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NATIONAL GEOGRAPHIC

A Long Last Look at TITANIC

698

WESTMINSTER, THE PALACE THAT BECAME PARLIAMENT 728

HALLEY'S COMET 758

GHOSTS ON THE LITTLE BIGHORN 787

TSETSE—FLY OF THE DEADLY SLEEP 814

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

NOT SINCE Eve offered Adam an apple has an event been so glamorized, publicized, and fantasized as the sinking of *Titanic*. And not since Custer led the Seventh Cavalry against Indians at the Little Bighorn has a fatal mistake so captured public imagination as the "unsinkable" *Titanic* being driven into an iceberg field at full speed.

We can forgive Adam for his weakness. Custer's mistake is understandable. Because of overconfidence or ignorance he grossly underestimated the Indians' ability and will to fight for their land.

But the mystique of *Titanic* remains and is even rekindled by the recent discoveries. There is still a Titanic Historical Society, whose members dote on every scrap of news. At least two of them were brought to tears by the first pictures from last year's expedition. And newspapers and wire services will give space to any character who claims he'll raise *Titanic*—whether with billions of Ping-Pong balls stuffed into the hull or by freezing her into an iceberg to float majestically to the surface. I thought about getting my name in the press by offering to raise her with hot-air balloons—filled by the publicity seekers.

But not everyone is blinded by the mystique. There have also been charges of public money wasted in looking for *Titanic*. But just as advertisers use sex to sell everything from cat food to cologne, why not use *Titanic* to sell and develop deep-sea exploration? Woods Hole Oceanographic Institution, Dr. Robert Ballard, and Secretary of the Navy John Lehman are to be congratulated for risking criticism to help focus public and government attention on the most neglected, least understood, and perhaps most strategically important part of the planet. As one massive archaeological site, the oceans are a treasured time capsule. And those courageous people really were conducting important research and equipment tests.

If Dr. Ballard had reported finding mermaids sipping champagne in the first-class lounge, he might have gained a billion dollars in private and government research funds. But just sticking to the truth has excited our imagination enough. All of us who have worked on the project admit to more than a modest curiosity. So much so that we are devoting another cover story to what was found on the return trip. It is titled—probably naively—"A Long Last Look at *Titanic*."

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

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A Long Last Look at *Titanic* 698

Robert D. Ballard, co-leader of the expedition that found the historic shipwreck last year, returns for a detailed exploration, aided by two ingenious seeing-eye undersea vehicles.

Westminster, the Palace That Became Parliament 728

Over the centuries a onetime royal residence in London has been transformed into the permanent home of Britain's lawmaking body. Patrick Cormack, member of the House of Commons, traces its history and traditions. Photographs by Adam Woolfitt.

Halley's Comet 758

The dazzling traveler that many watchers missed revealed its secrets to telescope, spacecraft, and jet aircraft, Rick Gore reports.

Ghosts on the Little Bighorn 787

After a 1983 prairie fire cleared brush along Montana's Little Bighorn River, archaeologists recovered artifacts that shed new light on Custer's Last Stand. Robert Paul Jordan reports on the still controversial 1876 battle. Photographs by Scott Rutherford.

Northern Plains Map

A double supplement traces the center of our continent from frontier days to the present.

Tsetse—the Deadly Fly 814

Scourge to cattle and humans alike in Africa, the tsetse fly stirs debate over land use. Georg Gerster investigates the continuing war to control the insect.

COVER: *Exploring* Titanic's *hulk, a robot camera-equipped submersible called Jason Jr. peers into a first-class cabin. Photograph by Woods Hole Oceanographic Institution.*

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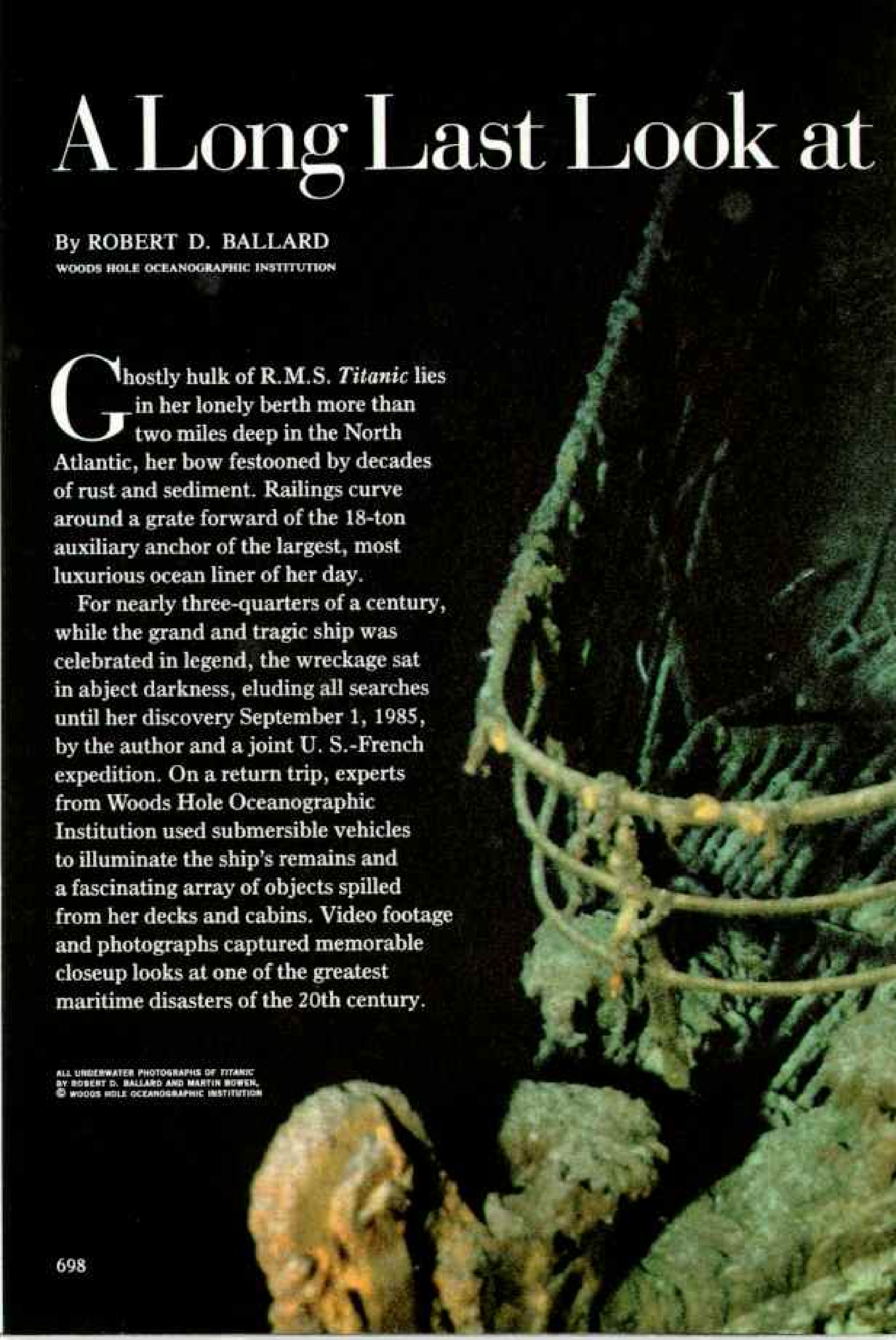
A Long Last Look at

By ROBERT D. BALLARD
WOODS HOLE OCEANOGRAPHIC INSTITUTION

Ghostly hulk of R.M.S. *Titanic* lies in her lonely berth more than two miles deep in the North Atlantic, her bow festooned by decades of rust and sediment. Railings curve around a grate forward of the 18-ton auxiliary anchor of the largest, most luxurious ocean liner of her day.

For nearly three-quarters of a century, while the grand and tragic ship was celebrated in legend, the wreckage sat in abject darkness, eluding all searches until her discovery September 1, 1985, by the author and a joint U. S.-French expedition. On a return trip, experts from Woods Hole Oceanographic Institution used submersible vehicles to illuminate the ship's remains and a fascinating array of objects spilled from her decks and cabins. Video footage and photographs captured memorable closeup looks at one of the greatest maritime disasters of the 20th century.



ALL UNDERWATER PHOTOGRAPHS OF TITANIC BY ROBERT D. BALLARD AND MARTIN BOWER, © WOODS HOLE OCEANOGRAPHIC INSTITUTION

TITANIC

POPPERFOTO

Scene of frantic activity on that chill April night in 1912 when *Titanic* struck an iceberg, a lifeboat storage area becomes a landing pad for the manned submersible *Alvin* in this photograph taken by the remotely operated robot *Jason Jr.* Lights shine on an open window into a first-class cabin.

The ship carried lifeboats for only 1,178, and many boats were launched only partly filled. Of the 2,227 on board, more than 1,500 perished, including Capt. Edward J. Smith (*left*, at right), shown on the boat deck with chief purser Herbert McElroy. A veteran of 43 years at sea, Smith had planned to retire after *Titanic*'s maiden voyage.

MY FIRST DIRECT VIEW of *Titanic* lasted less than two minutes, but the stark sight of her immense black hull towering above the ocean floor will remain forever ingrained in my memory.

My lifelong dream was to find this great ship, and during the past 13 years the quest for her had dominated my life. Now, finally, the quest was over.*

In a way I am sad we found her. After 33 hours of exploring her dismembered hulk, we know her fate, and it is not a pretty sight. Though still impressive in her dimensions, she is no longer the graceful lady that sank a mere five days into her maiden voyage, in 1912, after striking an iceberg. Her beauty has faded, her massive steel plates are dissolving in rivers of rust, and her ornate woodwork has been devoured by an army of countless wood-boring organisms whose hollow calcium tubes now litter her barren shape. After years of gluttony the creatures starved and dropped dead at the table. I have no sympathy for them; they robbed *Titanic* of her last touch of elegance.

Titanic's band has long since ceased to play. She is gone, home-ported at last. She will surely never be raised. Such stark reality often offends our romantic senses, but the search for this greatest of all sunken ships was first and last an exciting journey. First, it was almost too exciting.

Dive number one was to see how dangerous *Titanic* would be to *Alvin*, the indomitable submersible, and its crew: in this case, pilots Ralph Hollis and Dudley Foster, along with me. As we began our two-and-a-half-hour dead fall toward the bottom, we discovered the sonar was not working. The outside pressure was quickly doubling and then doubling again; it would eventually reach 6,000 pounds per square inch. Had it rendered the sonar useless for today's trip? Without sonar, we would have to rely upon our surface navigator aboard *Atlantis II* to guide us blind to *Titanic*'s side, and he now began driving us in circles: Go east, go west.

Then, another cruncher. Ralph noticed salt water leaking into one of the two battery packs that powered the small sub. It showed up on our instrument panel as a slow leak, but as the level of seawater in the battery tub rose, the leak caused us concern, for the protective oil in which the batteries are bathed was being replaced by short-circuiting seawater. *Alvin*'s batteries eventually could consume themselves. Bottom time would be short—if at all.

Finally, as we closed with the bottom, faint features emerged from the green gloom. No *Titanic*, no debris, just a gently rolling countryside of mud—much like an alpine meadow after a blanket of snow has all but erased its features. When our tracking system is working properly, the navigator on the surface knows where he is, where we are, and where *Titanic* lies, but the navigator was now having problems. We did not know what they were, only that his directions, echoed down to us on the underwater acoustic telephone, indicated he was lost.

To be so close—but to be so far away! Somewhere out there lies *Titanic*, just a few hundred meters away, perhaps less than the distance from home plate to the centerfield wall in Fenway Park. And those damn alarms have started. Seawater is continuing to short-circuit our batteries, and Ralph is already thinking about returning to the surface.

The snowstorm of underwater particles is blowing toward us from the south-southeast. Clearly, the current must have set us to the north of our desired location. *Titanic* should lie south. We begin driving in that direction, the single ski mounted under *Alvin* making us a one-legged skier gliding downslope over virgin snow, a single track left behind us for roaming crabs to exploit.

The alarms inside *Alvin* shrill as more and more seawater enters our battery pack and the electrical situation gets worse. Ralph is about to pull the plug.

*The author chronicled the discovery of *Titanic* in the December 1985 GEOGRAPHIC. He has written numerous other articles as well as the National Geographic book *Exploring Our Living Planet*.

Finally, a voice from above: "*Alvin*, this is AII. Tracking is working, *Titanic* should bear 50 yards to the east. . . ."

As we turn east, our pace quickens and our eyes strain to see. The bottom begins to look strange; it begins to slope up suddenly, steeper than it should, into a mound of mud and small glacial boulders dropped through eons of time by slowly melting icebergs, including the one that sank *Titanic*.

It has a bulldozed look, and what a bulldozer lies just beyond!

"Ralph," I say. "Come right."

Swinging the sub to the right, Ralph eases *Alvin* forward until he is stopped by an endless slab of black steel rising out of the bottom. Our journey at long last has reached its goal. *Titanic* is a few inches away. In that brief instant we become the first ever to actually see *Titanic* in her grave. Then Ralph pulls the plug, and we lift up from the ocean floor.

Most of the 11 dives that followed were more rewarding, such as the one that confronted the historic question of "the gash." Most accounts of *Titanic*'s loss attribute the disaster to a 300-foot-long gash ripped into the liner's starboard bow by the iceberg. I had long doubted such reports, for *Titanic*'s massive steel plates probably would have been bent or forced apart rather than ripped open by ice.

During one of our later dives we guided *Alvin* to a landing beside *Titanic*'s bow, driven deep into the mud of the ocean floor by the enormous momentum of the plunge from the surface. On impact the bow had shifted slightly to the left, leaving a gap between the bank of mud and the ship's starboard side. As we moved slowly along that vertical wall of steel, I half-expected to see a tear in the plates. But there was nothing—only an indication that the plates had bent inward and the rivets holding them together perhaps had sprung, allowing seawater to enter. Still photographs taken later of the section indicate at least one hole in the plates, so the question may never be fully answered.

