoe, and it won't set off any bomblets. The Mennonites also supply wire and a generator so that bomblets, once collected and put into a pit with explosives, can be detonated electrically from a safe distance.

Quakers, from the American Friends Service Committee in Philadelphia, brought 20,000 shovels. And to help reconstruct destroyed villages, they provided portable sawmills, powered by little Volkswagen motors, no parts weighing more than 200 pounds. That's the sort of low technology needed in Laos, a Quaker says. That and lots of patience. On a recent trip he logged 15 hours of project-related work, 16.5 hours of travel, and 17.5 hours waiting for vehicles and people to show up.

AT THE AIRPORTS consultants come and go, talking of economic development. A hundred projects are on the books, according to UNDP, the United Nations Development Programme. What potential! What frustrations! Australians, Cubans, Swedes, all have tales of Lao not carrying out what's projected. But why should a family grow a lot more rice, for example, when much of it must be sold at the government's low price? And what you get isn't cash but scrip—good only in government stores where there'll be few goods, or nothing you really want. So you raise just enough that your family won't be hungry. (And indeed it seems that nobody in Laos is starving. A UNICEF man tells me his countrywide surveys show no serious malnutrition; what he worries about is low vaccination rates and high infant mortality, due to poor hygiene.)

Quite a few Vietnamese advisers are said to be frustrated too. The census mentions 2,932 cooperatives, but few function as intended. It's not just that management skills are scarce, it's the attitude:

- A model farming cooperative has two tractors and requests a third. To farm more land? No, a visitor is told, to rent to neighbors who still depend on water buffalo.
- Cloth merchants in Vientiane were told to

An enduring enigma, *huge sandstone urns have lain on the Plain of Jars in central Laos for some 2,000 years; their origin and purpose remain uncertain. Measuring as much as 26 feet in circumference and eight in height, they may*

have served as funerary containers. According to Lao legend, they were built by giant mountain-dwelling ancestors for storing grain or for making alcohol—similar, perhaps, to the potent rice-based lau lao *widely consumed today.*

***Mongolian aid** has brought a new, much needed hospital (**below**) to a country plagued by malaria and high infant mortality. At a secondary school in Vientiane (**right**) a teacher brings her own children with her to class.*

form a trade cooperative—each merchant must put up a certain amount for buying cloth. Results: Two administrators obtain an air conditioner and a car but no cloth. They ask for more money.

In short, the Lao are laid back. That's nothing new. But apparently—am I hearing this right?—the Lao Communist Party can be too.

"Marxism-Leninism, in theory, cannot go along with religious practices, but in fact the party leadership aims to adjust the doctrine, to accommodate it to the reality of Lao society." That's what a senior government official says, after telling me that there still are 15,000 Buddhist monks in Laos.

Then I get a whiff of relaxed candor from the highest level, thanks to an unusual set of circumstances. My picture-taking colleague, Seny Norasingh, was born in Laos, came to the United States 16 years ago, and is now an American. But he looks Lao and managed to somehow tag along for an informal meeting of party brass with General Secretary Kaysone Phomvihane, whose movements are never announced in advance. Seny not only obtained unusual photographs (page 780)—he also left his tape recorder running, in plain sight, and so I learned how the Lao leader sounds when he lets his hair down:

"The most important thing now is to listen to the people, to understand what they want, why they complain. And you can't do that unless you get rid of corruption, among the officials, among the cadres. . . ."

All this against a background of traditional Lao music drifting in through a window.

BEHIND THE PRESENT-DAY REALITY in Laos lies the memory of postwar problems unlike those elsewhere in newly Communist Indochina. Not overpopulation and unemployment, as in Vietnam. Not bloodthirsty fanatics going berserk, as in Kampuchea. The Lao People's Democratic Republic has its own chronology of early troubles:

1975-76: New regime stresses reconciliation, but students, officers, merchants flee. Tax on rice, rains poor, farmers unhappy.

1977: Drought. Farmers unhappier, some flee, some join resistance. Government appeals for more Vietnamese troops.

1978-79: Too much rain, then floods. Resistance pockets persist. Radicalization—government seeks to force "cooperativization." Still more farmers leave.

1980: Biggest exodus yet. Resistance fades. Some old-regime civil servants, released from reeducation camps, get jobs in ministries. Some liberalization—a turning point.

Most observers tend to agree that many things have eased. People still leave surreptitiously, but not so many now that it's harder to go from the refugee camps in Thailand to the U. S. or Canada, to Australia or France. Chances are the daily plane to Bangkok will have an old couple aboard, off to visit their new grandchildren half a world away; they have passports, they'll be back.

Then there are Laos's widely noted efforts,

despite all the rhetoric, to improve relations with China and with the United States, whose embassy in Vientiane never closed. How far Laos can go in that direction would seem to depend on the sufferance of Vietnam. Under a treaty of mutual friendship and cooperation, some 50,000 Vietnamese soldiers remain stationed here.

WHAT'S MOST REMARKABLE to me is the continuing ability of the Lao to make the best of whatever is presented to them. The key is personal relations. To get along in Vientiane these days, a family will have a relative abroad who sends a little money and, for balance, at least one son in the military, serving the state; also a friend who can get another son a government job—not necessarily very high, but where he can do little favors for people so they'll do little favors for you. Perhaps you have a connection to someone really big in the party or the government, someone interested in your welfare because one of your daughters married one of his sons, or because your grandparents were friendly with his. Then you may become part of an influential group whose members look out for each other's interests and can expect big favors. Thus some can make big money and buy houses, cars, gold.

In short, the new ways are the old ways.

And where are the best parties these days? In the courtyard at the Ministry of Industry, says a well-connected foreigner. Disco music! Flashing lights! He thinks there'll be a good one next week at the central bank.

Could there be a switch back to a harder line, to tough collectivization? It seems unlikely right now, but it's possible.

What of the future of Laos itself? A few veteran foreign observers believe that even today the Lao People's Revolutionary Party is merely a branch of the old Indochinese Communist Party founded by Ho Chi Minh in 1930 and ostensibly dissolved in 1951. What if one day it were openly reconstituted? Then Laos, with Kampuchea, might find itself part of some new Indochinese confederation ruled from Hanoi as the 15 republics of the Soviet Union are ruled from Moscow. But most observers foresee no such drastic turn—rather that Vietnam will continue to dominate Laos as the U.S.S.R. dominates the Communist states of Eastern Europe. . . .

Early morning, a street in Vientiane. A duck, a goat, a Soviet couple. I'm told that housewives complain in the market, those insatiable Soviets are driving up the price of

Purifying waters *cleanse the spirits of monks and laymen during April's joyous pi mai celebrations in Luang Prabang. Sticky tapioca, luridly dyed, also flies through the air as the normally reticent Lao exuberantly welcome their new year. The Communist regime reluctantly recognizes the importance of Buddhism to the people.*

bananas. We pass a weathered stupa, a monument surmounted by a spire, or *that* (pronounced tat)—supposedly containing a relic of the Buddha. There are a lot of these in Laos.

In a few hours I'll be on the Bangkok plane, headed home. Now I pause for the last time before a new-style Lao stupa. It's gleaming white, and the spire of this one—honoring the dead of the Lao revolution—is topped with a Soviet-style five-pointed star. That's something to think about. According to the *Great Soviet Encyclopedia*, such a star symbolizes the ultimate triumph of the ideas of communism on five continents.

Not far away, near That Luang—the Royal That, the most revered in all Laos—a dozen women, kneeling, put handfuls of sticky rice into the bowls of passing monks. The women rise to go home, but three of them approach the wall encircling That Luang and stick on it little clumps of rice. That's for a powerful spirit believed to dwell in there, the spirit of King Samsenthai, who ruled in the 15th century.

To me, this is symbolic too, and also something to think about. Twenty-five years from now will traditional Lao ideas still hold sway over the minds of the people here?

I probably won't be back to find out, but I hope so. □

WATERTON-GLACIER

Pride of Two Nations

INTERNATIONAL PEACE PARK

Symbol of friendship between Canada and the United States, border-spanning Waterton-Glacier inspires cooperation, from training for canyon rescue to the uneasy alliance between man and nature.

By DAVID S. BOYER
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by
LOWELL GEORGIA

WATERTON LAKES NATIONAL PARK

Mount Blakiston 2,940 m 9,645 ft

Mount Crandell 2,381 m 7,812 ft

Lower Waterton Lake

BLOOD INDIAN RESERVE

Middle Waterton Lake

Prince of Wales Hotel

PARK HEADQUARTERS

Waterton Park

CONTINENTAL DIVIDE

PROPOSED ROAD

Upper Waterton Lake

Kintla Peak 3,079 m 10,101 ft

CANADA

U.S.

Flathead Provincial Forest

Rainbow Peak 3,015 m 9,891 ft

Bowman Lake

Quartz Lake

BRITISH COLUMBIA

MONTANA

North Fork Flathead

Kintla Lake

Polebridge

N

WATERTON-GLACIER INTERNATIONAL PEACE PARK

- Campground
- Fire lookout
- Paved road
- Unpaved road
- Hiking trail
- Drainage divide

Scale varies in this perspective view.

NOS CARTOGRAPHIC DIVISION
PAINTING BY CHRISTOPHER A. WILES
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PRODUCTION: KAREN PINGREE
MAP EDITOR: JOHN T. WEBER

Flathead National

Sharing a Mountain Wilderness

Set aside separately in 1895 and 1910, the Canadian and U. S. parks were joined in 1932 after a grass-roots effort led by Rotary International in Montana and Alberta. Each government administers the park on its side of the border, although jurisdictions freely overlap to manage wildlife, emergencies, or other activities. The nations have also cooperated to keep Waterton-Glacier largely pristine; 93 percent of its million acres lies undisturbed by man.

ALBERTA
MONTANA
Chief Mt.
2,766 m
9,080 ft
BLACKFEET INDIAN RESERVATION
St. Mary
Babb
HUDSON BAY DIVIDE
Belly
Lake Sherburne
GOING-TO-THE-SUN ROAD
St. Mary
Mount Cleveland
3,190 m
10,466 ft
Ptarmigan Tunnel
Many Glacier Hotel
St. Mary Lake
M O U N T A I N
Grinnell Glacier
Fifty Mountain (backcountry)
Swiftcurrent Mountain
2,571 m 8,436 ft
Garden Wall
Logan Pass
2,032 m
6,664 ft
Granite Park Chalet
Swiftcurrent Pass
2,190 m 7,185 ft
Mount Jackson
3,064 m
10,052 ft
Triple Divide Peak
2,442 m
8,011 ft
CONTINENTAL DIVIDE
Rising Wolf Mt.
2,900 m
9,513 ft
East Glacier Park
Glacier Park Hotel
BLACKFEET INDIAN RES
Two Medicine Lake
Mount Stimson
3,091 m 10,142 ft
Sperry Glacier
McDonald Creek
Sperry Chalet
Logging Lake
Lake McDonald Lodge
Gunsight Pass
2,117 m 6,946 ft
GLACIER NATIONAL PARK
GOING-TO-THE-SUN ROAD
Lake McDonald
Middle Fork Flathead
Pinnacle
Nyack
Essex
BURLINGTON NORTHERN RAILROAD
Apgar
PARK HEADQUARTERS
West Glacier
North Fork Flathead
Flathead National Forest
Flathead Range
Forest
Coram
Flathead
Martin City
Hungry Horse
HUNGRY HORSE DAM
Hungry Horse Reservoir

WILDLIFE, WATER QUALITY, silence, and scenic vistas are among the resources that are affected by external pressures on the park.

Existing

- T Logging
- O Oil/gas well
- S Seismic blasting
- B Grizzly bear hunting
- H Scenic helicopter flight
- L Livestock trespassing
- P Wildlife poaching
- R Access road
- S Summer homes/subdivision

Proposed

- A Amusement park/water slide
- C Coal mine
- O Oil/gas well
- R Road

MANTLED IN NEW SNOW, *the fire lookout on the summit of Glacier National Park's Swiftcurrent Mountain occupies a perch as precarious as it is beautiful. Hundred-mile-an-hour winds make it necessary to anchor the building with bolts and steel cables.*

*Both parks have been designated by UNESCO as biosphere reserves, to preserve genetic diversity and study contact between the parks and their neighbors. More than 50 activities threaten the perimeter (**above**), from seismic blasts and drilling for gas to a planned amusement park and water slide.*

SAVE FOR THE RHYTHMIC plunk-plunking of the ski poles in the snow, keeping time for the swishing music of the skis, there had been no other sound. But now we were hearing piano-like notes of tinkling water; an early April sun was releasing a few splashing phrases of melody through spring-time openings in the ice of the river.

By June the orchestration would be vastly different. Here would reverberate the bass-viol rumble of rapids, the saxophone screech of oarlocks on giant rubber rafts, the trumpet shouts and cheers of eastern vacationers jammed aboard for their first white-water ride down a western river.

Waterton-Glacier International Peace Park, the only such park in the world, would be performing its summer concert: a cacophonous medley of two million visitors, background music provided under the baton of nature, a complicated symphony sounding across a million-acre wilderness in the U. S. and Canadian Rocky Mountains.

The summer noise will be accented this year by meetings, speeches, and celebrations from Canada Day, July 1, through Independence Day, July 4. Like crowds at scores of other places along the border from the Atlantic to the Pacific, Canadians and Americans will be inaugurating their first annual United States-Canada Days of Peace and Friendship—the only such international relationship in the world. It all began here at the peace park.

For us, however, all sounds were muted that April day on the snow-blanketed North Fork of the Flathead River. Here at the park's western edge, we had stopped skiing to look and listen. Our thoughts were of animal tracks. We had been observing them for miles: deep wallows where moose had struggled through the snow; coyote footprints patterned in skittering circles on the surface, following the trails of mice or squirrels; the sedate hoof marks of deer and elk, some alone, some in congregation.

And now, along the river's bank and in bounding pursuit of a fleeing deer, ran the splayed footprints of a giant timber wolf. Both sets of tracks, barely 30 minutes old, disappeared into a long channel of open water—with no indication which animal had won the watery race of life or death.

The wolf track itself was a kind of miracle. For decades the timber wolf had been extinct in the western U. S. Only recently have a few drifted back into Glacier National Park from across the Canadian border—maybe 20 in all.

Out beyond that unfinished story in the snow stretched a panorama of white-frosted forest and foothills, then mountains, jagged and glistening, a saw-toothed wall of winter white against blue sky. Even though there was a murmuring of water at our feet, the silence seemed complete.

Spring-cleaning *Glacier's roads often lasts beyond Memorial Day—the date that a park bulldozer, guided by surveyor's stakes, begins plowing an 80-foot snowdrift to open Going-to-the-Sun Road through Logan Pass (**facing page**). The road remains open in autumn (**above**) until the first big snow.*

Packing a pet, *Clare Spurgis* ***(left)*** *treks through Glacier en route to Alaska from his Michigan home. Officially his passenger, even on a leash, is feline non grata in the park's backcountry.*

Howard Snyder of Alberta teaches daughter Risa the ways of Waterton ***(right)****. "Nature reserves her treasures for those who walk quietly," says Snyder, an author and mountaineer.*

The man on skis next to me pushed back his hat. "This is what this park is all about: wilderness, and the chance to experience it." From here across the mountains to the park's opposite boundary, he said, there would be no other people. "Except maybe a few little groups, alone and on skis, like us."

Here was a mountain wilderness enjoying its winter rest from visitors—a wilderness of some 60 kinds of mammals, 250 birds, 1,000 plants, 200 lakes, and an extraordinary geologic record—like a great open book—reaching back millions of years. The view before us was the same the Indians knew before the coming of the white man, the same glimpsed by early explorers and fur traders.

But Bob Haraden cautioned me: "The problem is how to keep it as it is. The park is in good shape itself; the threat lies in the deterioration of the lands around us. They were also once wilderness. Now there is logging, mining, oil and gas exploration, roads, buildings, people. We're afraid the park could become an island of wilderness surrounded by a sea of development."

Despite his concerns, Bob's face and voice were calm as snow, his hair as white. He loves this place and comes back to it often from his retirement home nearby. He'd been superintendent of Glacier, the U. S. portion of the peace park.

"For years our rangers and the Canadian wardens of Waterton Lakes National Park next door have been working together to preserve this area," he said. "And lots of concerned citizens in both countries too. We feel it's important. Canada and the U. S. together will soon hold nearly 300 million people—and it's getting harder to find places for silence and beauty in our lives."

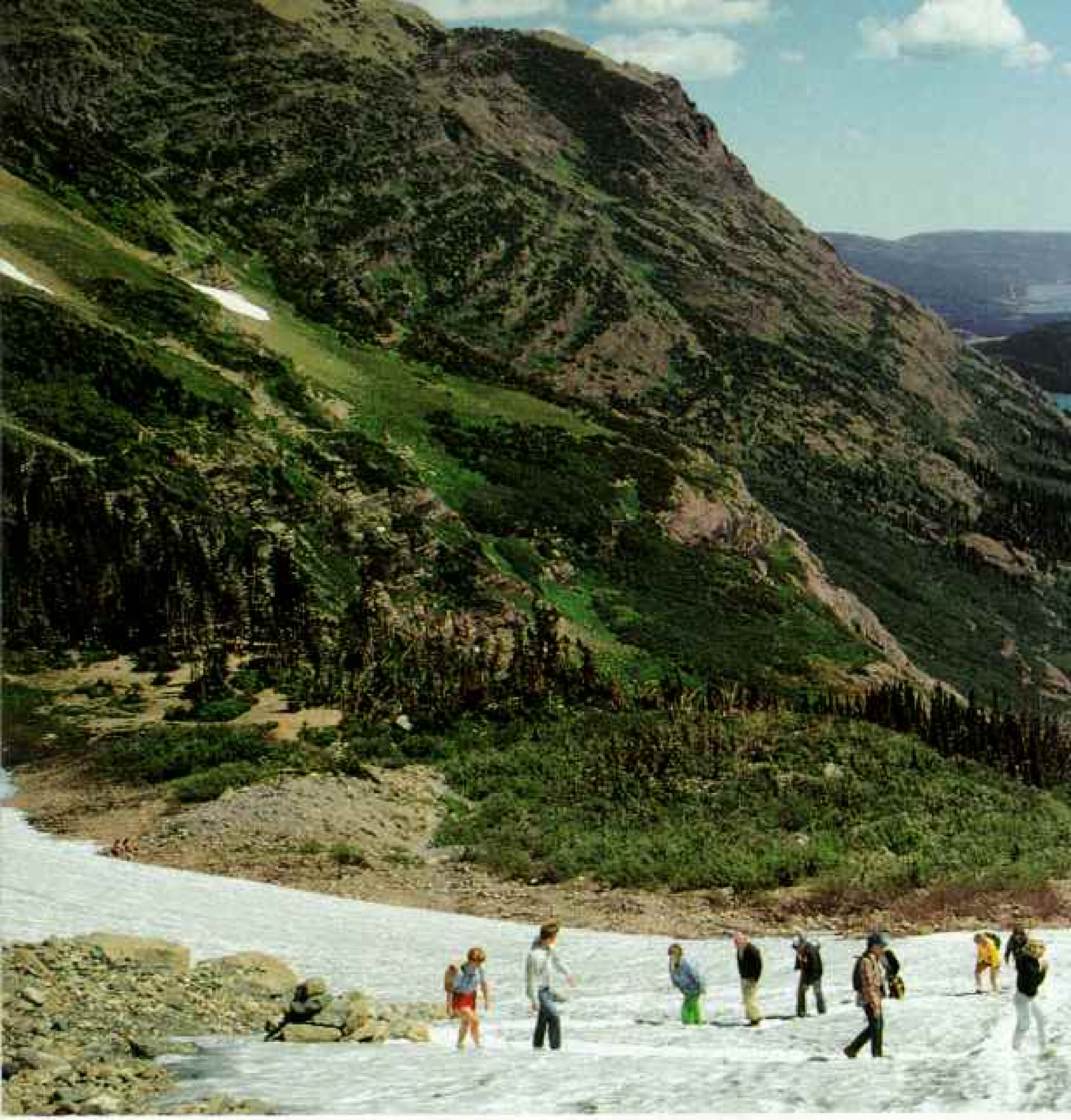
Bob pushed his hat forward, and the two of us resumed skiing into the great white, silent Rockies.

WHEN THE PARKS opened for the summer, I looked more closely into Waterton-Glacier: its animals, plants, geology; the people who protect and use it; the threats that seem to gather like storm clouds in the distance. Glacier Park was established by the U. S. Congress in 1910, Waterton by the Canadian Parliament 15 years earlier. In 1932, at the urging of Rotary International, Congress and Parliament joined the two as the world's only international peace park, to mark the historic end of border wars and today's tradition of peace and friendship.

Though joined in symbolism for peace and by the cooperation of their staffs and the mighty work of nature that shaped them, the parks are still administered separately.

"And separated," Glacier's new superintendent, Gil Lusk, told me wryly, "by that big bare slash cut through the forest along the boundary. We hope for a treaty to heal that wound one day."

Isolation is one secret of the park's success: Glacier *(Continued on page 812)*



Sculptured by ice, *U-shaped Grinnell Valley* (**above**) *is typical of the park's topography, carved by massive alpine glaciers during the most recent ice age. As the climate warmed, the ice melted to leave strings of lakes.*

To study glacial erosion, geologist Bob Anderson (**right**) *of the California Institute of Technology enters a cave accessible each summer beneath Grinnell Glacier. Instruments to measure pressure and temperature at the ice-rock interface are left year-round to record the way a moving glacier grinds and plucks at its bed—sometimes more dramatically than he would like. Last year the glacier destroyed every instrument in his subglacial lab. "It was a real mess," he says. "We never know what we're going to find down there."*

His data show the glacier sliding downhill about an inch a day. Grooves in the ice form as the glacier passes over irregularities in the rock. Geologists estimate that the 275-acre glacier was twice as large when naturalist George Grinnell discovered it a century ago.

The race to save a life

FIRST REPORTS were sketchy. On September 5, 1985, someone saw a low-flying plane enter a Glacier box canyon—and never come out. A dazed woman was found walking barefoot in the freezing rain, saying something about a crash. Within minutes, medically trained rangers were combing the hillsides. They found two dead and a 55-year-old man clinging to life.

*Lynn Fosbender (**facing page,** at right) and Patty Furbush followed instructions relayed by Kip Knapp (**left**) from a doctor patched through from Great Falls, Montana. Meanwhile a trail crew cleared a path for stretcher-bearers to reach a wheeled litter (**below**) near a road. The man lived, thanks in part to his fellow survivor, who covered him with clothes before seeking help.*

(Continued from page 806) tucked into northern Montana and Waterton into southern Alberta. The long, cold winter is another. Size also helps. Most summer tourists simply accept the inaccessible mountains through their car windows or cameras; only a relative few go backpacking. Nor is it any place for partying weekenders from big cities, as is Yosemite. Calgary is the only big city nearby, and it has other national parks much closer.

Thus the peace park is a refuge for wildlife: bighorn sheep, mountain goats, elk, moose, black bears, white-tailed and mule deer, beavers, otters, marmots, ospreys, ptarmigans, bald eagles. And of course, its fabled grizzlies.

Over the years the guns of hunters and the crush of people, towns, roads, and industries have made the park an island of refuge for a growing population of grizzlies. As the number of park visitors has increased, and the number of bear/people encounters, injuries and deaths have gone up too.

AMONG ALL THE WORLD'S EXPERTS on bears—on keeping black bears or grizzlies from attacking or killing people, on helping those injured—I rate three the highest:

Max Winkler and Bob Frauson are both genial giants, legends of their two parks. Max, an open-faced, square-jawed Canadian chief warden of the wilderness, stands six feet four in stocking feet and weighs 220 pounds, almost as formidable as a bear on hind feet. American ranger Frauson, with a matching grin, equals Max in height, if a few pounds lighter—a bulwark of mountain expertise. Backcountry U. S. ranger Jerry DeSanto is only about half their size, but as wilderness-wise as a lynx. Among them they have survived more than 60 years here, and any number of encounters with bears. All three, recently retired, have built homes just outside the park they love.

I found myself camped with this trio one night below Mount Cleveland, that broad-shouldered, ice-cream-covered leviathan of a mountain near the Canadian border, at 10,466 feet the highest of the park. These men had climbed, or helicoptered, or rappelled on Cleveland and a dozen other peaks to rescue lost hikers or climbers, or to carry out people injured or killed in accidents or in battles with bears.

Max and Jerry have souvenir scars from bear battles of their own. Waterton-Glacier can be an unforgiving place. Two or three people are mauled by bears in most years, four fatally since 1977.

"To see a bear is what thousands come for," Bob Frauson said. "People are both curious and scared, and looking for a 'wilderness experience.' When their hair is standing on end, they're really having it. But most of them probably walk right past bears feeding in the brush and never know it. Bears are mainly timid and quiet, but they can get very angry when their lives are disturbed or their cubs threatened."

How to avoid danger? Well, never tempt bears into a car or campsite or tent with food or garbage. And always hang your food on a high tree limb when you're backpacking.

"Beyond that," Jerry said, "there is no perfect prevention. You can make noise if you want—laugh or sing or ring bells or clap rocks together, whatever. Nobody knows for sure what bears think about any of that. Some people say you should lie down and play dead. I wouldn't. One thing for sure, don't run. Don't run from any wild animal. Try to stand your ground. That's probably what the bear will do. Maybe he'll decide to leave before you faint."

Max corroborated his colleagues' wisdom: "No two bears are alike. Just like you or me, they're different, unpredictable, and potentially dangerous. There's no foolproof way to deal with bears."

Climbing a tree may not help either, Jerry reminded us. A grizzly came up after him and dragged him down, and they fought on the ground. The grizz quit only when Jerry swore at her and smashed her across the nose with his backpack.

To try to keep bear confrontations down, rangers sometimes scare bears off the trails with red-pepper spray or shotgun-propelled firecrackers. Some have to be trapped and moved or even, dangerous ones, shot. Usually rangers simply close the trails.