Pilot Dudley Foster checks *Alvin*'s depth as author Ballard reports their position to the Woods Hole mother ship *Atlantis II*. MARTIN BOWEN

Other dives produced vivid cameo scenes that will also remain with me forever. As we explored *Titanic* cautiously, peering at her from inside *Alvin* or via our "swimming eyeball," the robot *Jason Jr.*, we came upon such haunting scenes as the disembodied head of a child's doll, lying amid the vast field of debris dumped loose when the ship broke up on or near the surface. Then there was the fragile cup balanced delicately atop one of the ship's massive steam boilers (page 722). Small electric space heaters scattered throughout the debris field were a pathetic reminder of the comforts enjoyed so briefly on that doomed voyage.

In such ghostly surroundings impersonal features took on human characteristics. On one dive, as we moved in slow motion along the hull, the darkened portholes seemed to me like rows of sightless eyes brimming with great tears of rust.

The more we explored *Titanic*, the more her parted sections assumed wholly different characters. The bow still had a certain dignity to it, but the stern section was utter devastation. It was here that passengers and crew had gathered to face the awful specter of death. Exploring with *Alvin*, we eventually chose a spot beside the rail

of the stern section to place a bronze plaque from the Titanic Historical Society commemorating the ship's 1,522 lost souls.

In a curious way descents to *Titanic* stood out in sharp contrast to return trips to the surface. During the two-and-a-half-hour ride down to the wreck, Ralph Hollis, Martin Bowen—*Jason Jr.*'s pilot—and I played classical music over the sub's stereo system. We studied notes and electronic data and generally followed a scientific routine. But once the day's exploration of *Titanic* was over and we started for the surface, rock music replaced classical on the stereo, notes were put aside, and we joked about the high and low points of the day's dive. The change in us stemmed not from a sense of relief—we three, after all, had made hundreds of dives in *Alvin*—but more from the feeling of a job well done both above and below the surface.

The day is fast approaching when that job can be done faster and better without man's physical presence in the sea. Until recently there has been no way of duplicating human skills at great depth—of providing man's sophisticated eyes and brain and articulating hands to solve complex problems or perform difficult tasks. Whatever the cost, and the risks, of transporting man into the deep, it has been worth it.

I am well aware of the costs and the benefits of that era. For more than a decade I have spent an average of four months a year at sea. I have logged countless hours below, crouched in one submersible or another, exploring the rugged and uncharted mountain ranges of the world's oceans.

Certainly the dives were exciting, many of them made in partnership with the National Geographic Society. They included exploration of the Mid-Atlantic Ridge, descents to 20,000 feet in the Cayman Trough, the study of deep-sea warm springs—unique oases of life—in the Galápagos Rift, and finally the discovery on the East Pacific Rise of "black smokers," hydrothermal vents that belch fluids hot enough to melt lead.

Historic achievements, every one of them. But in 13 years I had managed to explore a mere 40 miles of undersea mountain range. There are more than 40,000 miles of such ranges throughout the world's oceans. Did I really want to spend the rest of my life in the hope of exploring another 80 or 100 miles at best?

It seemed to me we had a choice. We could continue indefinitely with manned submersibles, which are limited in the time they can spend below by both their passengers' endurance and their expendable power supply. In a sense they are no better than a scuba diver who, air supply exhausted, must race back to the surface.

On the other hand we could begin thinking of remotely operated deep-sea vehicles, sophisticated robots that could give man what I have come to think of as a "telepresence" in the sea, an extension of his unique senses and capabilities to extreme depths without physically transporting him a foot below the surface.

Through such robots man could remain under the sea for weeks instead of mere hours at a time, extending his reach immeasurably into earth's last great uncharted frontier. Equally important, via live television these machines could bring the wonders of the deep to countless millions rather than to the lucky few who are able to ride in submersibles.

FROM THE VERY OUTSET of that vision *Titanic* seemed the key. The cost of developing deep-diving robots is astronomical, requiring a dramatic image or goal to capture public interest and support. Nothing in modern maritime history fits that description better than *Titanic*.

My first real hope of finding and filming *Titanic* came in the 1970s, when the undersea research group at the Woods Hole Oceanographic Institution decided to more than double *Alvin*'s depth range from 6,000 to 13,000 feet. The latter, I knew, was roughly the level at which *Titanic* lay. *Alvin* seemed the perfect deep platform to begin experimenting with robotic vehicles—first as extensions of manned submersibles, and ultimately as their replacement.

That is a challenging and costly goal. Without the support of friends and colleagues at Woods Hole and in the U. S. Navy, neither the search for *Titanic* nor the projects that have stemmed from it would have been possible.

Over the years, as I continued diving in manned submersibles, I kept careful note of ways in which robotics could overcome their limitations. New technologies such as fiber optics and lasers broadened the dimensions of what robots could do beneath the sea.

I envisioned a remotely operated system involving two components, which eventually became known as *Argo/Jason*. *Argo* was to be the eyes of the system and *Jason* the hands, both elements extraordinarily sophisticated. When perfected, the system would be able to search out objects or natural features at extreme depths, analyzing and recording them for as long as the surface operators wished. In the case of lost objects, *Argo/Jason* could either recover them or direct their recovery by other means.

By September 1985 *Argo* was ready for testing at sea. During the historic discovery of *Titanic* by the U. S.-French team, *Argo* exceeded our highest hopes; the robot's ultrasensitive "eyes," or video cameras, could see and record in almost total darkness. The next step was to give *Argo* a hand.

By last summer the system had the beginnings of one in the form of *Jason Jr.*, our "swimming eyeball." A more sophisticated version of "*J. J.*," known simply as *Jason*, will attach to *Argo* and will have not only cameras but also highly versatile arms able to perform complex jobs in areas where no manned submersible could ever safely go.

Drooping like stalactites, "tears" of rust obscure a porthole in which a jagged section of glass remains.

With *Argo* not yet ready for a partner, we attached *J. J.* to *Alvin* instead. The world's finest manned submersible thus played a key role in developing and testing a system that may one day replace its own kind.

Admittedly *J. J.* had its share of problems on *Titanic*. Returning from one dive, it fell out of its "garage," or housing, aboard *Alvin*, and only quick work by our support divers prevented a million-dollar loss. On another dive, when I remained on the surface, *J. J.* suffered an electronic stroke.

"*J. J.* was just hanging there above the bottom," Martin Bowen told me, "and suddenly it fizzled out. What looked like a wisp of white smoke—actually it was fluid—came out the top, and that was the end of *J. J.* for the dive."

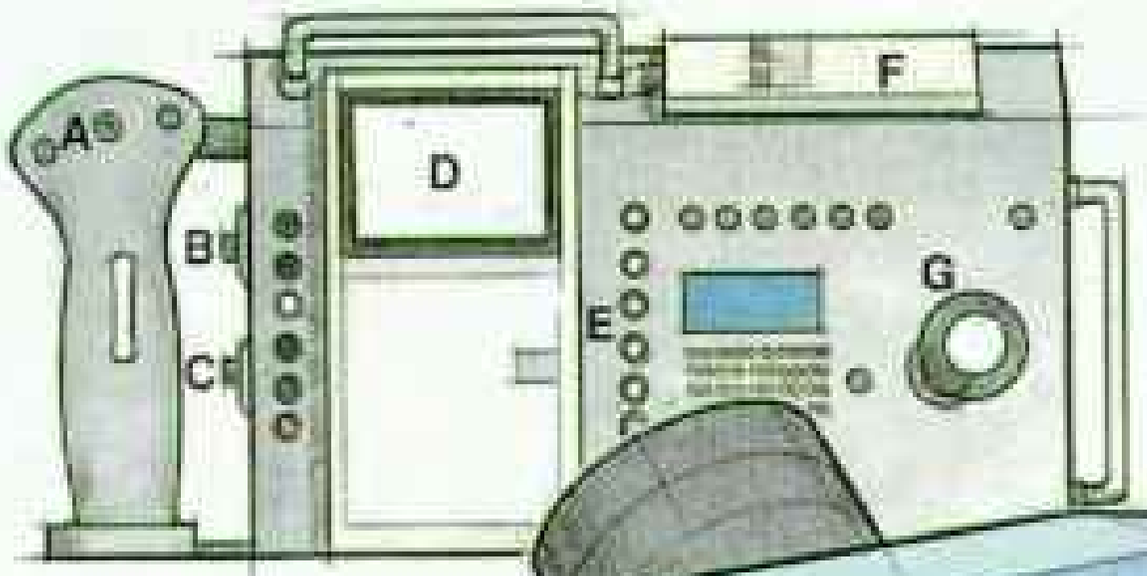
Fortunately the trouble, which proved to be a saltwater leak in *J. J.*'s tether, was quickly repaired, and the robot was soon ready to dive again. But the incident proved the point that when something goes wrong at 12,500 feet, you don't just get out and fix it. The only answer is to build systems that don't risk human life.

This winter the marriage of *Argo* and *Jason* will begin aboard the research vessel *Knorr*, the ship that discovered *Titanic*. Within two years *Argo/Jason* will be ready to enter the deep and remain there for extended periods, adding greatly to man's knowledge of the undersea world.

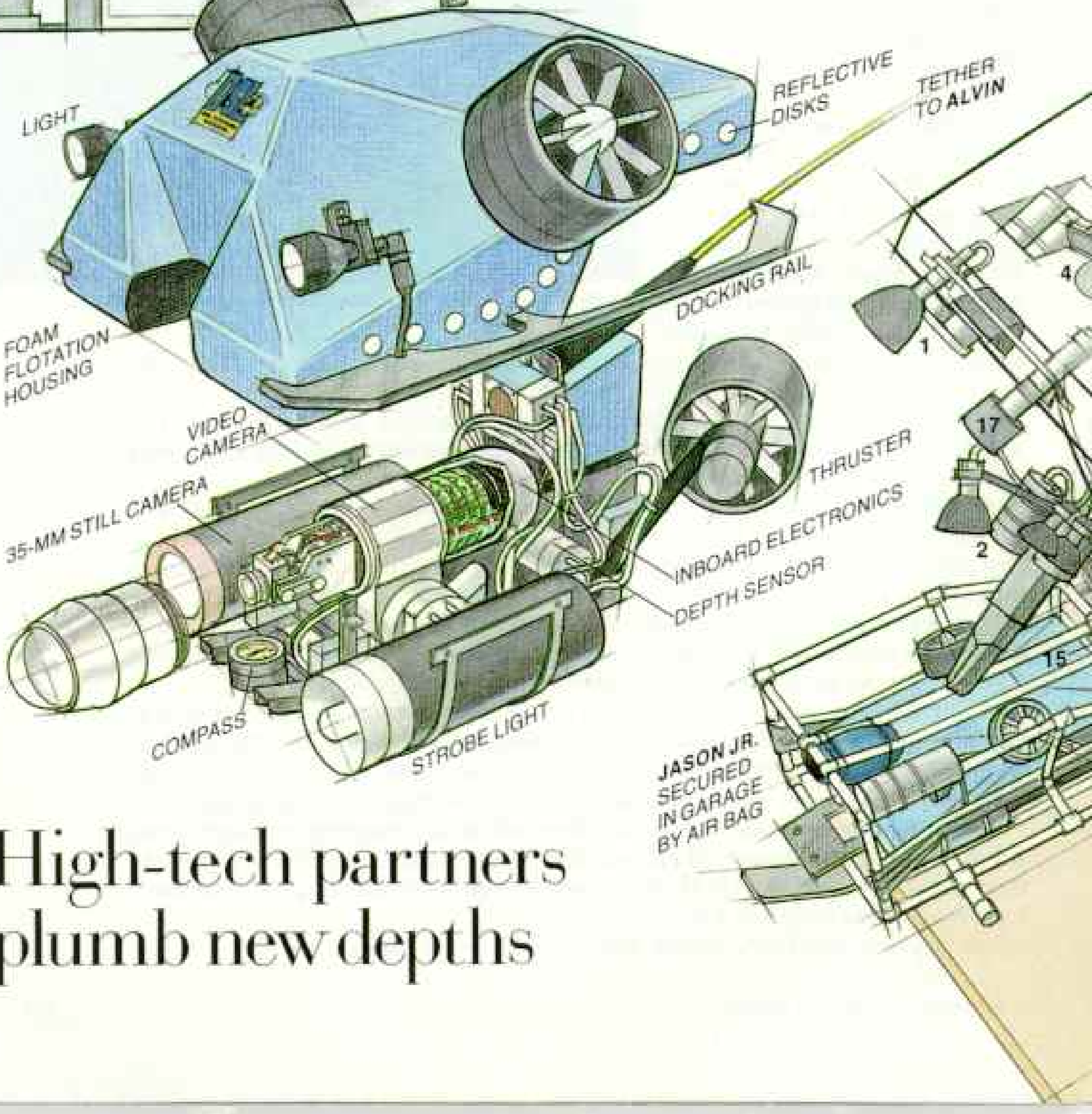
But the quest for *Titanic* is over. May she now rest in peace. * * *

Man and machines made exploration of *Titanic* possible. Two non-human partners: *Alvin*, a free-floating submersible with room for only a three-man crew (**below right**), and a smaller tethered robot called *Jason Jr.* (**below**), which travels to dive sites tucked in a cage-like "garage" attached to *Alvin*'s forward section.

PERRY THORSVIK



Jason Jr. is controlled by a console (left) held by a pilot in *Alvin*. Buttons in the handgrip **A** activate the robot's vertical thrusters and control the tether to *Alvin*. A photo trigger **B** activates the still camera; a companion button **C** adjusts video camera tilt. The video monitor **D** displays *J. J.*'s field of vision. Switches **E** work motors and lights. Other switches **F** operate the videotape. Joystick **G** controls horizontal movements.