Cliff Martinka, Glacier's chief scientist, says some people think bears should be banished. "But if we got rid of them, it wouldn't change things that much," he said. "In the past century or so Americans have killed

thousands and thousands of grizzlies. And if we polished them off here, and at Yellowstone, they wouldn't be extinct. There'd still be lots left in Canada and Alaska. Even so, I think it's morally important for us to learn to live with them.

"We're just two species, bears and people, you know. And we people cause a million times more havoc than they do. If we finished them off here, the loss would be more ours than theirs. We need to try to share this small, peaceable domain of the grizzlies. Especially since it's a peace park."

GLACIER PARK was not named for the 50 or so remnants of glaciers that lie isolated in today's high country, most of them small and not much more than snowfields. The name commemorates the vast oceans and rivers of ice that, over a million years in the Pleistocene epoch, chiseled the park's knife-edged peaks and ridges, carved out its glacial cirques, and left behind its lakes and its hanging valleys.

The story of the park goes back further. More than a billion years ago, today's mountains started as sediments deposited in an ancient sea. Slowly they hardened into rock. Some 65 million years ago pressures building up within the earth's crust caused the rocks to warp, fold, break. A gigantic 300-mile slab of sedimentary rock, pushing its way eastward, slowly rose up over the top of rocks a billion years younger. Finally the great Ice Age glaciers began their carving, creating these spectacular Rockies.

To visit the second largest of today's glaciers, Grinnell, I joined a July contingent of tourists for 11 miles of hot, high nature hike. Beside the trail rose the most dramatic of the park's wildflowers, bear grass, its white puffball blossoms big enough to serve as pom-poms. Behind them rose the Garden Wall, the jagged Continental Divide, ancient rocks, their past written in stratification lines and differing pastel hues.

On a glacial moraine now covered by grass, we ate our brown-bag lunches and listened to Bob Schuster, an Oregon high-school science teacher and for 20 summers a Park Service leader of nature hikes.

"A century ago," Bob said, "when explorer George Grinnell discovered this glacier, it was twice as large. Our climate has warmed since then; today the glacier is hardly half a square mile. If climate patterns continue, it will disappear, as those old Ice Age glaciers did." Bob went on to talk about George Grinnell, one of the first to propose that this area be made a national park. Grinnell realized that rain falling on Triple-Divide Peak flowed to the Pacific Ocean, the Gulf of Mexico, and Hudson Bay—and was the first to call Glacier the "crown of the continent."

I'd eaten my sandwich with a little old tourist in tennis shoes and learned more of what Cliff Martinka meant about people's relationships with wilderness and animals. George Viliani of Los Angeles was one of several senior citizens among us, but I was startled to hear this hard-striding and happy athlete confess to being 82.

Blizzard-proof *since 1914, the combination grocery store and post office at Polebridge, Montana (winter population 15), was recently named a national historic site. "The store is a real powerful entity," says owner Karen Feather. It's also the only thing open within 30 miles.*

"What's your advice for staying young?"

"Well, the first thing," George replied, "is stay interested! The second is keep going! Otherwise you could wind up dying by inches in a rocking chair. I've been hiking here for 50 years."

Usually, he said, he carries a motion-picture camera and tripod. "But the huckleberries aren't quite ripe yet, so the bears aren't out where I can shoot 'em. I'll have to stick around a couple more weeks."

Bears or no bears, George had thoroughly enjoyed the hike. Now at the end of the day, saying good-bye, he declared, "This has been the most interesting day of my life."

"He probably thinks that about most days," Bob said. "But he made my day. It's the older tourists, you know, the ones who keep coming back, who seem to appreciate the park the most."

ONCE LONG AGO I had climbed a ridge of the Rockies here with Wayne and Mae Luginbuhl of Medway, Ohio. Now, a dozen years later, we met for a reunion, to hike spectacular Ptarmigan pass into the Belly River lake country. Still photographing wildflowers, the Luginbuhls had spent 14 consecutive July vacations hiking these trails. It would take a long time to do all 830 miles of them.

Wayne and Mae introduced me to Bill Wanser, head of the Glacier Oldtimers club. Bill had grown up here. His dad had run strings of packhorses back in the halcyon days of the "dude business."

Sixty years ago trainloads of society Easterners and even European royalty were lured here along the rails of the Great Northern Railway. It was the ultimate summer vacation for the "beautiful people" of the Roaring Twenties. First, a week on the plush cushions of Pullman sleepers, their destination the newly opened, glorious West. Then more weeks on horseback, camping under the stars, dining on fine English china, dreaming under pressed sheets in snug tents with wooden floors; then luxuriating even more grandly when they reached, in turn, Great Northern's three magnificent, hewn-log hotels.

All three remain. I spent a night at the Prince of Wales, on the Canadian side of the park. The hotel stands in gingerbread Swiss

Wilderness road to recovery

GUYS WHO SHOW UP *at the Wilderness Treatment Center in Marion, Montana, are not exactly Boy Scouts. Most are city kids up to their necks in drug or alcohol abuse. "Some have never even seen snow," says director John Brekke* (**above, at left**). *Yet the final leg of his 60-day, Alcoholics Anonymous-style treatment program is a 16- to 21-day expedition deep into Glacier backcountry. Most are scared to death at the prospect of climbing a major peak, crossing freezing rivers, and camping in grizzly country, says Brekke. Bolstered by spur-of-the-moment group therapy* (**above right**), *patients slowly regain their self-esteem.*

Scott W. of Riverside, California (**right**), *says his feet ached for two weeks after the program, but he "can't find words good enough" to describe the drug-free life he now enjoys. With a success rate over 50 percent, Brekke observes that "for these kids, wilderness is a lot more therapeutic than a hospital room."*

Speaking with one voice *for conservation, Andy Russell and son Charlie (**below**) keep an eye on development around Waterton. Andy is an outspoken author who doesn't mind "pulling whiskers once in a while." Charlie (**facing page**, in his ultralight) presses for industry's cooperation in putting buffer zones between the park and neighbors like a Shell natural-gas processing plant.*

majesty on an exposed hilltop, assaulted by the wind. It whistled through my bedroom. ("We don't count it a really windy night till we get whitecaps on the toilets," the Canadian chambermaid told me.)

But the hotel offers one of the most memorable vistas in North America—the length of Waterton Lake, framed into lavender infinity by successively receding castles of the Rockies. It was worth the bedroom breeze.

In the 1930s came new gravel mountain roads, and packtrains began giving way to fire-engine-red, canvas-topped sight-seeing limousines. They still look as they did 50 years ago—still carrying cargoes of hotel tourists, still chauffeured by white-shirted college boys who know where to stop for the best photographs and where to expect wild animals for viewing through binoculars.

The greatest change, however, came in 1933 after an army of men with picks, shovels, dynamite, and a few machines had hacked across the Rockies one of the world's most daring highways. Up and down 50 miles of twists and turns, it crosses Logan Pass in Glacier Park at 6,664 feet. Some years 80-foot snowdrifts defeat the snowplows until mid-June. It is named Going-to-the-Sun Road: Near its summit, one legend tells, a mythic Indian ascended to a mountain peak, there to join the sun in eternity.

Ranger Jerry Bell had patrolled this road for 27 years. "Some drivers freeze at the wheel up here," he told me. "And some passengers get hysterical. I stopped one guy driving on the wrong side of the road. He said his wife screamed every time he got near the outside edge."

"What did you do?"

"Well, I told the lady that I'd driven this road a thousand times and knew every inch of it. She climbed in with me quite happily, even enjoyed the scenery. I think some wives just like somebody else driving besides their husbands."

MILLIONS of photographs have been taken from dozens of traumatic turnouts on the dugway over Logan Pass, but comparatively few from the trail over Gunsight Pass—it's a day's hike to get there. Near the top, rooted in the gray rock from which master masons erected it, stands Sperry Chalet, a Swiss-style aerie with accommodations for 50 overnight guests.

Here I found a staff of college girls content to remain atop a mountain for a summer. "We have to agree not to go down to civilization," one said. "And we haven't missed it. Boys aren't allowed to work here, and we haven't missed them either." Cyndi Hilyard, a university student from Plentywood, Montana, told me that she spent her spare time watching animals—squirrels, mountain goats, marmots—learning to mimic their sounds. She spoke of walking alone, looking out on the mountains, "trying to fix it all in my memory, record it on my soul." Cyndi said she wanted to come back next year too. "If Kay will have me."

Kay Luding looked at me through rimless glasses and grinned. Christened Kathleen, this 72-year-old miniature in white hair,

Never out of style, *the Prince of Wales Hotel on Waterton Lake was built by the Great Northern Railway in the early 1900s to attract tourists to the park. Weather has always been a favorite topic among guests; southerly chinook winds have been known to pound hotel windows with water from the lake.*

standing barely five feet tall, is scarcely the image of a mountaineer climbing up to Sperry for 33 summers, to open the chalet by the first of July. "Last year I made the trip on snowshoes, in October," she said. "I'd forgotten to empty out the septic tank!"

Why are no boys allowed?

"They used to swarm up here like bees making honey," she said. "Nothing but trouble. I just decided girls could get along better without boys."

Long ago, when the trail-riding caravans came to an end, Sperry and its sister chalet, Granite Park, ten miles distant near Swiftcurrent Pass, closed. Eventually the Great Northern sold them to the U. S. government for a dollar each. "My husband and I came to reopen them. We needed the jobs; our kids needed food. They all worked up here. And we put 'em all through college with the proceeds. Me too. I went back to get a degree myself. My husband's gone; my son now helps run both chalets. It's been a way of life, a good way of life."

Kay rose from our midafternoon coffee and began to bustle about: Fifty hungry, trail-weary hikers would soon be arriving.

WHAT ROLE, I wondered, could an international peace park play in the broader world? The question ran through my head one August morning as 17 of us crawled out of sleeping bags into a world of rain, hail, snow. Under a storm-whipped rain fly, Bob Haraden and Waterton Superintendent Bernie Lieff struggled to produce hot coffee and eggs.

We later called this the first annual Waterton-Glacier International Peace Hike —Canadians and Yanks, backpacking from the U. S. to Canada. The group included members of Congress and Parliament, businessmen, concerned citizens. The purpose was to make friends and to talk about how to extend that vision of Rotary International.

For 54 years Rotarians from Montana and western Canada have met at the park to commemorate the years of peace between Canada and the U. S. since the War of 1812.

Our second-night campground was to be Fifty Mountain, deep in the backcountry. Bob Frauson called on his radio for weather forecasts. The reply: more of the same, and worse. Only Frauson, veteran of a hundred mountain rescues and one particularly perilous one from Fifty Mountain, could have issued a recommendation to retreat without embarrassment.

"I wouldn't want to be trying to rescue all

17 of us from there," he said with a grin.

Our retreat, sloshing down off the dripping mountain, turned into a retreat in another sense. All of us pitched our sleeping bags in a log cabin and, before a roaring fire, held a 24-hour powwow punctuated by good laughs and freeze-dried food.

Up the chimney went a lot of smoke, and a few ideas. One was to prevail on Congress and Parliament jointly to proclaim the U. S.-Canada Days of Peace and Friendship. "Imagine 40 million of us flocking together from coast to coast," somebody said. "Think of picnics, dances, ceremonies, seminars. Sharing ideas, cultures; debating local and international problems." How about when hundreds of thousands of Canadians and Americans are crossing the border anyway, between Canada Day, July 1, and Independence Day, July 4?

"We might do more than just bring our two peoples and two nations closer together. We might inspire the world to do the same."

And so it came to be. The National Park Service, Parks Canada, Rotary, Kiwanis, Lions, the YMCA, the two countries' chambers of commerce, and another half hundred major organizations have all joined forces

to spread the concept across the continent.

Both national governments, as well as governors of states and premiers of provinces and mayors of cities, became involved. The U. S. Senate and House voted to create the annual United States-Canada Days of Peace and Friendship—July 2 and 3. They will be inaugurated this year from coast to coast across both countries. At Waterton-Glacier, Rotary International's president, Charles Keller, will join William P. Mott, Jr., and James Collinson, the directors of the National Park Service and Parks Canada, for speeches, ceremonies, and interpretative talks by local environmental experts.

Speeches, banquets, and marching bands will be only the beginning. New international exchange programs are planned among cities and towns, schools and universities, service clubs, and business and professional organizations, all aimed at improving U. S.-Canadian understanding and friendship.

"The U. S.-Canada Days," Superintendent Bernie Lieff points out, "are something all of us can take part in. You can just get on the phone and set up your own exchange program, for your own city or school or church or club—your own baseball or soccer or hockey team, your own rock band or dance group. Or, just get in your car and cross the border and make friends."

"After all," Superintendent Gil Lusk says, "we share the same continent. We fought over it, but now we have the same hopes and needs. If the U. S. and Canada cannot become a world example of peace and friendship, what hope is there for any other two countries anywhere?"

NOW IT WAS TIME to look at the threats facing this international park, things that might diminish its natural majesty. Two men came to mind. Both symbolize the freedom and beauty of the West; both share the same last name.

A statue of diminutive Charles Russell, the famous frontier artist, stands in the U. S. Capitol in Washington, D. C. Representing Montana, it is the only statue of an artist among many of statesmen and politicians. Russell died in 1926, but his log cabin still stands, empty, beside Lake McDonald. There you can see the line drawings of animals that he scratched into the fireplace.

Close encounters *of the hair-raising kind are inevitable where hikers share trails with some 200 grizzly bears. Tree climbing is not foolproof; a grizzly can shinny up, digging its five-inch claws into the bark* ***(above)****. "Six of our last seven bear injuries have been people trying to climb trees," says a ranger.*

And you can recall his words: "In spite of gasoline, the biggest part of the Rocky Mountains belongs to God." Fortunately, that is still so.

The other Russell is Andy, a Canadian, quite alive, formidable, an author, photographer, and environmentalist, a self-appointed protector of the peace park. He works to keep the magic of the West intact for all time. Andy's cabin perches on an overlook of Waterton; Hawk's Nest, he calls it. Andy is a mountain crag of a man, a one-time hunting guide, with flashing eyes, eagle's nose, and cheekbones rising like twin peaks from a valleyed face of 71 summers.

He is also the father of four sons who march in his footsteps, as scientists or wildlife experts dedicated to the preservation of the wilderness they were born into. All four sons were at Hawk's Nest that day to discuss citizen efforts to support the park.

Andy spoke of degradation of the neighborhood, threatening the park itself: "Right near Waterton's boundary with British Columbia, in what used to be prime wilderness

ERWIN AND PEGGY BAUER

and animal habitat, loggers have clear-cut to within two miles of the park, down to the edge of the creeks. That causes erosion. Of course, it's a visual disaster, too."

British Columbia foresters say they were only salvaging timber killed by the mountain pine beetle, and claim they practiced the best conservation possible.

Other potential assaults on the environment cause Andy's eyes to flash fire: Just north of Waterton, Shell Canada Ltd. has been drilling for and refining natural gas for years. On two occasions escaping hydrogen sulfide has forced evacuation of Twin Butte. And once there was talk of posting signs inside the park warning of possible poison gas. Shell Canada and park officials, however, now work closely to minimize the threat.

Nobody knows whether the area will become a major target for oil companies. "But if they do find big gas or oil," Andy says, "we could see Waterton-Glacier surrounded by roads and oil rigs, a visual slum."

"All we citizens can do about development outside the park," Andy's son Charlie said, "is to raise the alarms and lobby against degradation." Charlie and others, together with both park administrations, are also struggling to stop such things as the building of a water slide and amusement park just outside the gateway to Waterton. "Imagine that," he said, "a carnival atmosphere at the front entrance to one of the most undefiled pieces of scenery in all of North America!"

Another natural resource in the region, coal, has triggered a nettlesome international dispute. In British Columbia, just north of Glacier, a proposed huge open-pit coal mine, and a new town to house hundreds of workers, brought on a smoldering, ten-year environmental struggle.

The complex would sit on Canadian headwaters flowing down Glacier's boundary into Montana's Flathead River. Canadians have joined thousands of Montanans in the fight. "There's just no way," one irate Montanan told me outside a hearing room in Kalispell one day, "to mine that coal without sending all kinds of chemical pollution down

the river and right into Flathead Lake, the biggest natural lake in Montana."

Whether or not there is a way to mine the coal safely is one question before the U.S.-Canadian International Joint Commission, a treaty agency dealing with cross-border environmental disputes.

Economics have intervened to give the conservationists a helping hand. Coal and oil and timber have been in a slump. But demand will probably soar again. By the time the coal showdown occurs, the joint commission will have issued its report. But more important for the future, the two parks have become part of the Man and the Biosphere program, an initiative sponsored by UNESCO to monitor the effect of man on areas like Waterton-Glacier.

"We're trying to bring everyone into a system of careful planning, development, and protection," Glacier's assistant superintendent, Alan O'Neill, told me. "And the Forest Service, on our western flank, is our primary partner."

Flathead National Forest chief Ed Brannon corroborated that: "What we want is to get government agencies, citizens, and industry into a genuine good-neighbor relationship, to ensure that this park continues to be an international jewel. I think Alan and Bob Haraden and Gil Lusk and Bernie Lieff have been showing the way for the wilderness areas of our continent."

THE BLACKFEET INDIANS who occupy the park's eastern boundary are caught in a quandary. They love the mountains and forests their ancestors roamed, but they need jobs, money. "Our people are hurting," Ron Crossguns, a reservation official, told me. "We have high unemployment and virtually no industry. We've got people and lives involved. If we strike oil, we'll pump it!"

Other Blackfeet strongly disagree. To them the park is sacred ground, and they would hate to see roads and wells damaging the environment.

"I have to hope that the environment wins," Doug Chadwick said one sunny afternoon as he poured me a glass of wine at a picnic table. Doug's a writer, a biologist, and a lover of Rocky Mountain wildlife. He studies the animals literally from his front door—his cabin is just across the river from the park, on the North Fork of the Flathead.

***First signs of spring** in the park are the return of the varied thrush, usually in March, and snowmelt swelling lower elevation streams such as McDonald Creek. For those attuned to the lessons of Waterton-Glacier, every season is a reminder of the ideals that inspired the creation of the peace park.*

"A few years ago I was more fearful," Doug said. "Rampant logging. Even the possibility of a crash development of condominiums in this little stretch of private homesteads between the forest and the park.

"But there's a new tone. People are talking and listening more. And now there's also the prospect that UNESCO will declare the two parks a world heritage site. That would make them international treasures, protected by treaty. It would greatly strengthen the cause of conservation."

Bob Haraden joined us at the table. He was touching base with old Glacier neighbors. A doe and a fawn went wandering down toward the river.

"The park truly depends on the lands around it," Doug said. "Bear and deer and elk migrate in and out of the park past our houses here, sometimes right past our windows. At night we can listen to the wolves howl. You can't hear that any other place in the American West."

"Doug is right," Bob said. "There are things you can experience here that you cannot experience anywhere else. This is a special wilderness. But it cannot survive unless these neighboring lands survive."

Bob looked across at the Rockies, the same spectacular view we had first witnessed together on skis. Then it was a frosted foreground rising to a jagged breadknife of ice. Now a feathered blanket of green forest rose to the rocks of the Continental Divide and to the soft summer sky above.

"What these two parks need most, and what our two nations need most, are decades and decades more of peace—and quiet," Bob said. I thought of that superb wilderness of snow in winter, and of wildflowers and laughing waterfalls in summer. And of the rare and lonely call of the timber wolf. And I raised my glass: "Amen." □

By ALBERT A. DEKIN, JR.

Photographs by VICTOR R. BOSWELL, JR., and SCOTT RUTHERFORD

Paintings by JAMES M. GURNEY

Sealed in Time

Ice Entombs an Eskimo Family for Five Centuries

THE HIGH CLOUDS had warned the villagers of Utqiagvik that the storm was coming. The wind blew in from the sea, driving before it the pack ice so that it ground and crashed against the shoreline.

The village of dozens of driftwood-and-sod houses stood on a bluff overlooking the Arctic Ocean at a spot known today as Barrow, Alaska (map, page 831). Storms were common winter events along the coast, and no one was terribly alarmed.

The villagers, an Eskimo people known as Inupiat, had returned the previous fall to this winter settlement from scattered areas where they had spent the summer fishing and hunting sea mammals, birds, and caribou.

As the families arrived back in Utqiagvik, they rebuilt their houses, stocking them with food and supplies and arranging their tools and clothing inside for the winter.

It was a busy time, repairing winter clothes, nets, and the specialized tools for sea-ice hunting of seals and polar bears. The dogs had to be settled and teamed and hunting partnerships affirmed, so that when the sea froze and the winter storms arrived, all would be ready. The winter hunt would last for several months, until spring breakup and the whaling season.

In each household the women made skin clothes, sewing amulets and charms onto parkas, and saw to the family's assortment of baskets, wooden buckets, and earthenware pots. The men concentrated on their hunting gear—harpoons, ice picks, snow goggles, nets, and maintenance tools.

Among the households people would come and go according to their daily needs. Often the men traveled to trade with other settlements or to hunt, sometimes staying away for several days at a time.

As winter deepened, the days became shorter, until for long weeks the sun never rose above the horizon. Amid the dark days of cold the sea gradually froze, though strong currents and winds broke the ice into an active and treacherous surface.

The storms brought high winds and tides, moving pack ice angrily against the coast and tumbling the broken pans into huge onshore piles. Hunters on the sea ice were often stranded for days or killed by these storms, though Utqiagvik itself was only rarely threatened.

Now, as this new winter storm developed, the villagers made the usual preparations: They trimmed the lamps, checked the dogs, and brought in supplies of food from storage racks outside the houses. In each kitchen an open fire was built in order to melt snow for drinking water and to prepare a few meals in advance.

With their preparations completed, the people of Utqiagvik settled down to await the storm's fury, confident of a brighter day. In the expectation that the storm could last for several days, there was visiting among

Sheltered against the long clutch of winter, members of an Inupiat Eskimo household pursue chores as a storm pummels Utqiagvik, today's Barrow, Alaska (preceding pages). Ice cracks and grinds against the shore, startling the children; others calmly continue their tasks. The storm tightens its grip. Ice stacks up. That night, masses of ice slam over the shore and onto the house, dealing a rapid crushing death to the older woman (facing page) and to the others sleeping nearby. The site remains buried as centuries tick by, until a day in 1982, when an artifact hunter casually shows a frozen human cranium to archaeologists in the area.

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households and engaging the children in games to while away the hours.

As night approached, the sea ice crashed against the shore, hurling occasional chunks high across the bluff toward the village. These tongues of rafted ice had thrust into the village in other storms, but they had only rarely caused significant damage.

In one small house close to the bluff edge two women—one in her 40s, the other in her 20s—slept fitfully near a teenage boy and two young girls. The five occupants of the house tossed and turned as the storm raged outside, seeking comfort in the knowledge that they were prepared as they had been taught to weather such storms. As long as the house was intact, they had nothing to fear.

SUDDENLY and without warning, a giant tongue of jumbled ice chunks, which had massed against the shore, burst free, carrying up and over the top of the bluff in a violent surge known to the Inupiat as an *iuw*. Within seconds the surge sent tons of ice down on the tiny house near the edge.

Under this onslaught, the roof bent and then collapsed, hurling sod and roof timbers down into the house along with the ice.

The older woman, perhaps having been roused by the sudden cold, raised herself only to be struck down abruptly, first by the ridgepole and then by the roof itself. She fell back against her sleeping robes, her feet tossed amid the buckets, lamps, and tools lying near the entrance.

The younger of the two women and the boy and two girls were apparently struck suddenly as they slept on a raised platform near the back of the house. They were smashed down amid the remains of the platform, sleeping robes, clothing, and equipment. Mercifully, the force of the collapse and the severity of their injuries rendered them unconscious within seconds. Death followed quickly and quietly.

The ice advance stopped. Almost as soon as it had begun, it was over. Life and light were snuffed out beneath a pile of jumbled ice in the debris of a once safe and snug winter house. There was no sound or movement other than that of the still raging storm. By morning, the cold and lifeless house lay beneath a cap of ice congealed into a white shroud that covered all but the entrance tunnel and adjoining kitchen.

Frozen in time, the body of an Inupiat female in her early 40s was discovered lying on the floorboards in the main room of the house (facing page). She was covered by a fur, right arm crossed over her chest as if to ward off a blow. Separating the body from the frozen matrix of earth took five days, working around the clock, the author reports.

The body, which had lain buried for nearly 500 years, was autopsied in Fairbanks. The findings: The crushed chest, empty stomach, and distended bladder indicate a quick death in early morning. The woman had been lactating; she had given birth some months before. The infant was never found. Did it die before the tragedy? Was it snatched from the wreckage? Was it simply not found because of its tiny fragile bones? No one knows.

Safe haven against the cold, a woman's caribou parka and mittens (above) were found in the entrance tunnel. Warm, lightweight caribou skin was preferred winter wear. Eskimo clothing needed constant care—drying, softening, patching—but surpassed what Europeans wore in the Arctic when they appeared in the 1800s. Soon they switched to Eskimo garb. Inner boots were waterproof sealskin (left). Snow goggles (top left) protected against glare.

STURGEON ARCHAEOLOGY PROJECT (RIGHT)

Survival of the craftiest is the rule in the stingy, harsh Arctic. A hunter's ruse, a wooden seal call inlaid with a seal's claws (top left) was used to scrape ice near a blowhole to lure an animal within harpoon range.

Other tools of the hunt included, from lower left, a slate blade for a man's knife, three ivory harpoon heads used for seals, and a bola—bone weights tied to sinew that, when thrown, snared birds in flight. A wood-and-bone pick may have cleared ice from the tunnel entrance. A bear snout (right), found in a gut bag, probably served a ceremonial function.