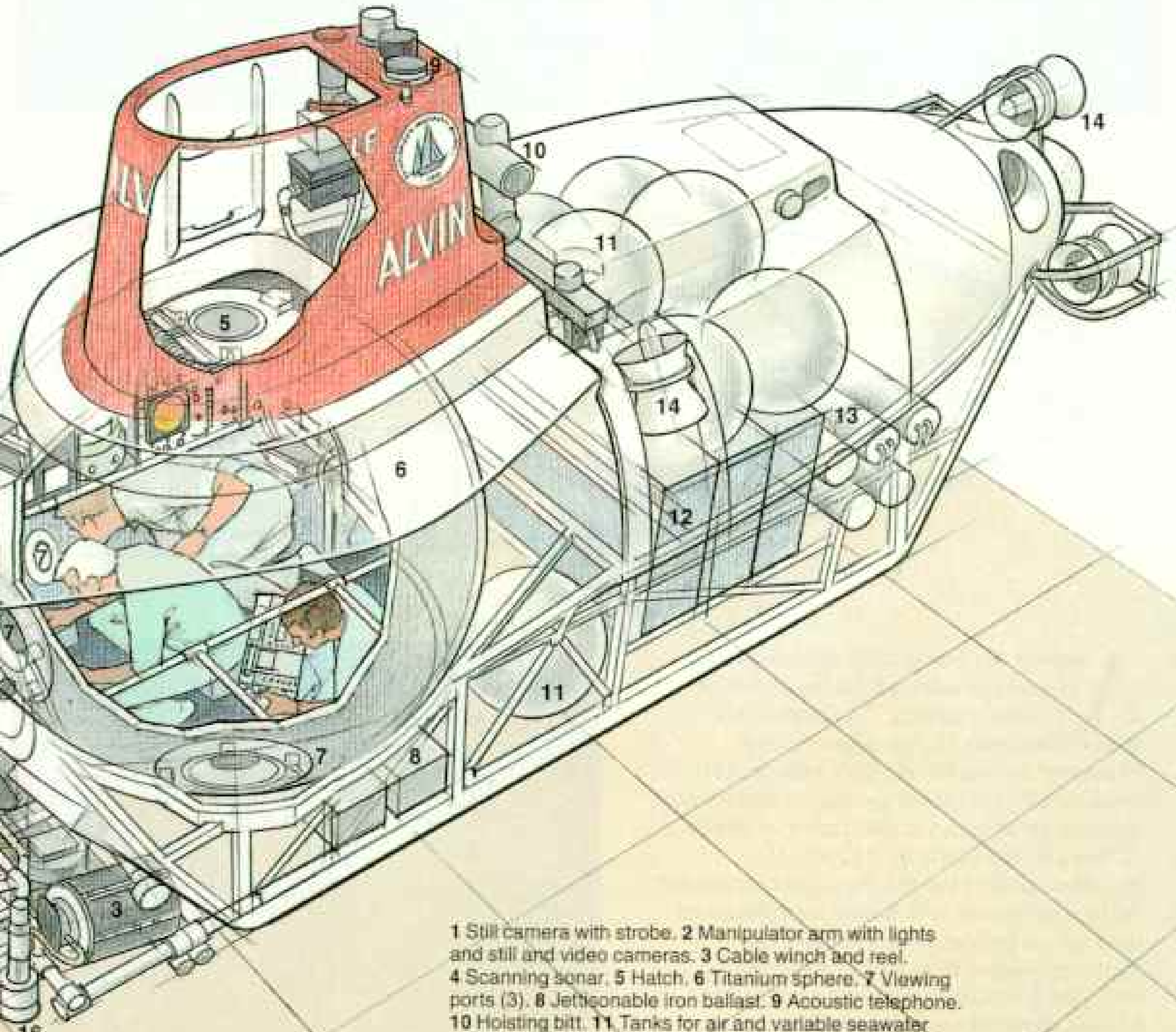
High-tech partners plumb new depths

Above the wreck site, divers David Sanders and John Salzig (**left**) stand atop *Alvin* to secure safety lines that buttress *Jason Jr.*'s garage as the vehicles are lifted out of the water to the support ship's deck.

Launched at Woods Hole in 1964, *Alvin* has been a reliable sea dog, logging more than 1,700 dives. It has proved invaluable in geologic and biologic studies during descents as deep as 13,000 feet.

Alvin's smaller partner, called *J. J.* for short, measures just 28 inches long and weighs 250 pounds on land. But its hull of syntactic foam—billions of microscopic air-filled glass spheres bonded by epoxy—makes it weightless in water. A 200-foot-long tether connects the two vehicles, enabling *Alvin*'s crew to send *J. J.* into spaces too small or too dangerous for a manned vehicle.

Woods Hole scientists are at work on *J. J.*'s successor, to be named simply *Jason*. Larger and more sophisticated than its predecessor, *Jason* will include robot arms for retrieving samples.



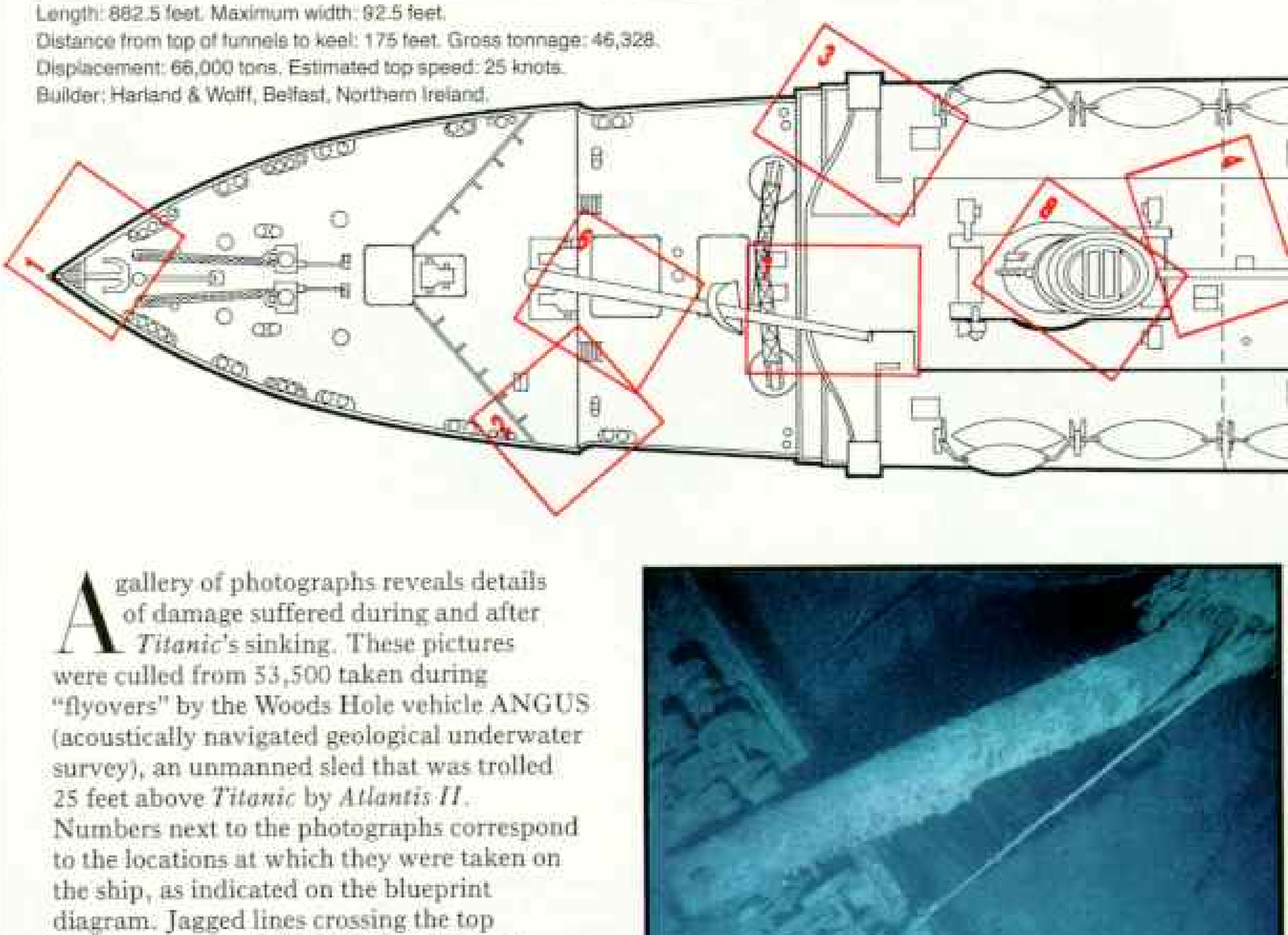
1 Still camera with strobe. **2** Manipulator arm with lights and still and video cameras. **3** Cable winch and reel. **4** Scanning sonar. **5** Hatch. **6** Titanium sphere. **7** Viewing ports (3). **8** Jettisonable iron ballast. **9** Acoustic telephone. **10** Hoisting bitt. **11** Tanks for air and variable seawater ballast. **12** Batteries. **13** Pressure housings for electric controls. **14** Thrusters. **15** Emergency tether cutter. **16** Down-looking low-light-level black-and-white TV camera. **17** Forward-looking low-light-level black-and-white TV camera.

PAINTING BY WILLIAM H. BOND, NATIONAL GEOGRAPHIC ARTIST

1 Normally pointed toward the stern, the anchor crane was skewed forward over the bow.

2 Railings separate the forecastle, left, from the well deck, upper right.

Length: 882.5 feet. Maximum width: 92.5 feet.
Distance from top of funnels to keel: 175 feet. Gross tonnage: 46,328.
Displacement: 66,000 tons. Estimated top speed: 25 knots.
Builder: Harland & Wolff, Belfast, Northern Ireland.



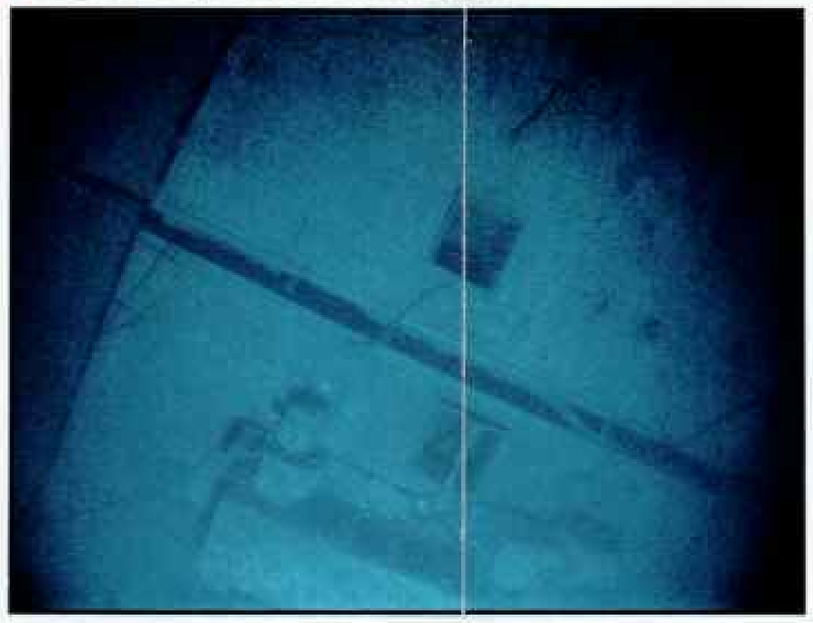
A gallery of photographs reveals details of damage suffered during and after *Titanic*'s sinking. These pictures were culled from 53,500 taken during "flyovers" by the Woods Hole vehicle ANGUS (acoustically navigated geological underwater survey), an unmanned sled that was trolled 25 feet above *Titanic* by *Atlantis II*. Numbers next to the photographs correspond to the locations at which they were taken on the ship, as indicated on the blueprint diagram. Jagged lines crossing the top deck just forward of the third and fourth funnels show where the ship broke up as she descended.

The forward section plowed into the ocean floor at high speed—30 miles an hour or more—buckling plates on the hull and burying the bow in 50 feet of mud (***painting, foldout overleaf***).

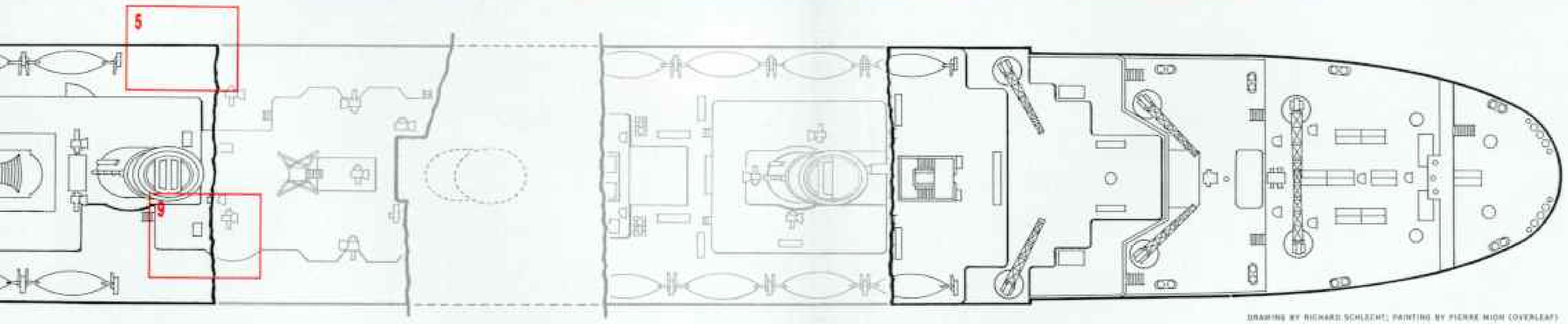
6 Winches flank the base of the toppled forward mast.

3 A rusted cable snagged by ANGUS dangles toward the starboard bridgewing.

4 Stress created a one-foot gap in a normally snug expansion joint crossing a deckhouse roof.

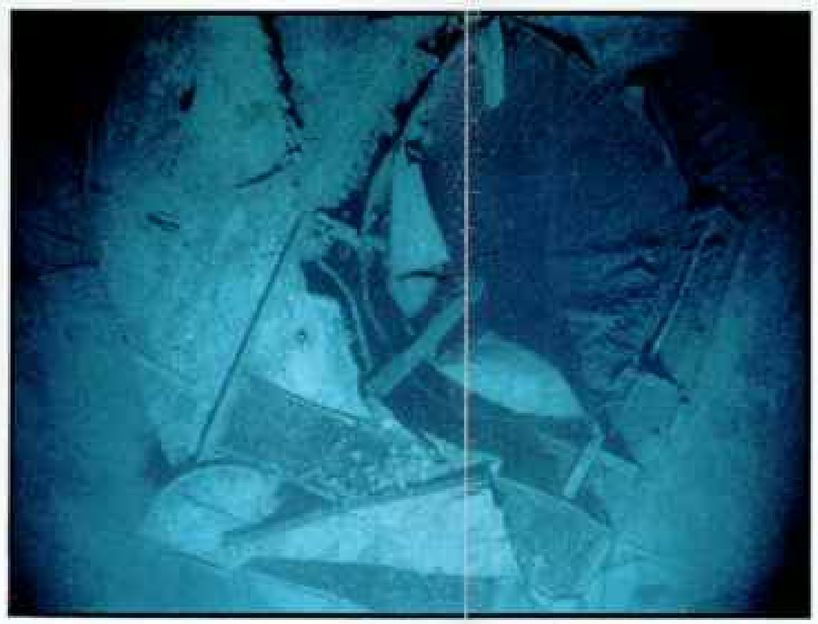


5 The ship separated along the ragged line just right of center near windows of the first-class cabins on B deck.



DRAWING BY RICHARD SCHLECHT; PAINTING BY PIERRE MION (OVERLEAF)

The foremast lies across the bridge. At top is the metal pedestal of the ship's wheel.



8 Jagged metal surrounds the hole left where the number one funnel tore loose.

9 Opening for air duct, top, overlooks hole in the roof of the first-class reading room.

A

B

C

D

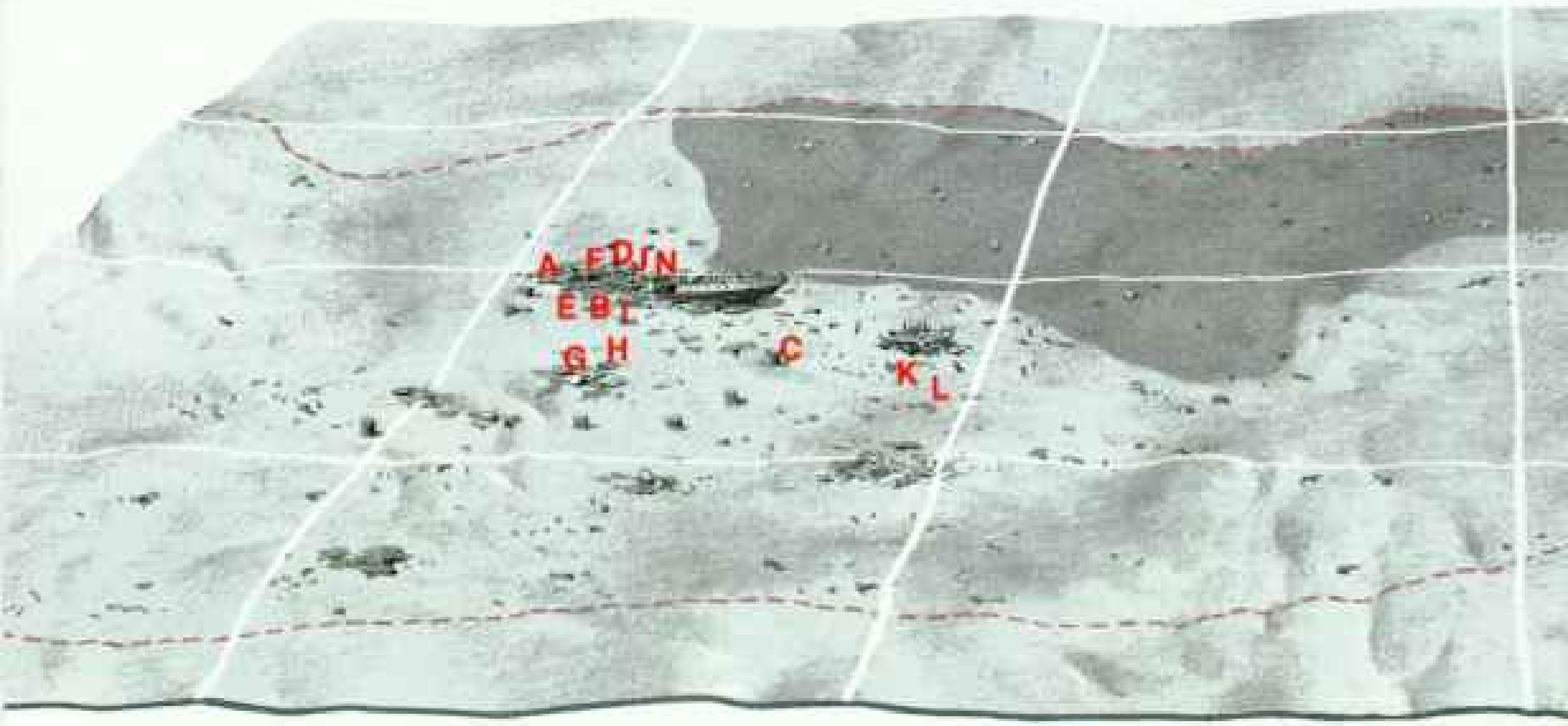
E

Poignant relics of a disaster

Like an eerie underwater museum, debris lies concentrated near *Titanic*'s severed stern section (***below***) on the seafloor 350 miles southeast of Newfoundland.

Wood-boring mollusks that ate nearly all exposed wood apparently found unappetizing the cork in this champagne bottle (***top left***). Though subject to pressure of 6,000 pounds per square inch, the bottle escaped shattering, perhaps because of the counteracting presence of liquid inside.

The sighting of a ceramic doll's head (***top center***) caused the author to shudder. "We were near the stern section, the area most likely to contain



F

G

H

human remains," recalled Ballard, who was peering out *Alvin*'s view port. "It scared the hell out of me."

An electric heater (***facing page, top right***), an adjunct to the ship's heating system, was a feature found only in first-class cabins.

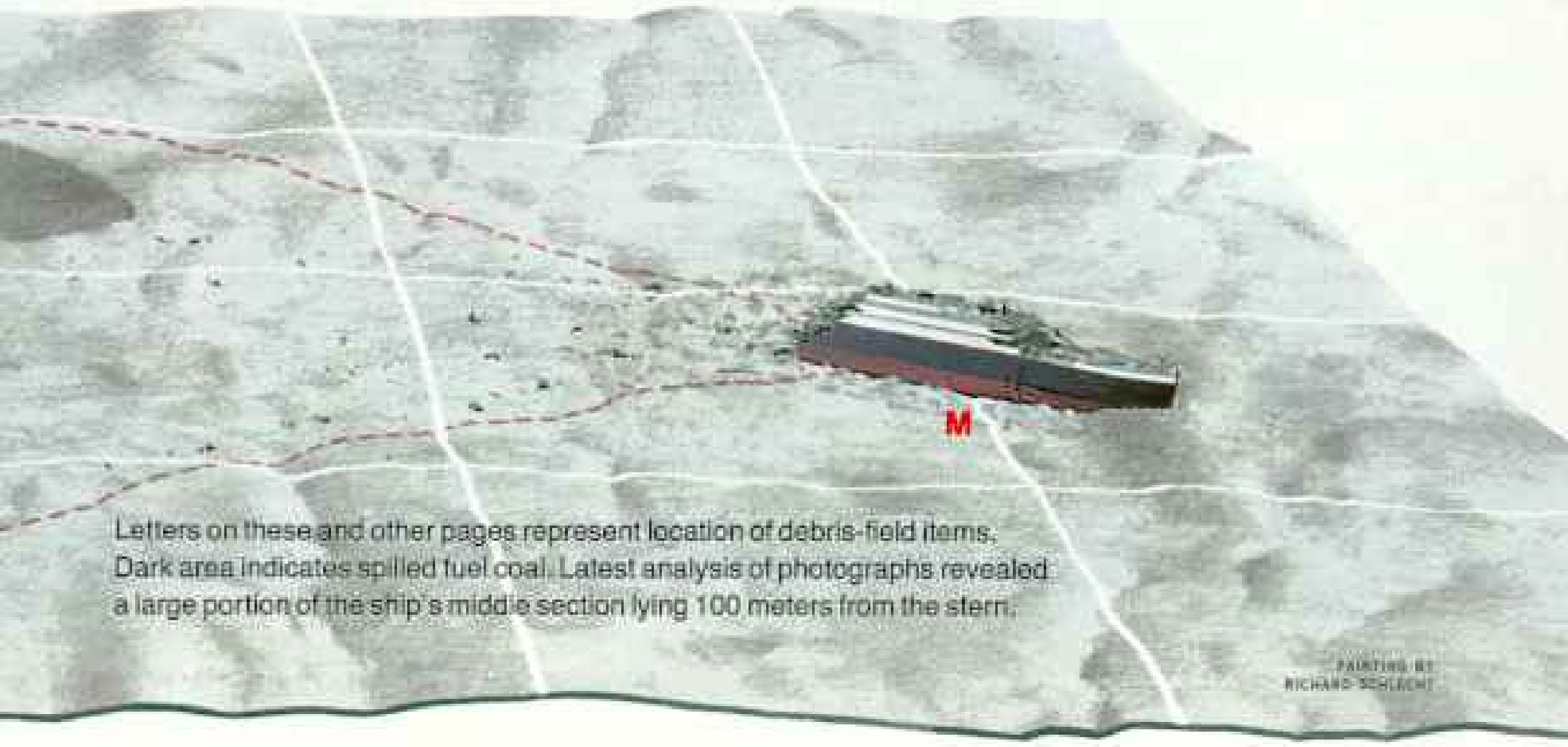
Battered but still shining, a silver serving bowl (***facing page, left***) lies next to a clogged steam pipe.

Remaining largely intact, wooden stairsteps (***facing page, right***) were spared by wood borers, possibly because of treatment with an anti-weathering compound.

Its wooden slats long gone, the metal frame of a deck bench (***above***) rests against a section of heating duct.

A weighted base made of lead keeps a spittoon from one of the smoking rooms in an upright position (***top***).

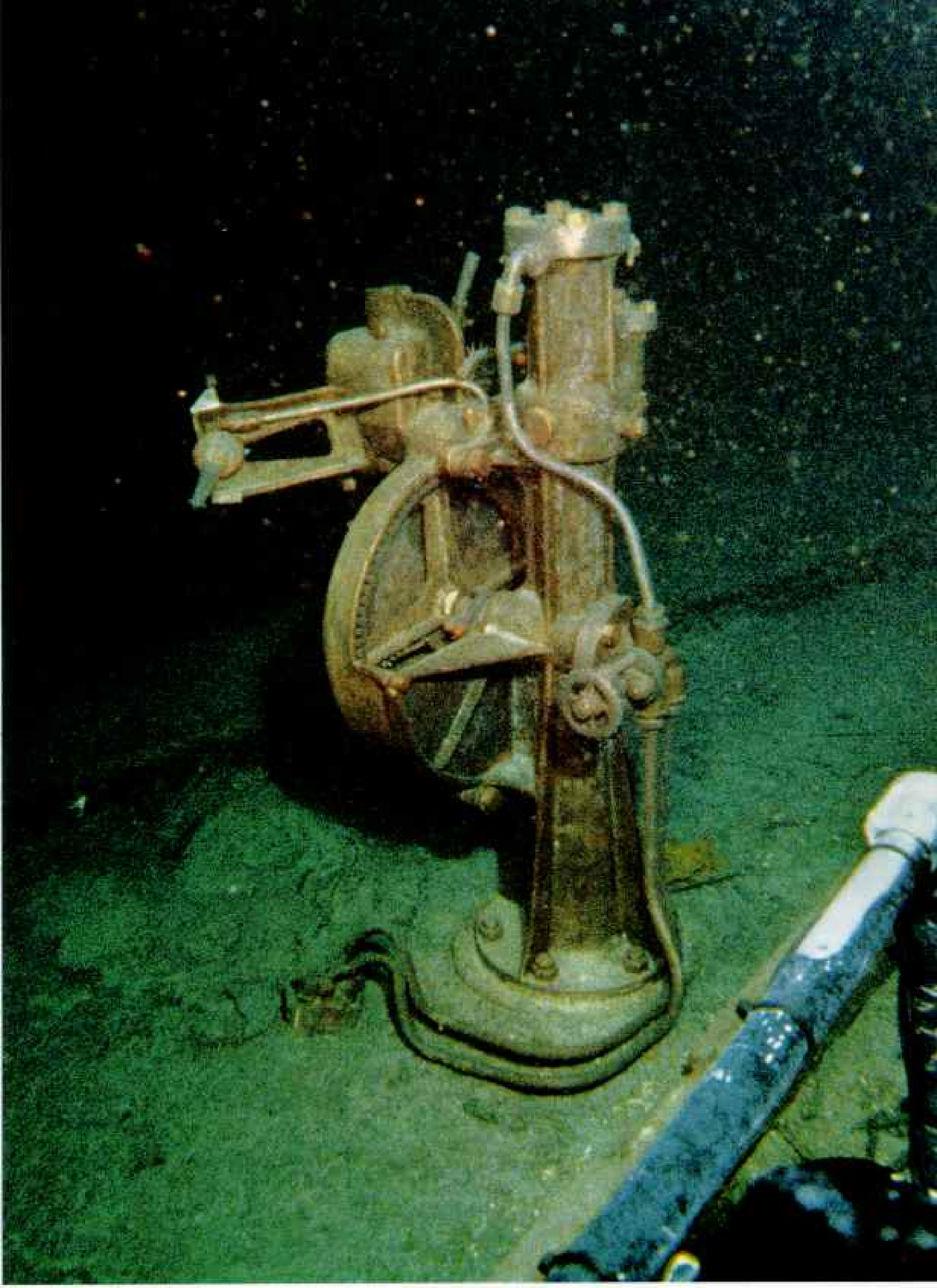
The corroding action of currents of up to three quarters of a knot, strong for the ocean floor, have had little effect on a corrosion-resistant copper pot (***above***).