When the storm died down, neighbors emerging from their own snow-crusted but undamaged houses saw the ice blocks covering the house at the bluff edge and hurried to the entrance tunnel to see what had happened. They found the entrance and kitchen intact, but the way into the house was blocked by the jumble of ice, timbers, and gear that now filled the home's interior.

Hearing no sounds of life and sensing the worst, the neighbors withdrew, leaving the place of death in peace.

Later, perhaps upon the return of the household's adult male members from a trading or hunting trip, some utensils and usable food were removed from the wreckage. Abandoned, the house structure collapsed further and filled with summer meltwater, only to freeze again, completing the preservation of both the structure and the entombed family. As time passed, others in the village scavenged the house's protruding upright timbers, thus removing all clues to what lay beneath the surface.

For nearly five centuries the household lay frozen and still on the bluff. During that time little disturbed what remained of the structure except for minor erosion. Then in 1982 local artifact hunters of Barrow began chopping into the frozen ground in search of items for collection or sale. With each chop of the chisel the tranquillity of the frozen household came closer to an end.

Westward along the same bluff a team of archaeologists, which I directed, from the State University of New York at Binghamton, worked carefully on other remains of Utqiagvik village. Unlike the relic collectors, we sought to understand the behavior patterns of the aboriginal Inupiat, whose successful whaling society ultimately evolved into the present community of Barrow. The community there had sponsored our archaeological studies in order to preserve their Inupiat heritage before modern construction further harmed or destroyed it.

The terrible weight of ice bears down hard and fast on much of Alaska's coast, where unprotected shores are vulnerable to ice override, or ivu, as it is known. An ivu occurs when storm winds and high tides conspire to shove pack ice against landfast ice. Something must give, and does. Huge pans of ice buckle and ride up over the shore, claiming property and lives. "This dangerous area has not stopped what it does; it can still do that," a native says.

I WAS NO STRANGER to Alaska and the Arctic. As an anthropologist I had previously studied prehistoric human occupations of the eastern Canadian Arctic and had worked with the University of Alaska at Fairbanks to locate and protect prehistoric living sites threatened by construction of the

Laced together by baleen stitching, a wooden bucket was discovered in the house, reached by a tunnel that doubled as storage space. Temperatures in the passage were often minus 10°F or lower.

Barrow's native community invited the author's team to excavate Utqiagvik in advance of utility installations.

Symbol of a hunting culture, a barbed ivory harpoon head stands against a tundra backdrop. Archaeologists uncovered numerous harpoon heads for seals and small sea mammals at the site, but none for whales. The author speculates that such equipment was destroyed at the whaling season's end. Fall and winter were spent constructing new gear—ensuring fresh, effective tools and helping affirm the sense of community. Animal bones from the site indicate that sea mammals were the primary food. Layers of fat found in the autopsied bodies suggest these Eskimos were adequately nourished, but their bones also bore evidence of malnutrition in past years.

trans-Alaska pipeline. I had cooperated in the latter studies with my colleague Dr. Raymond R. Newell, an anthropologist with the State University at Groningen in the Netherlands.

In 1981 Ray Newell and I joined with Dr. Edwin S. Hall, Jr., an anthropologist at the State University of New York at Brockport, to study the impact of planned construction in the area of Utqiagvik, which now is virtually overlain by the community of Barrow (right). Utqiagvik consists today of sixty mounds of earth, each containing a historic or prehistoric house.

On the afternoon of June 28, 1982, we were excavating several of those mounds, one of them containing a winter ceremonial structure. As we worked, relic hunters continued their searches along the bluff, two hundred yards away. Presently one of them sauntered toward us carrying something round in a plastic garbage bag. We had avoided these people because they had no authority to dig, but we nonetheless glanced at the contents of the bag. It was a clearly recognizable human cranium, frozen from its long burial in the Arctic soil.

THE DISCOVERY added a new dimension to the work at Utqiagvik. Acting cautiously because of community sentiments, the local magistrate declared the site where the cranium had been found a protected area and asked our archaeological team to cover it till it could be properly excavated.

In carrying out the order, we found human bones scattered down the talus slope below the household and a nearly intact frozen body that appeared to be an isolated find.

By itself the discovery of human skeletal remains in Barrow is not unusual. In earlier times disposal of the dead was simply a matter of placing the body on the tundra outside the village. The body at Utqiagvik, however, was no mere skeleton. The hair and most of the tissue were still intact, and the corpse was recognizable as that of a mature Inupiat woman.

Since the body had been found without any associated artifacts, its archaeological importance was unknown to us. On the magistrate's order we delivered it along with the bones we had discovered to the morgue in Barrow. Soon after that I left to resume my work in Binghamton, returning to Alaska later in the summer.

Though we ignored the site where the body had been found, relic hunters continued to visit it. Two weeks after I left, the relic collectors told our personnel that more human remains had been found there. On investigation we discovered that the relic hunters had done considerably more digging. They had exposed the unmistakable walls of a traditional Inupiat winter house, together with more bones and some artifacts.

To salvage whatever was left, Ray Newell obtained permission for our team to excavate the site. They found that the house was basically intact and still largely frozen. They also found a second frozen body on the floor; it appeared to be that of a woman considerably older than the first.

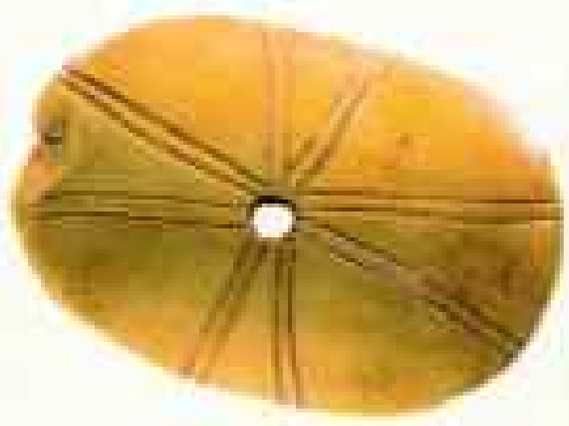
At that point we obtained community permission for autopsies on both the women, and the bodies were flown together with the bones to Fairbanks, where they were examined

Digging through the past, archaeologists excavate the tunnel passageway (above), in Barrow, a community of 3,000. Permafrost – the preserver of the Utqiagvik bodies – limited work to summer. Warm water was poured on artifacts to loosen the frozen ground's grip.

Typical of Inupiat winter structures, the Utqiagvik house had no nails and was held together by a matrix of frozen earth. Hand-hewn driftwood formed floorboards and wall panels. Sod on the roof provided insulation. Houses were abandoned in spring when meltwater flooded the tunnel, then rebuilt and reoccupied in fall.

In all, the archaeologists found some 1,200 objects, including a pin-and-ball child's game made from a seal bone (left).

Quiet elegance graces everyday objects found at the site, including, clockwise from below, a small ivory toggle bearing a simple decoration of intersecting incised lines;



an ivory comb to clean and decorate a woman's hair; a curved pull handle carved with a pair of loon heads; an ivory rectangle with six small drill holes and incised lines, perhaps a decoration piece for a brow band; and a flaker handle that, tipped with hard bone, shaped flint for knives and harpoons.

A pair of ivory shaft straighteners (top) were used in making arrows. A bow repair kit (right) consisted of a bone bow splice, three marlinespikes for manipulating lashings that bound the bow, and two sinew twisters to tighten lashings.

by Dr. Michael Zimmerman from Hahnemann University, Philadelphia, and Dr. Arthur Aufderheide of the University of Minnesota-Duluth School of Medicine. The two physicians were flown to Fairbanks for the examination with funds provided by local groups and the Atlantic Richfield Foundation.

DETAILED STUDY of the bones revealed three separate individuals, probably two young girls and an adolescent boy. Since no soft tissue survived with the bones, it appears that the children had lain closer to the surface than the women and had not been permanently frozen.

The doctors obtained a radiocarbon-dating test on a sample from one of the older woman's vertebrae. Considering her body's remarkable state of preservation, the results were astonishing—440 years, give or take 70. The woman had been in her 40s at the time of death, the other woman in her 20s.

Both women had died almost instantly of crushing injuries to the chest. The doctors deduced that the accident had occurred late at night, since both women's stomachs were empty and their bladders were distended, though the urine had long since drained away. The women were naked beneath their skin sleeping robes, probably to avoid buildup of moisture in their everyday clothes. Such moisture would freeze when the owner went outside, presenting a serious danger to the body.

The women had been reasonably healthy, although both suffered from anthracosis—the black lung that afflicts coal miners today—obviously caused by breathing smoke and oil-lamp fumes in close quarters during the long winters. They also suffered from atherosclerosis, or narrowing of the arteries caused by deposits of cholesterol and fat, probably the result of a heavy diet of whale and seal blubber.

The older woman had given birth approximately two months before the ivu struck, and was still lactating, though we found no evidence of a baby in the house. Whether the infant survived, died before the time of the storm, or was totally destroyed by the ivu, we shall never know.

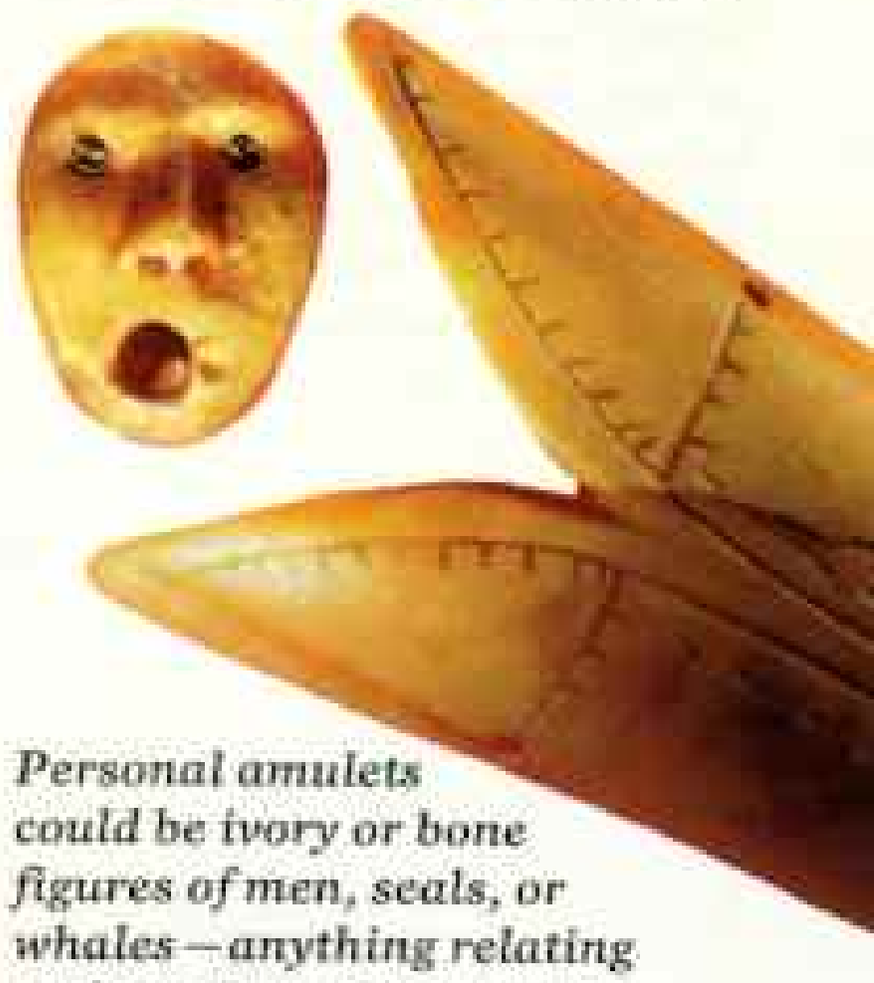
Both women had suffered periods of poor nutrition and illness, as indicated by lines of growth arrest in the long bones of their arms and legs. In addition they showed signs of severe osteoporosis, bone-mass deterioration.

The older woman had not had an easy life. She had recovered from pneumonia and may have suffered from trichinosis, a painful infection of the muscles, perhaps contracted from eating raw polar bear meat. Finally, the older woman had suffered considerable tooth wear, obviously from a lifetime of chewing skins and biting sinew thread.

Hair samples from the two women showed they had slightly elevated levels of lead and iron in their bodies, but relatively low levels of mercury and zinc. Samples taken from Inuit mummies, found some years ago in Greenland and dating from the same period as the bodies at Utqiagvik, contained lower levels of lead and mercury, potentially harmful substances.*

*See "The Mummies of Qilakitsoq," by Jens P. Hart Hansen, Jørgen Meldgaard, and Jørgen Nordqvist, in the February 1985 NATIONAL GEOGRAPHIC.

To give spiritual weight to an object, an Eskimo sometimes added human or animal features. This small ivory sphere, carved with a face (below), may be a bola weight that was also used as a charm.



Personal amulets could be ivory or bone figures of men, seals, or whales—anything relating to the surroundings. These were sewn on clothing to ensure success in an undertaking. The three-inch wood figurine (below) may have been such a charm or a child's doll.

An archer's ivory wrist guard (above) provided more practical protection.