M

Letters on these and other pages represent location of debris-field items. Dark area indicates spilled fuel coal. Latest analysis of photographs revealed a large portion of the ship's middle section lying 100 meters from the stern.

PAINTING BY RICHARD SCHLECHT



With its block still in place, a lifeboat davit extends from the port side on the boat deck (***right***). The first lifeboat was lowered at 12:45 a.m. on April 15, 1912, one hour after the ship was struck. Even then, some passengers doubted they were in danger. When the crew ordered them into lifeboats, they instead remained in the warmth of the ship's enclosed decks.

In the debris field *Alvin*'s mechanical arm reaches for the handle of the assistant purser's safe (***below***), one of four aboard ship. The handle turned, but the door would not open. A steward testified that shortly before the sinking he saw other crew members emptying the safe. Moments later he heard the door clang shut.

The pedestal that held the ship's wheel sits like a forlorn metallic seahorse (***left***). Bronze construction saved it from the corrosion that afflicts the ship's iron-based structures. A corner of *J. J.*'s garage

protrudes from *Alvin*, at lower right, as it sits outside what was once the wheelhouse, the walls long ago devoured by wood borers.

It was near this station that the officer of the watch heard the warning from the crow's nest "Iceberg right ahead!" His attempt at evasive action was futile, and the ship's starboard side struck the berg.

The port-side bow gets close scrutiny (***overleaf***) by *Jason Jr.*, its tether payed out from *Alvin* 12,500 feet below the surface. The ocean floor is littered with fingers of rust sloughed off from the ship.

The Woods Hole team did not find the 300-foot-long gash that has long been held to be *Titanic*'s undoing. Rather, Ballard observed a hole on the starboard side, along with several plates that had been bent inward, springing the rivets. Any additional damage suffered by the bow, whether caused by the iceberg or by impact with the bottom, lies hidden from view in the mud.

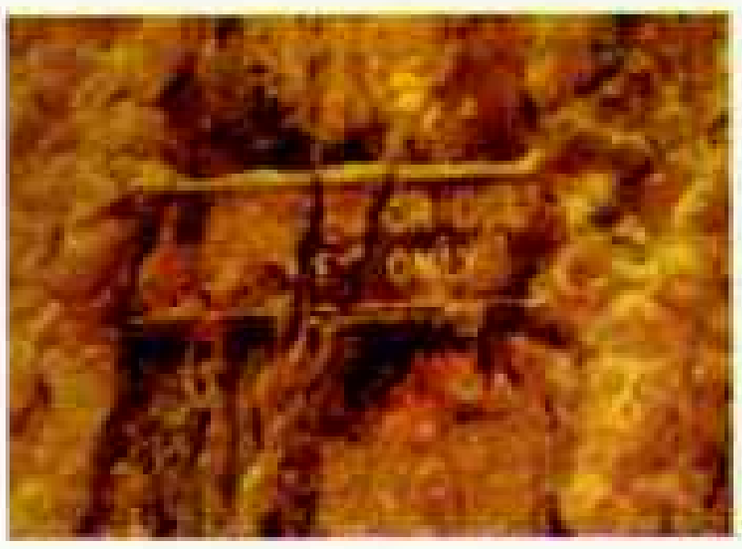
DIAGRAM BY RICHARD SCHLECHT

As if to mock the opulence of *Titanic*'s furnishings, a feathery sea pen sprouts from the side of a skewed brass-and-crystal light fixture (***facing page***) that once was mounted flush to the ceiling.

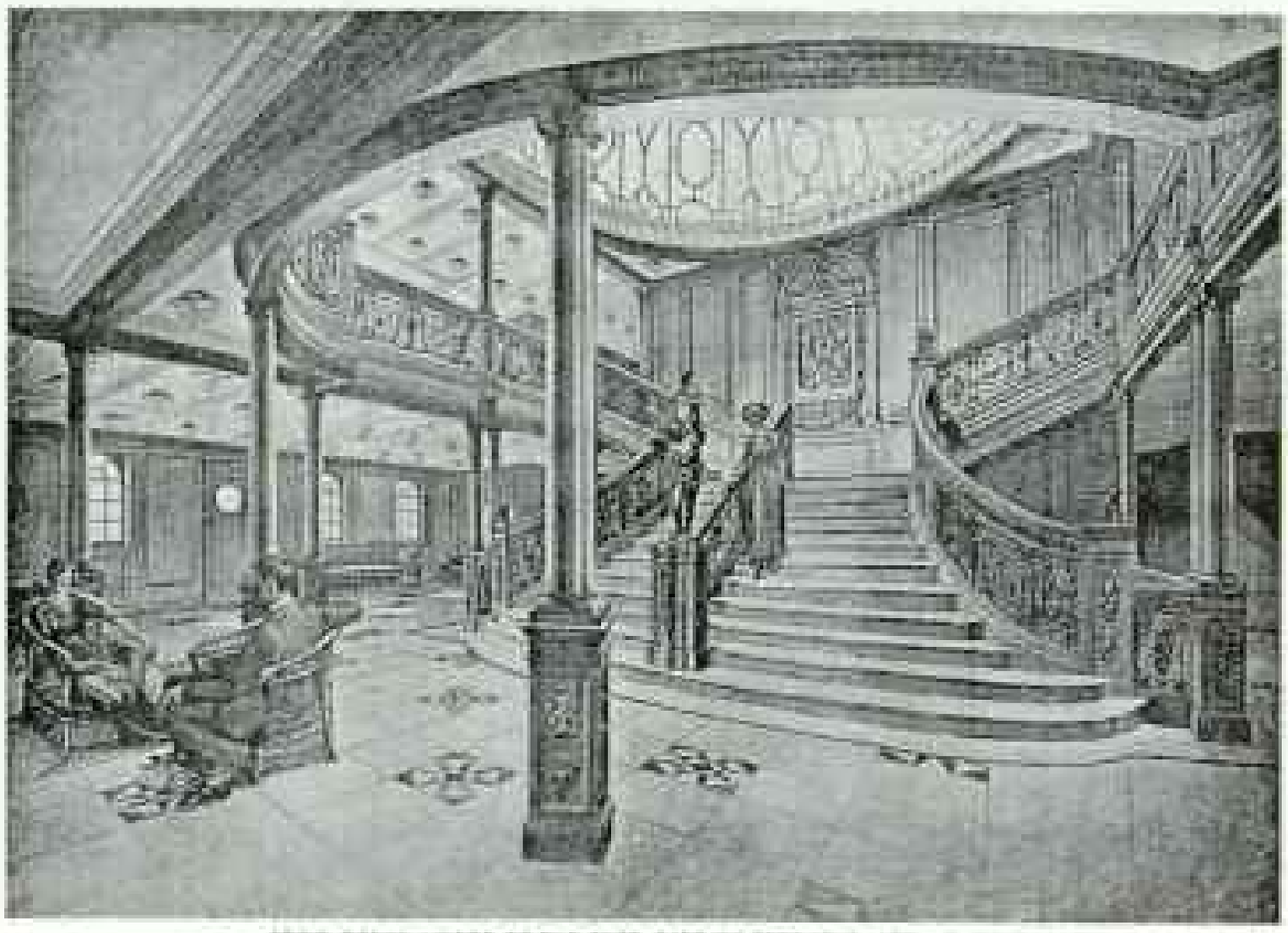
A steel column that was once sheathed in elegant oak is now covered with rust that formed like drippings on a candle (***facing page, lower left***). Handsome features abounded in such lavishly appointed areas as the skylighted grand staircase connecting first-class decks (***facing page, lower right***).

The team obtained these video images by parking *Alvin*, as shown in this sketch (***left***), then carefully guiding *Jason Jr.* down the stairwells. *J. J.* performed the tricky maneuvering "beautifully," according to the author.

Marine organisms, probably hydroids, obscure a brass plate reading "This Door for Use of Crew Only" (***below***), found beside a stairway leading to the bridge.



Though wood borers ate nearly all the wood, some areas near metal were spared. A section of deckhouse roofing remains partially intact (***below***), possibly because oxides bleeding down from the metal plate at top made the wood toxic.



FROM *OCEAN LINERS OF THE PAST*, PATRICK STEPHENS, LTD., THORSONS PUBLISHING GROUP

A curious grenadier fish eyes *Alvin*'s mechanical arm as it pauses above one of hundreds of china cups scattered about in the debris field (***right***). The cups still bear the emblem of the White Star Line, a white star within a red burgee.

The difference in falling time between light and heavy objects in seawater can be read in the juxtaposition of certain debris. A cup and a doorknob assembly came to rest on one of the ship's mammoth boilers after it crashed to the ocean floor (**below**).

Giant tears of rust, dubbed "rustsicles" by the Woods Hole team, make a bizarre figurehead on the bow of the ship (***facing page***). The elongated shapes reflect one way that rust forms in deep areas of the ocean.

For optimum growing conditions, iron-oxidizing bacteria favor a medium more acidic than seawater. To compensate, the bacteria form slime layers between the water and the iron surface. Like hair from a follicle, the slimy rustsicles grow from the metal surface, their fragile material apparently becoming firmer as they lengthen. So long as the metal lasts, the rustsicles grow, finally breaking off of their own weight.

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Disaster drew no distinctions, savaging deluxe quarters as well as the ordinary. A bed's painted footboard (***left***) from a first-class cabin (***center left***) becomes just another piece of twisted wreckage on the debris field.

As the ship assumed an almost vertical position during her plunge, even seemingly secure items were sent flying. A toilet bowl, part of its base broken off (***bottom left***), lies next to a liquor bottle. Rust wins out over the snowy porcelain coat of an iron bathtub (***below***).

A bronze statue of Diana, Roman goddess of the hunt, reposes amid stones deposited by melting icebergs (***left***). *Titanic* experts feel the statue came from one of two sources: a collection for which an art dealer later pressed a legal claim, or the baggage of Margaret Tobin Brown. A colorful millionairess from Denver, she was transporting to a museum three crates of art objects collected in Europe and the Middle East. Mrs. Brown, who took command of a lifeboat, was later celebrated in the Broadway musical *The Unsinkable Molly Brown*.

With a tenacious grip, an eight-inch-wide running light holds fast to its fallen foremast (***right***), now caked with corrosion.

Traces of red antifouling paint are still visible amid the rivets on the hull (***below***), just above the bilge keel. A two-foot-wide skirt of metal running for 300 feet amidships, the keel was designed to reduce the ship's rolling action.

Entwined with rustsicles, the end of the shank and the flukes of one of the ship's three bow anchors protrude from a port-side hawsepipe (***left***).

"While examining the bow, we looked for the name of the ship," Ballard said, "but the paint and the engraved letters themselves were gone.

"There is hardly an inch of exposed upper surface that has not now been photographed," Ballard declared, "but it will take years to totally absorb and understand what we have documented."

During both the initial discovery mission in September 1985 and this expedition, the Woods Hole team was scrupulous about not disturbing *Titanic*. When ANGUS accidentally snagged a piece of cable, Ballard had it thrown back overboard as soon as the vehicle surfaced.

For now, since *Titanic* lies in the open sea, there is no authority to prevent plundering by less sympathetic parties. But Ballard hopes that world opinion will foil any plans to exploit this symbol of an age long past. □

ILLUSTRATIONS TEXT BY CLIFF TARPY EDITORIAL STAFF

THE PALACE THAT BECAME PARLIAMENT

The Palace That Became Parliament

By PATRICK CORMACK

Photographs by ADAM WOOLFITT

IT WAS QUESTION TIME in the House of Commons. As tradition dictates, the Right Honourable Neil Kinnock, leader of Her Majesty's Loyal Opposition, and Prime Minister Margaret Thatcher sat just two sword lengths apart, facing each other from behind thick red lines woven in the carpet.

A few days before, addressing a conference of her supporters, Mrs. Thatcher had replied to critics of her policies by saying that "it wouldn't be spring without the voice of the occasional cuckoo." Pointing an accusing finger, one of Kinnock's supporters demanded to know how many cuckoos there were in the Prime Minister's Conservative Party. Mrs. Thatcher leapt to her feet and made the lightning rejoinder that there were no Conservative cuckoos, though she conceded there might be "the occasional grouse." The Prime Minister's supporters, and many of the public in the packed galleries above, erupted in laughter.

The House of Commons, the lower house of the British Parliament, which also contains the less tumultuous House of Lords, is famous for ready wit—brilliantly subtle or brutally crushing. During the war against the American colonies, one of Britain's least successful but most amusing prime ministers, Lord North, was accused by a boring opponent of being asleep. "I wish to God I was," North retorted.

Some historians trace the origins of Parliament to the Anglo-Saxon witan, the council of wise men who advised the kings of England in the days before the Norman Conquest of 1066. Thereafter a council of noble and ecclesiastical advisers, known as the Magnum Concillium (king's great council), was established. William the Conqueror and his successors often summoned it.

Edward I followed a precedent set by rebel baron Simon de Montfort in 1265, and included representatives of the counties (the knights of the shires) and of the towns (the burgesses from the boroughs) when he summoned his Model Parliament in 1295. This wider body met

(Continued on page 737)

TIME-HALLOWED SITE *along the Thames, the Palace of Westminster has witnessed the evolution of British authority from rule by kings to government by the people in Parliament. Reconstructed after an 1834 fire, the "magnificent pile" incorporates 11th-century Westminster Hall, left. The portcullis badge of Henry VIII* **(above)**, *last king to reside at Westminster, serves as the symbol of Parliament.* JENNIFER WESCLEY

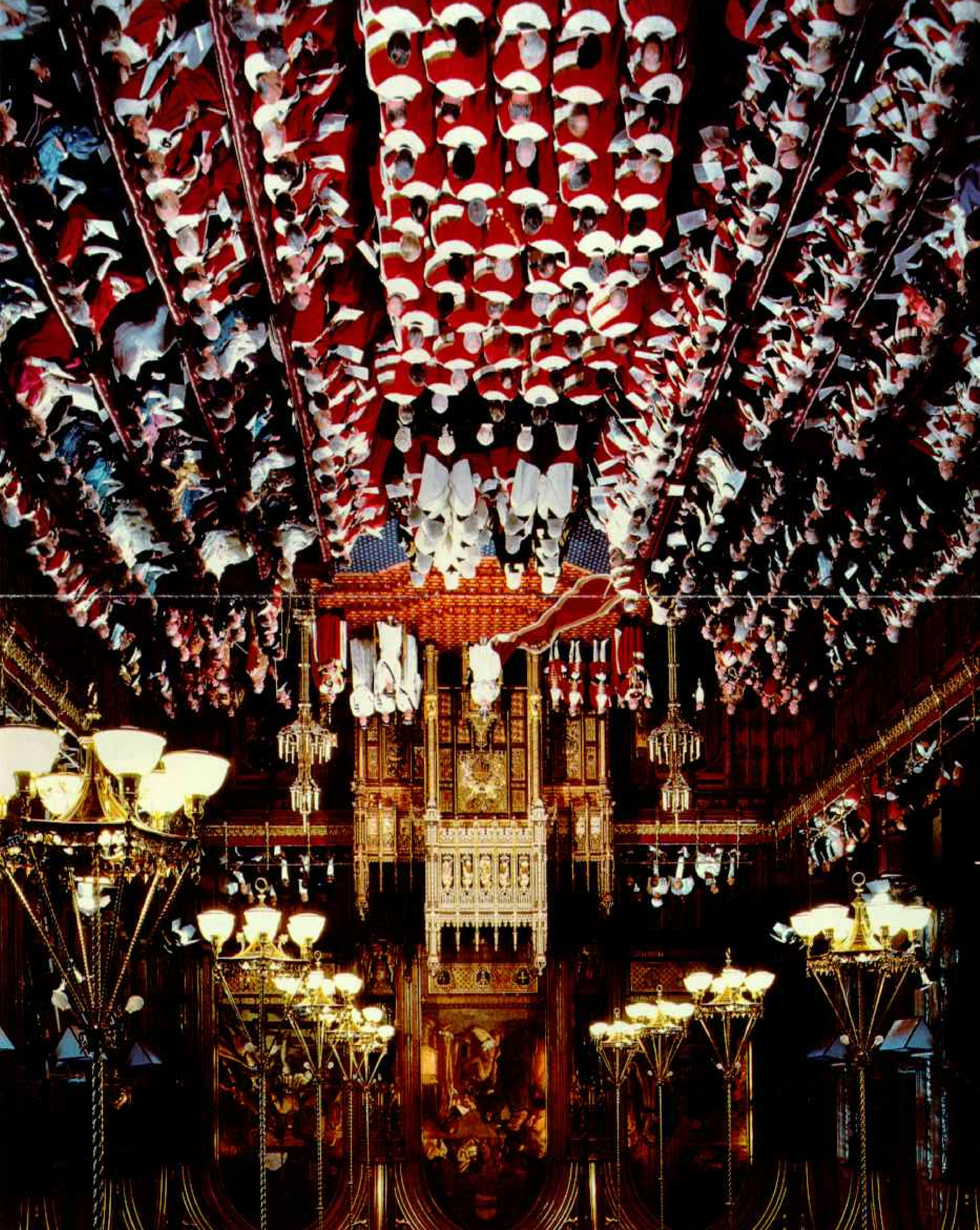
Royal Pomp Before Debate

IN CENTURIES-OLD CEREMONIAL, THE QUEEN OPENS PARLIAMENT

The British monarch, who once summoned Parliament at will, now presides over a ritual with roots in the time of Elizabeth I. Here in November 1985 Queen Elizabeth II (**right**) arrives to open Parliament in the Irish State Coach, first used by Queen Victoria for the 1852 ceremony. The monarch sits on the gilded throne of the magnificent House of Lords (**below**) and reads a speech outlining the legislative program proposed for the coming session. As a constitutional monarch —with the right to consult, to advise, and to warn—the Queen may not express her political opinions, only those of her government, drawn mostly from the majority party in the House of Commons. Thus in 1978 the speech put forth a Labour Party program sympathetic to nationalization, but since 1979 it has announced Conservative Party goals, including denationalization.

ETIENNE BOL (ABOVE)

Attended by Princess Anne, seated to her left, the Queen addresses a prestigious audience: bewigged judges, black-cloaked clerks, and —in scarlet, fur-trimmed cloaks —hereditary and appointed-for-life peers. Custom decrees that wives of peers wear evening gowns with elbow-length white gloves; tiaras are optional. Bishops of the established Church of England sit on the front bench, at left. Behind them are seated ambassadors, wearing formal or national dress. Members of the Commons stand in the back. Millions watch the spectacle on television.

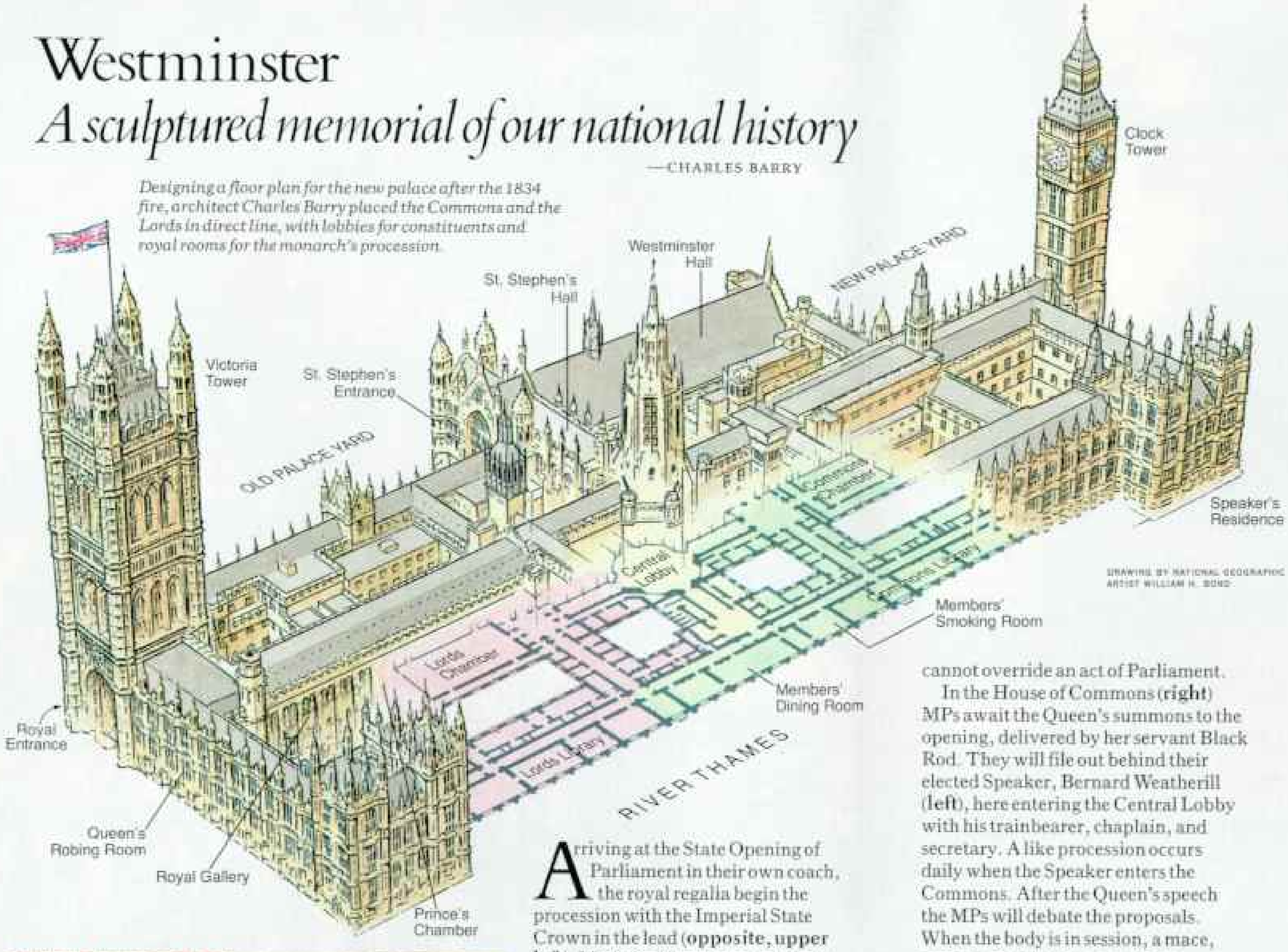


Westminster

A sculptured memorial of our national history

—CHARLES BARRY

Designing a floor plan for the new palace after the 1834 fire, architect Charles Barry placed the Commons and the Lords in direct line, with lobbies for constituents and royal rooms for the monarch's procession.



DRAWING BY NATIONAL GEOGRAPHIC ARTIST WILLIAM H. BOND

Arriving at the State Opening of Parliament in their own coach, the royal regalia begin the procession with the Imperial State Crown in the lead (**opposite, upper left**). Made for Victoria's coronation from older jewels, including a sapphire of Edward the Confessor and pearls said to be from Elizabeth I's earrings, it now also holds a piece of the Cullinan diamond.

Meanwhile at Buckingham Palace, the Queen's London residence, a member of Parliament from the Commons (MP) is entertained with sherry and biscuits, a symbolic hostage against the safe return of sovereign and jewels.

In full-bottomed wigs, senior judges (**upper right**), attending as special guests, chat before the opening. Other judges who are peers—law lords—form the final court of appeal in Britain, but they cannot override an act of Parliament.

In the House of Commons (**right**) MPs await the Queen's summons to the opening, delivered by her servant Black Rod. They will file out behind their elected Speaker, Bernard Weatherill (**left**), here entering the Central Lobby with his trainbearer, chaplain, and secretary. A like procession occurs daily when the Speaker enters the Commons. After the Queen's speech the MPs will debate the proposals. When the body is in session, a mace, symbol of authority, rests on the table and photographers are excluded.

Under the British parliamentary system, the leader of the majority party becomes Prime Minister. First woman to serve in that capacity, Margaret Thatcher sits on the Government Front Bench to the Speaker's right. Members of opposition parties sit across the aisle. During heated debates, which often become shouting matches, MPs may not step across the red lines in the carpet—two sword lengths apart.

Destroyed by a German air raid on May 10, 1941, the Commons Chamber was rebuilt to its 19th-century dimensions, though it seats only about 430 of the 650 MPs.

ERIC ROBERTS, WESTMINSTER PRESS (ABOVE)

JOHN BULMER (ABOVE); CROWN COPYRIGHT RESERVED (BELOW)

(Continued from page 728) infrequently, but by the 16th century whenever members of the Lords were convened, so was the Commons. During the 17th century, at a time when throughout Europe absolute monarchs claimed to rule by divine right, here at Westminster Parliament successfully challenged the concept, and in the centuries since, the modern constitutional monarchy evolved.

Today's visitors to the Commons would recognize the description of a German visitor who listened to a debate during the American Revolution and expressed surprise at seeing "the whole of the British nation assembled in its representatives, in a rather mean looking building. . . . The Speaker, an elderly man dressed in an enormous wig . . . sat opposite me on a lofty chair. The Members have nothing particular in their dress. . . . It is not at all uncommon to see a Member lying stretched out on one of the benches while others are debating." Some might say that the only difference wrought by the passage of two centuries is that today's members do not "crack nuts . . . eat oranges or whatever else is in season." Certainly the Speaker still wears his full-bottomed wig and a costume that remains virtually unaltered.

MICHAEL ST. MAUR SHEIL (FACING PAGE)

FIRST AMONG EQUALS, *Margaret Thatcher with members of her cabinet (**facing page**) awaits the opening. On Tuesdays and Thursdays the Prime Minister takes questions. A bronze bar (**above**) marks the area where MPs debate. Anyone disciplined for misconduct can be reprimanded by the Speaker before the bar.*

THE PALACE OF WESTMINSTER, standing between the River Thames and Westminster Abbey, has long been Parliament's home. There has been a palace here since the reign of Canute, the Danish King of England, who died in 1035. The first palace burned down before 1042, but Edward (known as the Confessor because of his reputation for piety), replaced it. After Edward's death in 1066 and the last successful invasion of England, the invader, William the Conqueror, established his main residence at Westminster. It was the Conqueror's reckless and boastful son, William II, called William Rufus because of his red beard, who built Westminster Hall. Braggart that he was, William Rufus denounced the completed structure as "a mere bedchamber" compared with what he had intended.

King Richard II, who came to the throne in 1377 and was deposed in 1399, was responsible for the Hall as we see it today. He ordered the replacement of the roof, and of the rows of columns that supported it, by a feature that was the wonder of its age and is still one of the glories of European architecture—the mighty hammer-beam roof, spanning the Hall in one prodigious leap.

Here medieval statues of England's kings still look down upon the place where Richard was deposed and Charles I stood trial 250 years later. For almost 700 years kings came to the Hall after their coronations in nearby Westminster Abbey for a celebration banquet. At the coronation of George IV in 1821, 17,000 pounds of beef,

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Patrick Cormack is a member of Parliament and a former academic who has written on architecture and other subjects. Photographer **Adam Woolfitt**, also a Briton, has contributed to 15 previous GEOGRAPHIC articles.