Once the autopsies were completed, the bodies of the two women and the bones of the children were returned to Barrow for proper burial. As we gradually excavated the house further, we uncovered new clues to the tragedy that had occurred there five centuries before.

The level of destruction—and its direction, from seaward—was such that only an ivu could have caused it. As we dug deeper into the structure, we found vertical timbers smashed, sidewall boards canted landward, and one entire wall knocked from its sill.

The ivu is referred to in Inupiat oral traditions and in the logs of early whalers in the Arctic. The phenomenon still threatens man today, including his offshore oil rigs.

Excavation of the house taught us a good deal about everyday Inupiat life five centuries ago. Both the variety and location of tools and artifacts discovered in the dwelling revealed that these Inupiat families were well organized and highly adapted to their hunting life. We found their tools and weapons arranged in kits according to function and season. Winter hunting equipment such as snow goggles, ice picks, and harpoons was stored in the tunnel, often in skin bags, keeping it dry and therefore free of frost for ready use.

Inside the house space was at a premium. Along the entrance tunnel small storage alcoves contained items that were less frequently used, such as summer equipment, extra fishing nets, and skin bags to hold seal oil. In the adjacent kitchen we found items of constant use such as cooking equipment and food-storage containers—all necessities for winter housekeeping.

Plain and simple, a woman's comb is charming in its unfussiness. Streamlined forms were important because many Eskimo implements were handled under conditions in which hands could not be exposed for fear of frostbite. After study by archaeologists, the recovered

artifacts were turned over to the Barrow community. The Utqiagvik bodies were also returned, and the remains buried. A minister conducted services.

Last year, a mukluk-shod foot was spotted protruding from the bluff, two hundred yards from the Utqiagvik site. But before investigation could proceed, a severe storm washed the grave out to sea. As usual, the Arctic had final say.

WE FINISHED our excavation in the summer of 1983, though the recovered material will be studied for years. As we boarded the plane at Barrow for home, I felt satisfied with the work we had done, shedding new light on a distant and fascinating chapter in Alaska's past.

I glanced out the window and saw mail being loaded aboard, then instantly realized we had miscalculated. The boxes contained copies of our precious field notes, which we had painstakingly made and then earlier put in the mail for home, so they would survive if our plane went down.

I felt a sudden kinship with the Inupiat family that had gone to sleep that fateful stormy night some 500 years ago. Like us they believed that they had done all they could and trusted that what had been successful in the past would continue to be so—yet knowing it was not always to be. □

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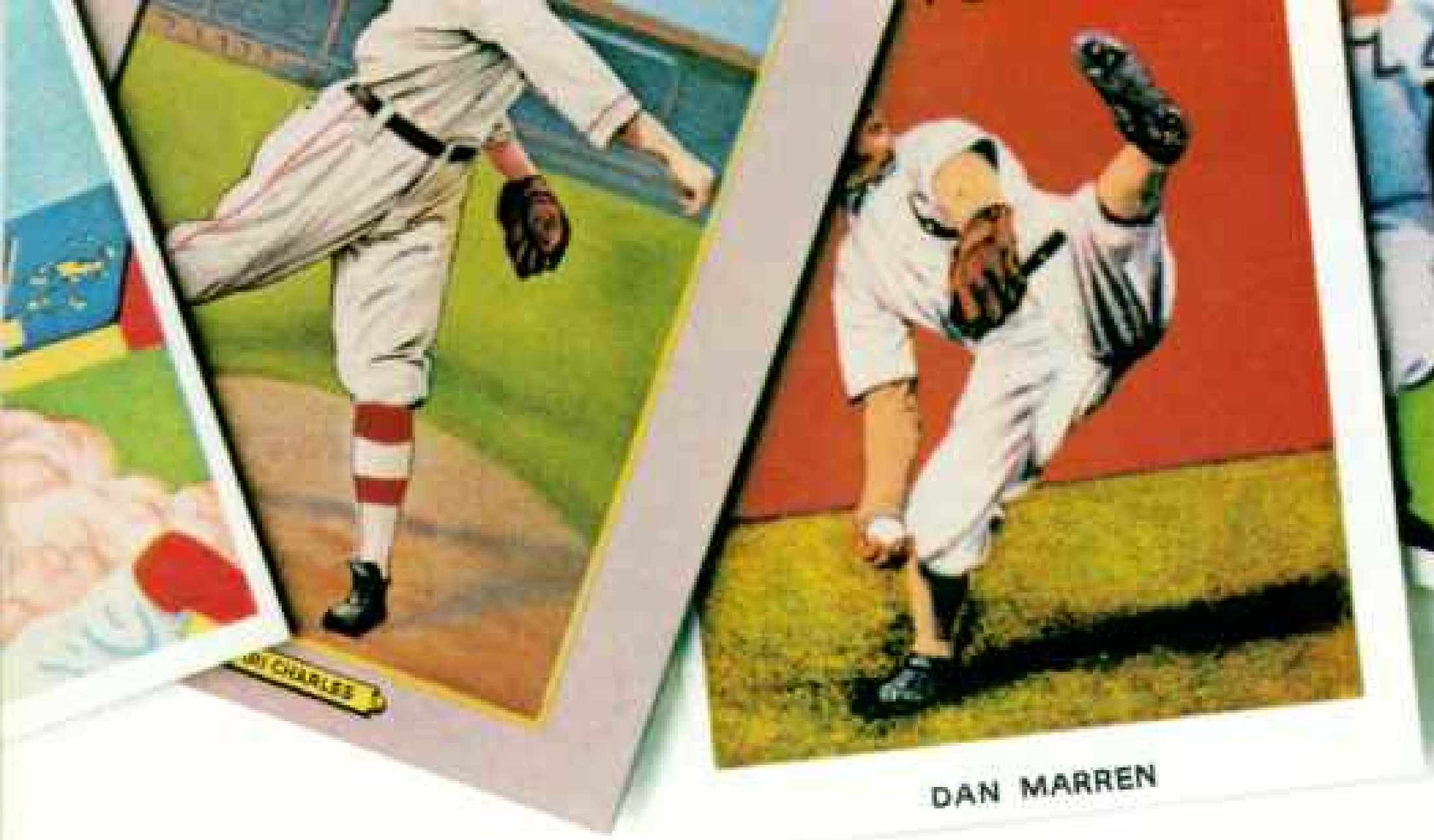
NATIONAL GEOGRAPHIC MAGAZINE



Are you still collecting the same old stuff?

Well stamps are a lot of fun to collect, too.

Especially now with our new Special Occasions booklet issue. A single, 10-stamp pane that greets family and friends with warm wishes.

This colorful, special issue is a unique way to start a collection. Or a great way to add to your collection.

Because it's a little mini-collection in itself.

Head to your post office today to pick up this new issue.

And while you're there, consider two booklets. One for your hobby. And one to use to personalize your mail with happy, upbeat messages.

Available April 20.

Start something new with stamps.

U.S. Postal Service

THE WAGON YOU'LL WANT TO DRIVE EVEN WHEN THERE'S NOTHING TO CARRY.

FORD TAURUS.

The first thing that strikes you about the Ford Taurus wagon is just how unlike a wagon it is. Its sleek silhouette recalls all the style of an expensive touring sedan. And its exhilarating road manners will have you glancing in the rear-view mirror just to remind yourself you're actually driving a wagon.

Designed to handle and respond like a sedan.

One important factor to Taurus' remarkable ride and drive begins with its aerodynamic shape. It enables the Taurus wagon to sit down through curves for exceptional road-holding. The Taurus wagon is also equipped with a specially-engineered independent rear suspension for superb control.

Buckle up—Together we can save lives.

It's this kind of innovative design and thinking that has put Ford Taurus on *Car and Driver's* Ten Best list two years straight.

Does what a wagon does best. Only better.
The Taurus wagon boasts an expansive load area (81.0 cubic feet), more than any other domestic wagon in its class. But what's even more impressive than how much it carries, is how well it carries it. The convenient 2-way liftgate and versatile 60/40 split fold-down second seat make carrying even difficult loads anything but difficult.

New 6-Year/60,000-Mile Powertrain Warranty.
Ford now covers all new 1987 cars with a 6-year/60,000-mile warranty on major powertrain components. Restrictions and deductible apply. Also, participating Ford Dealers stand behind their customer paid work with a free Lifetime Service Guarantee. It's good for as long as you own your Ford car. Ask to see the limited warranty and the service guarantee when you visit your Ford Dealer.

Ford. Best-built American cars... six years running.
In fact, for the past six consecutive years, Ford quality has led all other American car companies. This is based on an average of owner-reported problems in the first three months of service on '86 models, and in a six-month period on '81-'85 models designed and built in North America.

Ford

Have you driven a Ford...lately?

Jane Goodall's newest gift

"AT ABOUT TWO O'CLOCK on the afternoon of July 14, 1960, we arrived at Kasekela, a campsite midway along the 10-mile coastline of the reserve." So Jane Goodall described in the August 1963 NATIONAL GEOGRAPHIC her landing for the first time at Gombe on Lake Tanganyika.

Last autumn—and 26 years of observations later—Jane Goodall celebrated publication of *The Chimpanzees of Gombe: Patterns of Behavior*, by the Harvard University Press. It has been received as a masterwork by the scientific community. Remarkably, her nearly 700-page scholarly volume has found a wide public audience; more than 20,000 copies have been sold, and it is now in a fourth printing.

Our association with Jane has been long and fruitful. She has authored four magazine articles and a book for us; two Society Television Specials have been devoted to her work.

I very much appreciate her generous published acknowledgment: "The National Geographic Society funded the entire research program for many years and to the present day continues to make grants and support the work in various other ways."

My colleagues mentioned by name with "warmest thanks" take affectionate pride in her kindness, as do I. And, I am sure, so would the chimpanzees in their way; they are last but certainly not least among the many others whom Jane thanks.

In her they have a champion. She writes in the conclusion to her book: "Let us hope that, even as our greed and shameless destruction of the natural world gradually take from yet more chimpanzees their forests, their freedom, and often their lives, our knowledge of their capacity for affection and enjoyment and fun, for fear and suffering and sadness, will lead us to treat them with at least the compassion we would accord fellow humans."

JANE GOODALL WITH THE PUBLICATION OF HER LIFE'S WORK.
PHOTOGRAPH BY MIKE DUAN

To that end, Jane Goodall and her scientific colleagues have formed a new organization, the Committee for Conservation and Care of Chimpanzees (CCCC), with two overriding objectives—to promote the survival of wild chimpanzees and to improve the care of those in captivity.

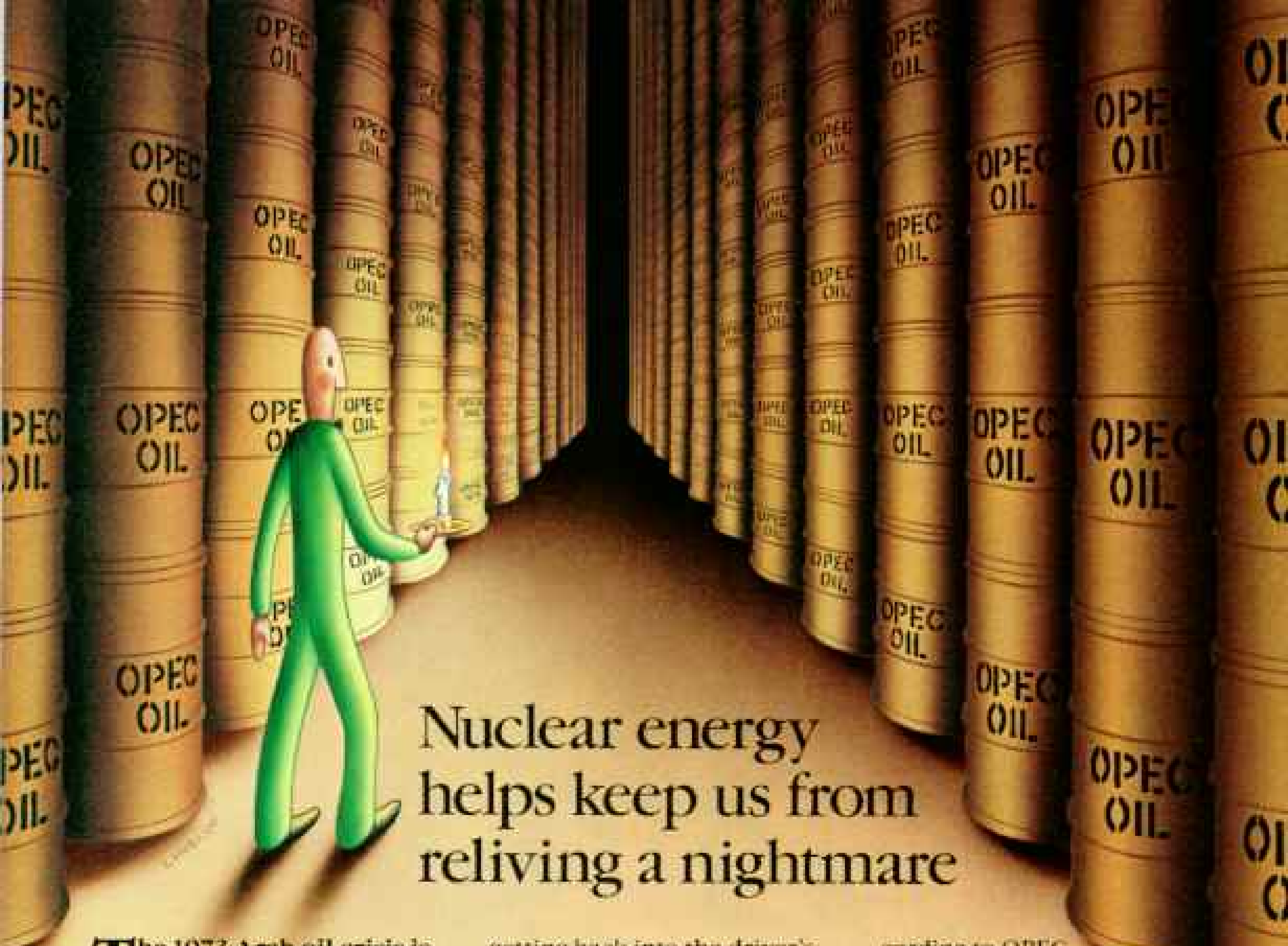
I am pleased that the Society has made a public service grant to help the CCCC in this first year of its operation. It is particularly significant, I think, that scientists themselves are the organizers and members of the CCCC and are committing to it their personal time, energies, and expert knowledge.

Too often, and I believe wrongly, we tend to see the objective procedures that are fundamental to science as mechanical exercises devoid of human feeling. It is good to be reminded—as by the scientists of CCCC—that such thinking is in error.

The astronomer loves stars no less than the poet, the geologist loves landscapes no less than the painter. Jane Goodall and a few others have the gift of making us know that good science is an expression of love and a gift to us all.

Gilbert M. Grosvenor

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY



Nuclear energy helps keep us from reliving a nightmare

The 1973 Arab oil crisis is a haunting reminder of the darker side of foreign oil dependence. Since then, America has turned more to electricity from nuclear energy and coal to help restore our energy security. As a result, these are now our leading sources of electricity and a strong defense against an increasing oil dependence that again threatens America's national energy security.

A dangerous foreign oil dependence

America imported four million barrels of oil a day in 1985. Last year that increased by another 800,000 barrels a day. The danger? Most of these new barrels come directly from OPEC. And the U.S. Department of Energy estimates that by year-end 1987, oil imports will be 30% higher than the 1985 level—an ominous trend.

U.S. Interior Secretary Donald Hodel recently warned that "OPEC is most assuredly getting back into the driver's seat" and our increasing dependence will be "detrimental to the country's economic and national security and its financial well-being."

Nuclear electricity's contribution

America's electric utilities have helped diminish OPEC's impact. Today, over 100 nuclear plants make nuclear energy our second largest electricity source, behind coal.

And nuclear energy has helped cut foreign oil demand. It's saved America over two billion barrels of oil since 1973, and our nuclear plants continue to cut oil use. The energy analysts at Science Concepts, Inc. estimate that by the year 2000, nuclear energy will have saved us between seven and twelve billion barrels of oil.

Nuclear energy for a secure future

Nuclear energy is not just helping here in America. According to OPEC, nuclear energy has permanently displaced about six million barrels of oil a day in markets throughout the world.

The lessons we learned in 1973 are lessons we can't afford to forget. Nuclear energy and coal can't offer us guarantees against another oil crisis. But the more we hear about the return of OPEC dominance, the more we need to remember the critical role played by electricity from coal and nuclear energy in fueling America's economy and protecting our future.

For a free booklet on energy independence, write to the U.S. Committee for Energy Awareness, P.O. Box 1537 (OP14), Ridgely, MD 21681. Please allow 4-6 weeks for delivery.

Information about energy America can count on

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The latest test equipment. Because it takes a computer to know one. And the latest training. So he knows what to look for, before he starts looking.

Put Mr. Goodwrench to the test. He's got what it takes to take care of you—and your electronic car.

No one knows your GM car better than Mr. Goodwrench. No one. Mr. Goodwrench's full line of genuine GM parts includes GM Goodwrench Motor Oil. Ask for it.

GM QUALITY SERVICE PARTS

Does your ceiling fan go ka-bump-ka-bump-ka-bump in the night?

Don't laugh. It can happen. Particularly with some of those "bargain" fans you see these days.

Of course there is a way to avoid nightmares like this. Choose a Hunter *Original*.

Hunter's cast-iron construction, "oil-bath" lubrication and precision-balanced hardwood blades keep our fans running quiet as a churchmouse.

Plus our Hunter *Original* motor has a lifetime warranty.

Granted, you may pay a bit more for a Hunter.

But just think how much better you'll sleep.

HUNTER

The Quiet Fan.

Hunter. Building The Best For Over 100 Years.

Suddenly, there are 250 million more computers in America.

You probably don't think of a piece of cardboard as a high-technology peripheral.

But this simple AT&T cardboard template helps release the considerable computer power latent in a common telephone.

Because behind every telephone is not just communications technology, but computer technology, as well.

In fact, the people at AT&T Bell Laboratories are merging these technologies so that voice and data can share the same networks.

One example of their success is AT&T Unified Messaging (which employs the cardboard template shown). This allows businesses to...well, unify all their data and voice communications.

And not just between AT&T phones and AT&T computers. It welcomes all denominations.

The result is that you don't have to be at the PC in your office to get your electronic mail. With AT&T Unified Messaging, you can also access your mail from any phone anywhere. A synthesized voice reads it to you.

Now that voice and data can share the same networks, information is more accessible, more usable and, therefore, more valuable than ever before.

You see, data networks not only move information instantly, they can also interpret, rearrange it and apply it in the most useful way. All automatically.

And though the benefits of data networking are still fairly new, people everywhere already take them for granted.

Automatic bank tellers, the new flexible investment accounts and just-in-time manufacturing are only a few examples. The potential is tremendous.

And as phones grow more powerful and computers grow more sociable, the benefits to all of us will grow only more abundant.

AT&T
The right choice.

It's so close to infallible, we actually guarantee the pictures you take.

You've thought of getting a really good camera. But could you be sure you'd really get better pictures? The uncertainty was always there.

Now there's the Olympus OM-77AF. With its unique Great Picture Guarantee: If you take a picture that's not perfectly focused or exposed, send it to us and we'll send you a dollar. That's our guarantee—for up to 24 photos sent by August 31, 1987.

The promise is remarkable. But then, so's the camera.

Infallibly easy. The OM-77AF computer-controls everything automatically. From loading to focusing to rewinding. So you get great 35mm pictures at the touch of a button.

Infallibly precise. It's also a superb 35mm, auto focus SLR (single lens reflex). So you can change lenses, for pictures lesser cameras simply can't take.

Infallibly thoughtful. The OM-77AF is the first auto focus SLR with a built-in illuminator, for accurate auto focus in even the dimmest light. And it's the first with a built-in flash, ready to pop up whenever a great picture does.

So for all the pleasure of professional-quality 35mm pictures without the anxiety, get your OM-77AF now. And if you send us a picture not perfectly focused or exposed, we'll send you $1.

Clearly, the only mistake you can possibly make with this camera is not buying it.

Olympus OM-77AF Great Picture Guarantee. Print your name, address, and OM-77AF serial number of the camera used on the back of your imperfect (not perfectly focused or exposed) picture or on a sheet of paper attached to your slide and mail with copy of OM-77AF sales receipt to Olympus GPG, P.O. Box 1358, Medina, OH 44258. Pictures and slides will not be returned. Limit $1 per print, 24 per camera, sent by August 31, 1987. Allow 4-6 weeks for check to arrive. For full details, see your Olympus dealer or write Olympus Corporation, Dept. 185, Woodbury, NY 11797.

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OM77AF

PHOTOJOURNALIST'S PHOTOJOURNALIST

BRIAN LANKER

Washington, Kodak Ektachrome 64 professional film

Los Angeles, Kodak Ektachrome 400 film

France, Kodachrome 64 professional film

Bora Bora, Kodachrome 64 professional film

"In my work, I'm continually confronted by variables—the subjects, the situations, the light.

"Every negative variable is a problem to be solved. I need to eliminate as many of these as I can. That's why I use Kodak film. It's one constant I never have to worry about.

"I put Kodak film in my camera, and I know exactly how it's going to respond.

"If I'm on a 7-week shoot for Sports Illustrated in Australia, exposing hundreds of rolls of film, I'd have nightmares if there were even the slightest chance that my film wouldn't perform predictably.

"It's this kind of reliability that allows me to concentrate on what I'm hired to do—discover, collect, and deliver vital information for the reader.

"My type of work involves very high pressure. The publications I work for expect results, not excuses. It takes a great load off my mind not to have to worry about film quality. I just load it and start working.

"It's extremely reassuring to know that there are several hundred people in Rochester who are totally dedicated to making sure that I never have to think about it."

Brian Lanker

Kodak professional film.

Choice of the world's top photographers.

Members Forum

Appalachian Trail

I have read many articles and books about the Appalachian Trail and have walked all of its miles, but I believe the words of Noel Grove and the eye of Sam Abell (February 1987) have brought together the spirit and feeling of the trail like no other account I've come across.

FRANK HONEYCUTT
Stephens City, Virginia

What a wonderful article Noel Grove wrote! The phone hasn't stopped ringing since your magazine hit the streets—or homes, I should say. Last Friday I responded to 65 phone calls and 30 letters. This is Tuesday, and another 100 packets have gone out. Callers don't mention NATIONAL GEOGRAPHIC until asked. They remark that this has been on their minds for a long time. The article tickled their memories, and they are now doing something about it.

JEAN CASHIN
Appalachian Trail Conference
Harpers Ferry, West Virginia

The hikers on page 231 are not Boy Scouts but a group from Camp Timberlake of the Farm and Wilderness Foundation in Plymouth, Vermont. I'm sure Boy Scouts contribute to trail maintenance, but campers from Timberlake have gained an enviable reputation for trail manners, clearing, and new shelter construction ever since the camp was begun by Ken Webb in 1939.

TOM MCGUIRE
Baltimore, Maryland

As a cartographer for the Bureau of Land Management, I have admired your fine maps and tried to imitate their format. But the Appalachian Trail map by Chandler and Schweickart is probably the best designed map you've ever done. Using flora found along the trail as background and border gave the map a beauty that complements its usefulness.

KEITH A. FRANCIS
Morrison, Colorado

In April I begin my second thru-hike, this time to commemorate the trail's 50th anniversary. My partner and I will join enthusiasts at festivities in communities near the trail and arrive on August 15 at the official party in Hanover, New Hampshire, 50 years to the day after the final section of trail was completed. Your article will inspire many people to sample the pleasures of the A.T. I hope that each new hiker will take a few moments to say "thank you" to the thousands of people who built and now maintain the trail.

DANIEL WINGFOOT
Conyers, Georgia

We at the Pacific Northwest Trail Association in Seattle invite veteran or wanna-be distance hikers to thru-hike the 1,100-mile Pacific Northwest Trail. It begins at Glacier National Park and crosses the Selkirks, the Columbia River, North Cascades, and Olympics, ending at Cape Alava on the Pacific Ocean. Anyone who completes the P.N.T. on foot or horseback and provides us with a critique of our 300-page guidebook will be pictured in the 1989 edition. You will become a P.N.T. pioneer comparable to the A.T. pioneers of the 1930s.

RON STRICKLAND
Pacific Northwest Trail Association
Seattle, Washington

Iceland

Thank you for the superb feature on Iceland (February 1987). My maternal and paternal grandparents emigrated before the turn of the century, and I am one of a very small Icelandic ethnic minority in the United States.

LESLIE MASON
Peoria, Illinois

Perhaps the term "venceremos" means something different in Icelandic than in Spanish. "We will overcome" is a lovely slogan for the so-called peace rally shown in the February 1987 article on Iceland. These are Sandinista signs. Perhaps the Icelanders at the rally would prefer to have their socialist brethren from the Soviet Union occupying the military base near Reykjavik.

MARK CROSBY
Arlington, Virginia

New Englanders are striving to tease puffins to return by putting out decoy puffins, and now it is revealed that the Icelanders are eating them like peanuts (page 203).

ELEANOR J. JONES
Phoenix, Arizona

In this excellent feature I was amazed to find nothing about Icelandic names, that is family names: They have none. With a few exceptions they have kept alive the old Scandinavian tradition of naming a child after its father. If Sveinbjörn Beinteinsson had a daughter named Helga, she would be Helga Sveinbjörnsdottir. If she married Sturla Fridriksson, her name would not change, but their son Árni would be Árni Sturlasson, their daughter Helga Sturlasdottir.

J. CARY DAVIS
San Clemente, California

Madagascar

The fine pieces on Iceland and Madagascar illustrate the effects of human numbers on conservation and the quality of life. Icelanders recognized that their numbers had to be controlled to prevent overuse of resources. The result: a high standard of living in a resource-poor area. Madagascar, with a population doubling every 25 years, presents a precarious situation for mankind. Madagascar's struggle to preserve its natural heritage deserves fullest support from other nations. But only partial success can be hoped for unless there is control of human numbers.