"A SPECTACLE . . . *horridly beautiful.*" *Thus a spectator described the fire that consumed most of the Palace of Westminster on October 16, 1834. It started when workmen burned a centuries-old collection of tax receipts—split wooden wands like these (**right**). A broadsheet later reported the crowd's sentiment: "Damn the House of Commons, let it blaze. But save, oh save, the Hall!" Firemen pumped valiantly, and miraculously by morning the medieval Westminster Hall and Westminster Abbey, at left, still stood.*

The fire destroyed the palace, clearing the way for total reconstruction.

TULLY GRAUGHT, BBC-TV

In the crowd that witnessed the blaze stood the men who would redesign the palace, Charles Barry and A. W. Pugin.

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EARLIEST PARLIAMENTS *were called to Westminster by kings seeking advice, support, and money. In a 16th-century manuscript painting of a 13th-century council (**left**), King Edward I heads a table of archbishops and royalty of Wales and Scotland. On red woolsacks, representing England's then major commodity, sit the Lord Chancellor—as he does today—and judges. Lords spiritual (bishops and abbots) align on the left, lords temporal (hereditary earls and barons) on the right. On a crossbench is the Commons.*

PETER JACKSON COLLECTION (TOP); THE PEPYSIAN INDEX

POLITICAL STRUGGLES *of the 17th century pitted Parliament against crown and brought a commoner, Oliver Cromwell, to power. He signed the death warrant of King Charles I and, through the Commons, abolished the Lords. When the Commons, meeting in St. Stephen's Chapel in 1653 (**left**), would not adjourn, he expelled it. Needing money, Cromwell was forced to reconvene Parliament; after his death, members supported restoration of the monarchy and invited Charles II to take the throne.*

veal, and mutton were consumed, together with a vast quantity of sweetbreads, cows' heels and calves' feet, 160 geese, 1,160 chickens, 1,730 pounds of bacon, 160 dishes of fish, and more—all washed down with more than 4,000 bottles of wine.

Until 1882 England's royal law courts were housed in Westminster Hall, and it was here that most of her great state trials were held. One of the first was that of Sir William Wallace, leader of Scottish resistance. In 1305 Wallace was brought to the Hall in chains and charged with treason to Edward I, "the Hammer of the Scots." Wallace's defense was simple. "I cannot be a traitor to Edward," he said, "for I owe him no allegiance. . . . As governor of my country I have been enemy to its enemies. I have slain the English. I have mortally opposed the English king." His eloquence and logic availed him nothing. He was condemned to suffer the foul indignities of a traitor's death—he was disemboweled, beheaded, his heart burned, his body quartered, his head displayed on London Bridge.

BBC HULTON PICTURE LIBRARY

HEAVYWEIGHT BOXER *and popular pub owner Benjamin Caunt is believed by many to be the man whose name was given to the giant bell made in 1856 for Westminster's Clock Tower* ***(facing page)****. Others claim the bell was named for Sir Benjamin Hall, First Commissioner of Works. That bell cracked, and a smaller, 13-ton Big Ben, also bearing a crack, has tolled since 1862.*

Westminster remained the main home of England's monarchs until damaged by a fire in 1512, after which Henry VIII moved his court to Whitehall Palace. Kings had always summoned their parliaments wherever they were in residence, and because Westminster had been the principal royal home, it had become the principal seat of Parliament. Initially the Commons had no fixed meeting place. Unlike the Lords, who had sumptuous, though not very comfortable, apartments, the Commons had to sit wherever its members could find themselves a room if they wanted to meet separately. But in 1547, during the religious upheavals of the English Reformation, Henry VIII's successor, the young boy-king, Edward VI, gave the by-then-deserted St. Stephen's Chapel within the palace to his "faithful Commons."

Members of the House of Commons sit facing one another, rather than in a semicircle as in so many legislatures. That is because their predecessors occupied the pews of St. Stephen's, opposite each other across a central aisle. This arrangement led also to those two red lines in the carpet, and in turn to a familiar figure of English speech. Members who "overstep the mark" are out of order.

The first inhabitants of the new chamber also placed a chair where the altar had been for their Speaker to preside over their proceedings, and according to some historians the custom of bowing to the Speaker derives from the former practice of genuflecting to the altar. As spokesman for the Commons, the Speaker often had to tell the king what he did not want to hear, not an enviable position. To this day, whenever a new Speaker is elected, he puts up a token show of resistance as he is installed in the chair.

IN THOSE EARLY DAYS power still rested with the king and his closest advisers, all of them important courtiers or powerful bishops—the lords temporal and spiritual. But within a little more than 200 years of the move to St. Stephen's the balance had shifted far enough for Admiral Rodney, the hero of victories over the French, the Dutch, and the Spanish, and a former and aspiring member of

HISTORIC PRECINCT *of English law, Westminster Hall hosts delegates to the American Bar Association's 1985 convention as they join British counterparts to pay tribute to a common heritage. To this great hall that accommodates 2,000*

people, early kings called the councils that gave birth to Parliament and to the law courts that met here for centuries. During repairs of the extraordinary hammer-beam roof, tennis balls turned up, possibly from the games of Henry VIII.

Parliament, to write in 1780: "To be out of Parliament is to be out of the world and my heart is set upon my being in."

Not that election to the Commons signified any great personal triumph in the days when many boroughs had so few people qualified to vote that they were known as rotten or pocket boroughs, either because their electorates could easily be bribed or because they were in the gift of some wealthy landowner who himself sat in the House of Lords. Not until 1928, after a series of parliamentary reform bills spanning a century, was every man and woman over the age of 21 given the right to vote. Today every Briton over 18 has the vote.

In 1909 the unelected House of Lords vetoed Liberal Chancellor of the Exchequer David Lloyd George's reforming budget, and so the 1911 Parliament Act took away the Lords' authority even to discuss financial measures and removed its power to veto other legislation. Although the Lords must approve proposed legislation before it becomes law, it can now delay Commons proposals for only a year.

FRIENDS OFF THE FLOOR, *Conservative MP Alistair Burt, at right, visits Labour member Anthony Blair to discuss issues, as they did at Oxford University. "Such trust is invaluable in making democracy work," says Burt. MPs usually share one-room offices and make do on a $30,000-a-year allowance for staff and equipment.*

Although many of the most active members of the Lords are those who have been ennobled for distinguished service in politics, the services, or the professions for their lifetime and are known as life peers, all Britain's hereditary peers—the heirs of those ennobled over the centuries—as well as the law lords, are entitled to sit in the upper house, together with the 26 senior bishops of the Church of England, who are known as the lords spiritual.

The House of Lords maintains its ancient judicial functions. Although no trials take place there, it is the United Kingdom's highest court and provides the judges for the final court of appeal for some countries in the Commonwealth. In the House of Lords the Lord Chancellor, Britain's senior judicial figure, sits on the woolsack, as his predecessors have done for seven centuries. A seat stuffed with wool long seemed the appropriate chair for the king's chief adviser, for it emphasized that the country's prosperity rested on the wool trade (page 738).

Tucked away near the door to the Terrace of the present palace—still, as in Victorian days, the most desirable place to take tea in London in the summer—is a glass case with some wooden sticks in it. These "worm eaten, rotten old bits of wood," as Charles Dickens, perhaps the most famous of parliamentary reporters, called them, were responsible for the great fire of 1834 that virtually destroyed the old palace. For seven centuries, notched tally sticks—pieces of hazel or elm split down the middle, one half being retained as a record of payment, the other half being given as a receipt—were the official means of recording payments to the exchequer. Their use was abandoned in 1826. As Dickens had it, "they had never been useful, and official routine required that they never should be, and so the order went forth that they were to be privately and confidentially burnt."

On October 16, 1834, two hardworking stokers overfed the furnaces below the

House of Lords with piles of this ancient tinder. The palace ignited, and by the next morning almost all that was left was smoldering acres of gutted masonry. By a massive effort, the Hall was saved (pages 738-9).

The Palace of Westminster we know today—a "dream in stone," in the words of Tsar Nicholas I of Russia—is the product of an amazing collaboration between the architect Sir Charles Barry and the eccentric, brilliant Augustus Welby Pugin, who had been commissioned to design furniture for the royal castle at Windsor at the age of 15. After the fire Barry won the competition to build the new palace "in the Gothic or Elizabethan style" and engaged Pugin to assist him. The overall design for the new palace was Barry's, while Pugin was responsible for almost all its ornamentation.

Parliament squabbled over the cost of construction. Members questioned every estimate, and every delay led to a further increase in cost. They even argued over the architect's fee. Laborers went on strike. Not until 1840 was Mrs. Barry able to lay the foundation stone, after the architect had created a concrete raft on which the vast building, covering some eight acres, would be erected. In 1845 Barry wrote to Pugin in exasperation that he was "in a towering rage and in the right humour for throwing up my appointment at the New Palace."

BARRY HAD BEEN DEAD for two years, and Pugin for eight, by the time Big Ben was regularly tolling in 1862. Barry's design created the most imposing legislative buildings of the 19th century, but his palace confronts its current occupants with even worse problems of overcrowding than the old one presented. Though Westminster Hall can comfortably seat 2,000 on great ceremonial occasions, as when Parliament assembled to present loyal addresses to the Queen on the occasion of her Silver Jubilee in 1977, the palace itself cannot house the 3,000 who work there in anything approaching comfort. Fewer than one-third of the members have offices of their own, and every secretary has to share a room, usually a very small one.

That the chamber of the Commons itself is congested is, however, a matter of choice and tradition. When German incendiary bombs fell on the palace on May 10, 1941, the chamber was destroyed. Prime Minister Winston Churchill and his colleagues in all parties insisted that it be replaced in as faithful a style as possible and not enlarged, even though there were seats for only two-thirds of the members. The theory was that when few were present, the chamber would not look empty, and when many attended, the tenseness of the atmosphere would match the importance of the occasion.

Elizabeth I (1558-1603) dismissed her Commons with lofty disdain, saying, "they had small experience and acted like boys." The boys grew up remarkably quickly. In one of the lobbies of the Commons where members record their votes reposes a copy of one of Parliament's proudest possessions—the journal mutilated by James I, Elizabeth's Scottish successor, when he angrily rejected a protest of 1621 in which

FOES IN THEORY: *Conservative Chief Whip John Wakeham, at left, and his Labour counterpart, Derek Foster, urge MPs from their respective parties to attend, especially for voting. In practice the two work together to schedule business and voting, assuring the smooth working of the Commons. Their title derives from whippers-in, who help control the hounds on the hunt.*

SPREADING OUT, *Lord Home shuns his two-person office for the Royal Gallery to discuss mail with his secretary, Lady Home (**right**). His half-century career in Parliament has included a rare crisscrossing of the Central Lobby. In 1931, as Alexander Douglas-Home, he was elected Conservative MP. When his father, a hereditary earl, died in 1951, he quit the Commons for the Lords, then disclaimed his peerage in 1963 when his party asked him to stand for election to the Commons to become Prime Minister. In 1974 he was made life peer, Home of the Hirsel.*

GETTING A PROPER FIT *by a London tailor, Brigadier David Stileman (**above**) orders court dress for his job as yeoman usher, deputy to Black Rod. "The right shoulder gets shiny rather quickly," he notes, worn smooth by the mace he carries daily into the Lords Chamber.*

*In the Royal Gallery (**right**) Black Rod, Air Chief Marshal Sir John Gingell, and Brigadier Stileman, both in jabots, pose for a rare group portrait with the doorkeepers—two in scarlet swallowtail coats. The office of Black Rod dates from 1350, when Edward III appointed a doorkeeper with an ebony wand for meetings of the Knights of the Garter. The doorkeepers —most of them retired military men—politely police the House of Lords.*

Today's 790 hereditary lords, 26 lords spiritual, and nine law lords have, since 1958, been joined by the life peers, currently numbering 365, chosen from all walks of life by the Prime Minister and named by the Queen. About 250 peers regularly attend to debate and amend bills but cannot veto them. Some Labour MPs would like to see the Lords abolished.

the Commons sought to assert its rights. James was a clever man but a weak king—"the wisest fool in Christendom."

But he had more guile than his son and heir, Charles I, whose arrogant insistence on divinely derived infallibility made him incapable of coming to terms with a Parliament that wanted a fundamental place in the constitution. Events came to a head one cold January day in 1642, when Charles brought a posse of soldiers to arrest five members of the House who had caused him particular offense by asserting the rights of the Commons. When the king asked where his tormentors were, Mr. Speaker Lenthall, not known before that for his courage or distinction, uttered the most famous words ever spoken in Parliament: "I have neither eyes to see, nor tongue to speak in this place but as this House is pleased to direct me." The king went away, and since that day no monarch has been allowed into the Commons, and the royal messenger must knock to gain entry. The dents in the outer door have been made by the Gentleman Usher of the Black Rod, who comes from the House of Lords to summon the Commons to attend upon the monarch at the State Opening of Parliament.

LORD HIGH CHANCELLOR, *Lord Hailsham of St. Marylebone oversees the nation's judicial system, serves in the cabinet of the prime minister who selects him, and presides over the Lords. He carries the Queen's opening speech in an embroidered purse in the royal procession, which passes through the Prince's Chamber* (**facing page**), *dominated by a statue of Queen Victoria.*

ALTHOUGH its overriding political purpose is to debate the Queen's speech, written for her by her ministers, the State Opening of Parliament is the most solemn, splendid, and colorful of Britain's annual ceremonies. It is a ceremony, moreover, for which the three most ornate and impressive rooms in the palace were specifically designed. In the Robing Room, decorated by William Dyce's five great frescoes based on the Arthurian legends, the Queen puts on her crown and robe before walking through the Royal Gallery, the largest apartment in the whole palace, to the Chamber of the Lords, where she takes her seat on the throne.

The Royal Gallery is more than a grand processional route. This is where chiefs of state address both Houses of Parliament. President Reagan spoke here in 1982; in 1984 it was the turn of President François Mitterand of France, and in 1986 both King Juan Carlos of Spain and President Richard von Weizsäcker of West Germany have addressed the assembly.