ERNEST P. IMLE
Adelphi, Maryland

I don't share the author's optimism for the future of Madagascar's wildlife unless the human population explosion is somehow arrested.

TOM DEMARCO
Fort Rae, Northwest Territories

On my flight as a NASA astronaut, August 30-September 5, 1984, I had the opportunity to view Madagascar from a 160-nautical-mile altitude and was amazed at the magnitude of the destruction. Even at that distance the soil erosion was easily visible, great rivers of red washing into the blue of the Indian Ocean. It's hard to believe restoration will ever be possible.

RICHARD M. MULLANE
Houston, Texas

Folger Library

What a splendid piece on the Folger (February 1987)! I especially admired the skill with which Merle Severy wove the near debacle of the theater into the library's history, a delicate spot of diplomacy. You gave credit to the man who most deserves it for the theater, O. B. Hardison.

RICHARD L. COE
Washington, D. C.

I see that NATIONAL GEOGRAPHIC goes along with the tradition that the Stratford man wrote the plays. Evidence for it is very weak. A powerful case that the playwright was Edward de Vere, 17th Earl of Oxford, is most effectively made in Charlton Ogburn's *The Mysterious William Shakespeare*, published in 1984.

TERTIUS CHANDLER
Berkeley, California

What a magnificent treasure the nation has in the Folger Library! One hopes that the Shakespeare Theatre at the Folger will be immensely successful. I wish, though, that writers about William Shakespeare would never refer to him as "the Bard," or by any other silly and vulgar title. Nothing is better than the writer's own name.

JOHN A. ZVONE
Watsonville, California

I was surprised to see an "expert" book restorer touching the pages of an old manuscript with ungloved hands (page 250). I would think that body oils could be as detrimental to these papers as atmospheric conditions.

K. BARRY HEATH
Kindersley, Saskatchewan

Gloves do not afford the sensitivity needed to handle fragile materials, says the head Folger conservator, J. Franklin Mowery.

For some time I have been meaning to compliment your choices of typesetting, as in the Folger article with its exquisite letter plates and simulated parchment. The various styles you use always enhance the article and show care and research into what is most appropriate.

JEAN D. GRANEY
Hancock, New Hampshire

Caesarea Maritima

I am a pastor, and I often use articles such as "Caesarea" (February 1987) and "The Byzantine Empire" (December 1983) to enlighten people in my parish as to what life was like in those days. You have proven invaluable.

REVEREND RANDY NORD
Hampton, Nebraska

The word "procurator" as a title for a Roman governor of Judaea was proper only from A. D. 44 to A.D. 70. The inscription on page 268 proves that Pilate's proper title was "prefect." Here are the legible and partially legible letters in capitals: ponTIUS PILATUS praefECTUS IVDAeae. This translates Pontius Pilate, Prefect of Judaea.

RICHARD L. BATES
Villanova University
Villanova, Pennsylvania

New England Map

The Society's map of New England (February 1987) is really not one since the eastern reaches of Maine are left to our imagination. I realize you documented the Pine Tree State in your Northern Approaches map of February 1985. Still the accurate title for this latest addition to "The Making of America" series should have been Western New England—which you rightly used for much the same area in the "Close-Up: U.S.A." series.

WAYNE ADAM
Ottawa, Ontario

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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Every week is an adventure!

JUNE 7—Learn Old World customs of Florida's Greek-heritage sponge divers.
JUNE 14—Check into Bombay's elegant turn-of-the-century Taj Mahal Hotel.
JUNE 21—Hold on to your hat as you raft down a river in the Canadian wilderness.

NATIONAL GEOGRAPHIC **EXPLORER**

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TRANE

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When driving conditions are less than ideal, Pontiac 6000 STE helps keep you out of a bind with advanced anti-lock braking. This new system delivers improved braking capability on almost any surface, wet or dry. Together with superb handling and fuel-injected V6 power, it gives you a machine with some of the finest performance credentials going. Or stopping.

PONTIAC 6000

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One full year of comprehensive protection, covering your home's 11 major working components.

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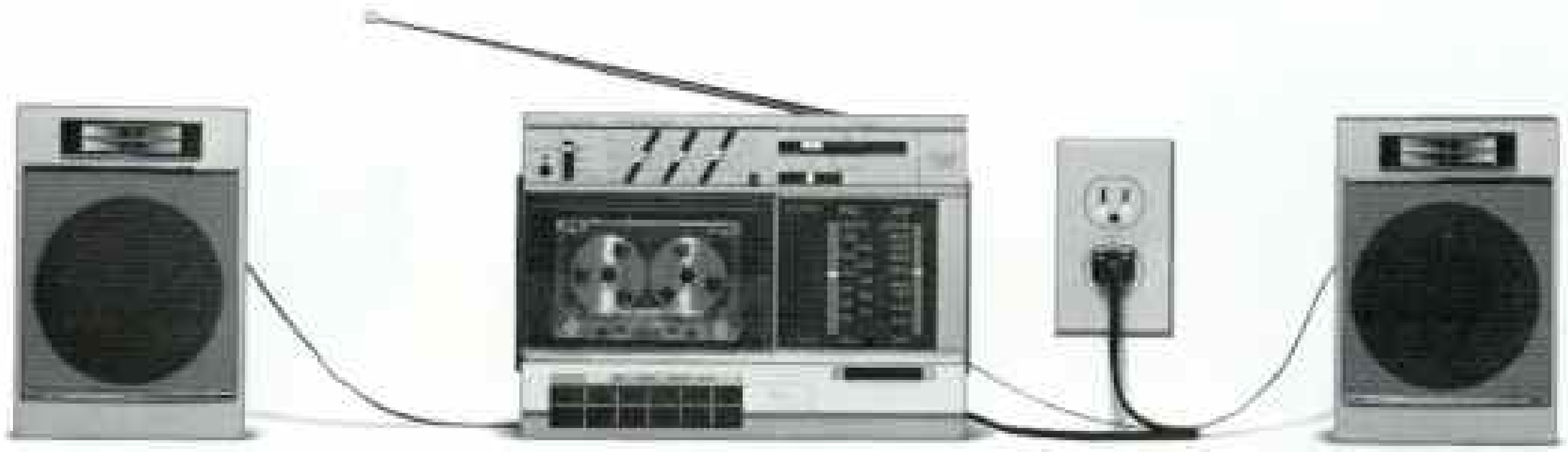

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Pygmy Hippopotamus **Genus:** Choeropsis **Species:** liberiensis
Adult size: Head and body length, 1.5–1.75m; height, 75–100cm
Adult weight: 180–275kg **Habitat:** Lowland forests and swamps in Liberia, Ivory Coast, Sierra Leone and Guinea **Surviving number:** Unknown Photographed by Erwin Bauer

Wildlife as Canon sees it

One of the greatest roles of photography is to record and preserve images of the world around us worthy to be handed down as a heritage for all generations. A photograph of the pygmy hippopotamus has a unique capability to enhance people's awareness of this rare animal.

The pygmy hippo is less aquatic and weighs only about one-tenth as much as its better-known relative, the river hippo. At night, pygmy hippos travel alone or in pairs, following their own tunnel-like paths through the dense vegetation in search of roots, grasses and fruits. Threatened by habitat loss and overhunting, the pygmy hippo requires protection and a secure habitat if it is to survive as an integral part of the forest ecosystem.

An invaluable research tool, photography can play a vital role in the preservation of the pygmy hippo by promoting a greater understanding of this species and the habitat that is so critical to its future.

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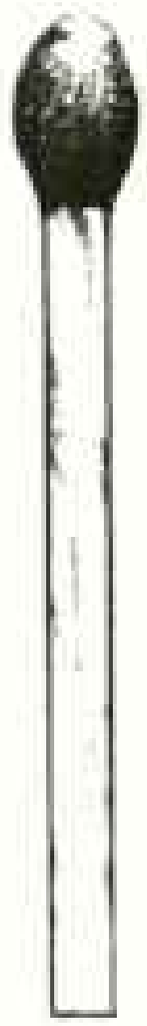

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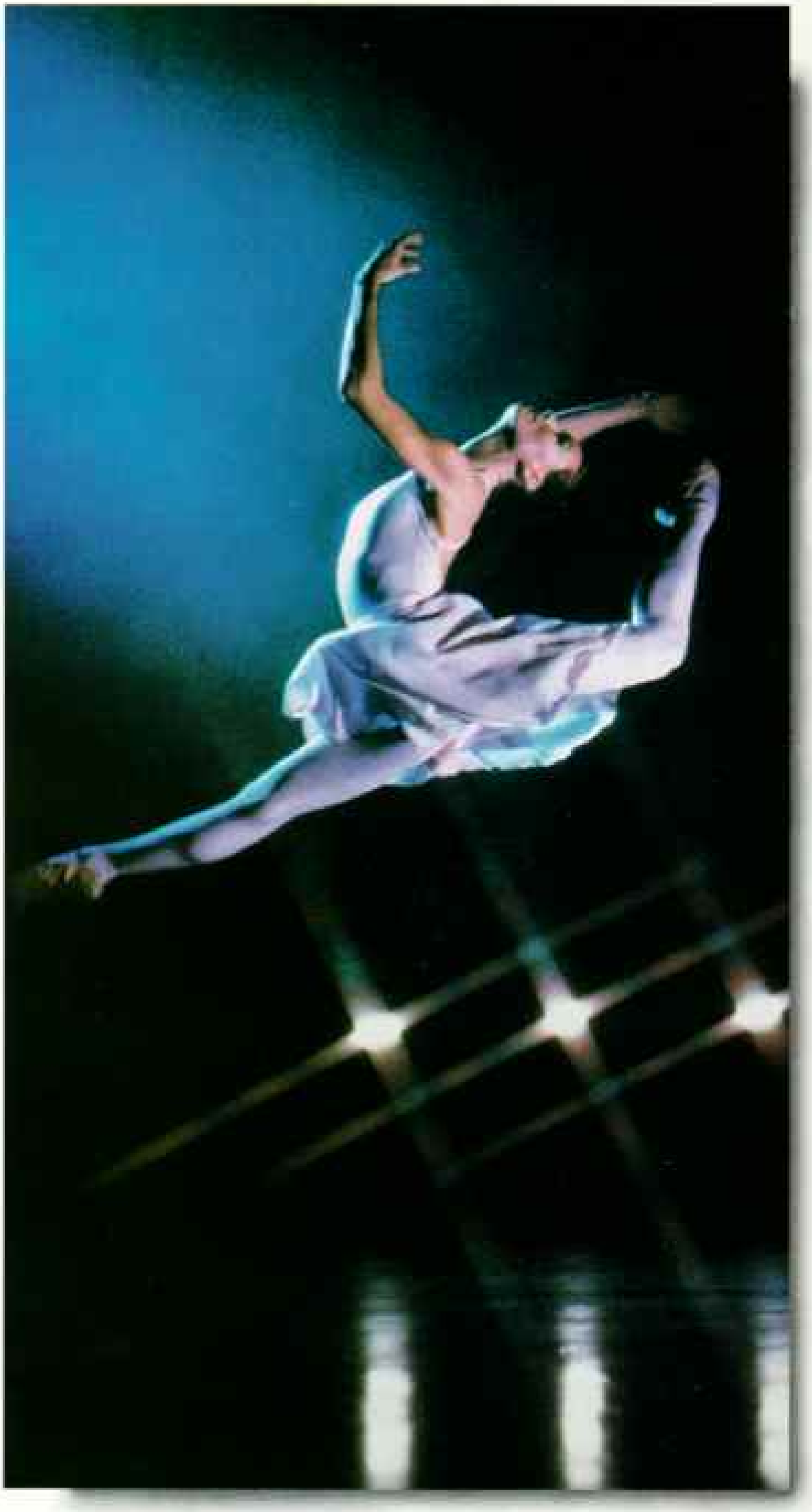

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PHOTOGRAPHS BY SANGKHOM PHOMPHAKDY (ABOVE) AND SENY NORASINGH

THE RETURN TO LAOS, now a Communist state, was an anxious homecoming for free-lance photographer ***Seny Norasingh (above)***, who left his native land for the United States in 1971. Fearing the worst, he was surprised to find the buildings of his hometown, Vientiane, virtually unchanged ("It was like being in the twilight zone") and his countrymen full of typical high spirits ("No one ever stopped the Lao from having fun").

His colleague, GEOGRAPHIC assistant editor ***Peter T. White,*** was likewise traveling familiar ground. A veteran who has covered Southeast Asia for the GEOGRAPHIC—sometimes under fire—since 1961, White (***below,*** left) credits Seny with gaining access to people and events "we never could have seen otherwise."

Of White, Norasingh says, "I've never seen anyone work harder in the field. He works every waking moment. He's relentless. He put questions to Communist officials that made my hair stand on end. Peter is also very brave. He eats things I wouldn't even touch."

If there were a White's Law of fieldwork, how would it go?

"Listen to everyone, go everywhere, do everything," he counsels. "Even when things go wrong, everything that happens is grist for the mill."