A laconic entry in the Journal of the House records that on November 5, 1605, "This last night the upper house of Parlyament was searched by Sir Tho. Knevett, and one Johnston servant to Mr. Thomas Percye was there apprehended who had placed 36 barrelles of gunpowder in the vault under the house with a purpose to blowe the King and the whole company, when they should there assemble." This was the famous Gunpowder Plot, a scheme devised by a group of Roman Catholic opponents of James I to bring England back to the "true faith" by destroying the king and his Parliament at its State Opening.

Johnston was in reality one Guido Fawkes, or, as he has been known to schoolchildren ever since, Guy Fawkes. A Yorkshireman and a convert to Catholicism, he had served in the religious wars in the Low Countries and was a trained mining engineer. Under torture Fawkes revealed the names of fellow conspirators and was

sentenced to death. To this day November 5 is remembered as Guy Fawkes Day, and his effigy is burned on thousands of bonfires. And still, before every State Opening of Parliament, royal bodyguards search the cellars of Westminster.

I WAS FIRST ELECTED to Parliament in 1970 after a campaign that was typical for a British parliamentary candidate, but that would seem very short, and very inexpensive, to a U. S. congressman. By law British election campaigns are limited to approximately three weeks. The amount that a candidate can spend to get his message across is strictly limited too; it worked out in the last election, in 1983, to approximately £4,000 ($6,200). My own election was a particularly exciting affair for me. It was my third attempt to enter Parliament, and I faced a sitting Labour member of 25 years' seniority. With an electorate of about 80,000, I emerged the victor by 1,500 votes.

MAKING WESTMINSTER A FAMILY TRADITION, *David Trippier, M.P., and his wife, Ruth, a barrister, have their son Edward baptized by Canon Trevor Beeson (**facing page**) in the Chapel of St. Mary Undercroft, restored after the 1834 fire. At the reception (**above**) Speaker Weatherill toasts the godparents.*

Our system does not have primary elections. Candidates are chosen by a party caucus within each constituency, or district. Unlike our U. S. counterparts, members of Parliament do not have to be resident in their constituencies in order to qualify for selection, or even after winning election, though many of us have our principal homes there, returning, just as congressmen do, throughout the year.

When I was elected to the House of Commons, the only recognition of secretarial needs was a yearly allowance of £500. Today it is about £20,000, barely enough to cover equipment and a staff of two, and so, like many of my colleagues, I frequently have to collect and open the mail with which every member's day begins. It will generally take me two hours to deal with the demands and problems of constituents: difficulties with government departments, political grievances, invitations, vast batches of entreaties lobbying my support for causes worthy or bizarre.

Never a day goes by without its quota of committees—party and all-party committees covering every subject, as well as the official parliamentary committees. The standing committees consider in detail legislation after it has been approved in principle by the House, and the select committees monitor the works of government departments. As a very new member supporting a Conservative government with a small majority, I would often spend more than ten hours a week on standing committee work. And very boring it was, for government supporters assist by keeping quiet, so as not to provoke the opposition into making even longer speeches, for their only real power is the power of delay.

On the mornings when I am not attending committees, I often have parties of constituents to show around the House. Sometimes I have uninvited guests too, for electors who want to see their members must be admitted to the palace unless they are part of a mass lobby or demonstration. Because my constituency of South Staffordshire is four hours away, casual callers are few, though I have my share of eccentrics—like the couple who had spent the night on the Thames embankment.

JOHN BULMER (RIGHT)

REGAL SETTING *of the Royal Gallery was designed by architect Barry expressly as a stage for the passage of the monarch's procession at the State Opening of Parliament. Queen Elizabeth II donned the robe and three-pound crown in the Robing Room and now proceeds (**right**) behind other regalia, the Sword of State and the Cap of Maintenance, to the Lords. Pages of honour, lifting her heavy train by handy loops, walk ahead of Princess Anne for the 1985 opening. Flanking yeomen of the guard earlier searched the basement in a ritual recalling the timely discovery of gunpowder placed by Guy Fawkes, who tried to blow up Parliament on opening day in 1605.*

*The wealth of decoration in the 110-foot-long, 45-foot-high gallery (**above**) demonstrates the painstaking skill of woodworkers, glass and metal crafters, painters, and tilemakers, who executed the designs of Barry's assistant, Augustus Welby Pugin. With the Queen's permission, the gallery hosts other functions, such as joint sessions for visiting chiefs of state. French presidents must blanch at the 45-foot-long historical frescoes depicting events during the 19th-century British victories over the French by Nelson at Trafalgar and Wellington at Waterloo.*

Few mornings pass without a call or a visit to the Library. Barry provided a suite of handsome rooms for the Lords and Commons libraries, and splendid dining rooms too. It seems remarkable to think that the old palace possessed neither, though in 1818 a small room was set aside for a tiny collection of books, and in 1773 John Bellamy, the new deputy housekeeper, began to provide food for members. Whether Prime Minister William Pitt called for one of Bellamy's meat pies with his dying words in 1806 is doubtful, but by the early 19th century Bellamy's was a well-established institution, the young Dickens describing one of the regulars as "a complete walking reservoir of spirits and water."

THIS GUY'S FOR BURNING *on Guy Fawkes Day, November 5, by children who fashion effigies and beg coins in memory of the traitor.*

*The clublike Lords Library (**facing page**) offers old references—and computer terminals. Victoria Tower houses all acts of Parliament since 1497; these and custom form the law in Britain, which has no written constitution.*

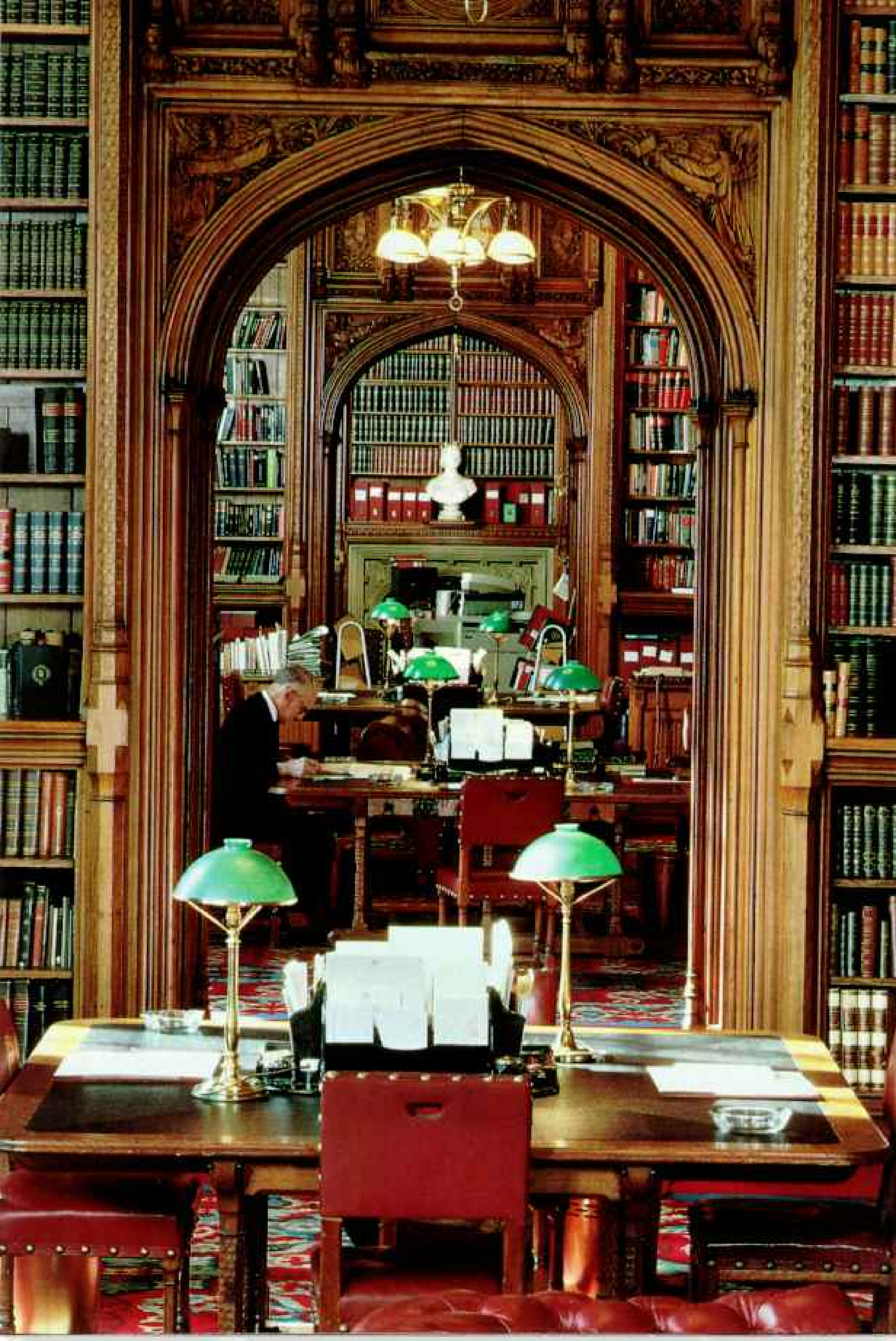
In today's Commons dining room Conservative members of Parliament sit at one end, while members of the Labour Party sit at the other, with the Liberals and the Social Democrats in the middle. But, as with so much else in Parliament, this is convention rather than rule. I remember one night when, in a gesture of defiance, a group of Labour members took over the prestigious corner table at the Conservative end that is always reserved for the party's chief whip, the member who is in charge of getting the government's business through the House. As a lighthearted indication of our displeasure, a group of us sent over four large vodkas. Not a word was said, but a few minutes later we were presented with four large cognacs.

ON THE STROKE OF 2:30 each afternoon (9:30 on Friday mornings) when the House of Commons is sitting, a small procession, led by the principal doorkeeper and consisting of the Sergeant at Arms, the Speaker and his trainbearer, his secretary, and his chaplain, enters the chamber. The Sergeant at Arms carries the mace, symbol of the Queen's delegated authority, which rests on the table when we are in session and under it when the House goes into committee.

The same prayers have been said in the chamber for more than 300 years, and regular attendance does not necessarily indicate piety. We do not assign seats in the House of Commons, and the only way a member can lay claim to a particular place is to be there for prayers. If you then put a card on the seat, by custom that place remains yours for the day.

The Houses' spiritual needs were catered for by Edward Barry, Charles Barry's son, who created a lovely chapel in the crypt beneath St. Stephen's Hall, the site of the old chapel. The crypt had survived the fire, but Barry adorned almost every inch of it and created the most beautiful Victorian Gothic place of worship in England. Members meet here for occasional services, and they and members of their families can be married here. The glorious Baptistry, its marble font encrusted with semiprecious stones, is the favored place for the baptism of members' children. My younger son was christened there in 1972.

On Tuesday and Thursday afternoons between 3:15 and 3:30 the Prime Minister is obliged to come to the chamber to face a series of probing questions and vehement accusations from opponents, mixed with helpful suggestions from supporters. It makes the press conferences through which most heads of government



communicate with their electorate seem like sedate and formal audiences, for here in Westminster the Prime Minister is merely regarded as leader of a cabinet of ministers, first among equals. All members of the cabinet must face this cross-examination by colleagues, for on every day but Friday, when members leave early for their constituencies, business in the Commons begins with an hour of questions.

Following questions, and any ministerial announcements by the government, the House begins the day's debate, often on a motion highly critical of the government. At least one day a week has to be given over to the opposition. Traditionally known as supply days, these are a reminder that the original function of the Commons was to grant or withhold revenue. If you want to speak, you stand in your place, hoping to catch the Speaker's eye—often a frustrating exercise. Until 1685, when Sir John Trevor was called to the chair, the practice was for the Speaker to point at a member, but Sir John's squint made it difficult to know who was indicated and so began the calling of members by name. The Speaker is the only person who can do so. We must refer to each other by our constituencies or offices so that the Prime Minister is "My Right Honourable Friend the Prime Minister," and I am "The Honourable Gentleman, the Member for South Staffordshire."

In deciding who will speak, the Speaker has to balance his choice so that every point of view, however unpopular, may be expressed, and in calling members, he alternates between the government and opposition sides. His power does not stop there. If a member persistently disregards the rules of order, he can be "named," a process that invariably results in his suspension from the House. Sometimes the Speaker will be deliberately blind and deaf in order to deny a publicity-seeking member this brief notoriety.

Members record their votes by emerging from the Aye or No Lobbies and bowing to the tellers who do the counting. It all sounds very cumbersome, but it does mean that we meet several times a week, and this helps preserve the intimacy and the conviviality of the House, a conviviality that is often continued after the vote in the Members' Smoking Room, the room that former Prime Minister Harold Macmillan called the second most important in the palace.

Until the 19th century there were no official reports of Parliament's debates, but there was nevertheless an army of reporters, including Dr. Samuel Johnson. He compiled fascinating accounts of debates based on hearsay, a fertile imagination, and a greater command of rhetoric than even the most eloquent of orators.

One night in 1670 Sir John Coventry, a member possessed of robust independent views, was set upon by footpads on his way home. The suspicion was that the ruffians were acting on the king's orders, but such was the danger of the London streets at that time that it became customary for members to gather together and, led by a torchbearer, to make their way to their houses. To indicate that business was over, the cry "Who goes home?" would echo through the old palace.

Even today when the House rises, the policemen stationed in the lobbies take up the same cry, "Who goes home?" Another parliamentary day is over. □

IN A DEFIANT *"never surrender" stance, Winston Churchill in bronze (**facing page**) guards the entry to the Commons. The arch, damaged by a World War II air raid, was preserved at his urging "as a monument of the ordeal which Westminster has passed through." In another bow to the past, sword loops hanging in the Commons cloakroom (**above**) remind that no member can enter the chamber armed.*

Much More Than Met the Eye

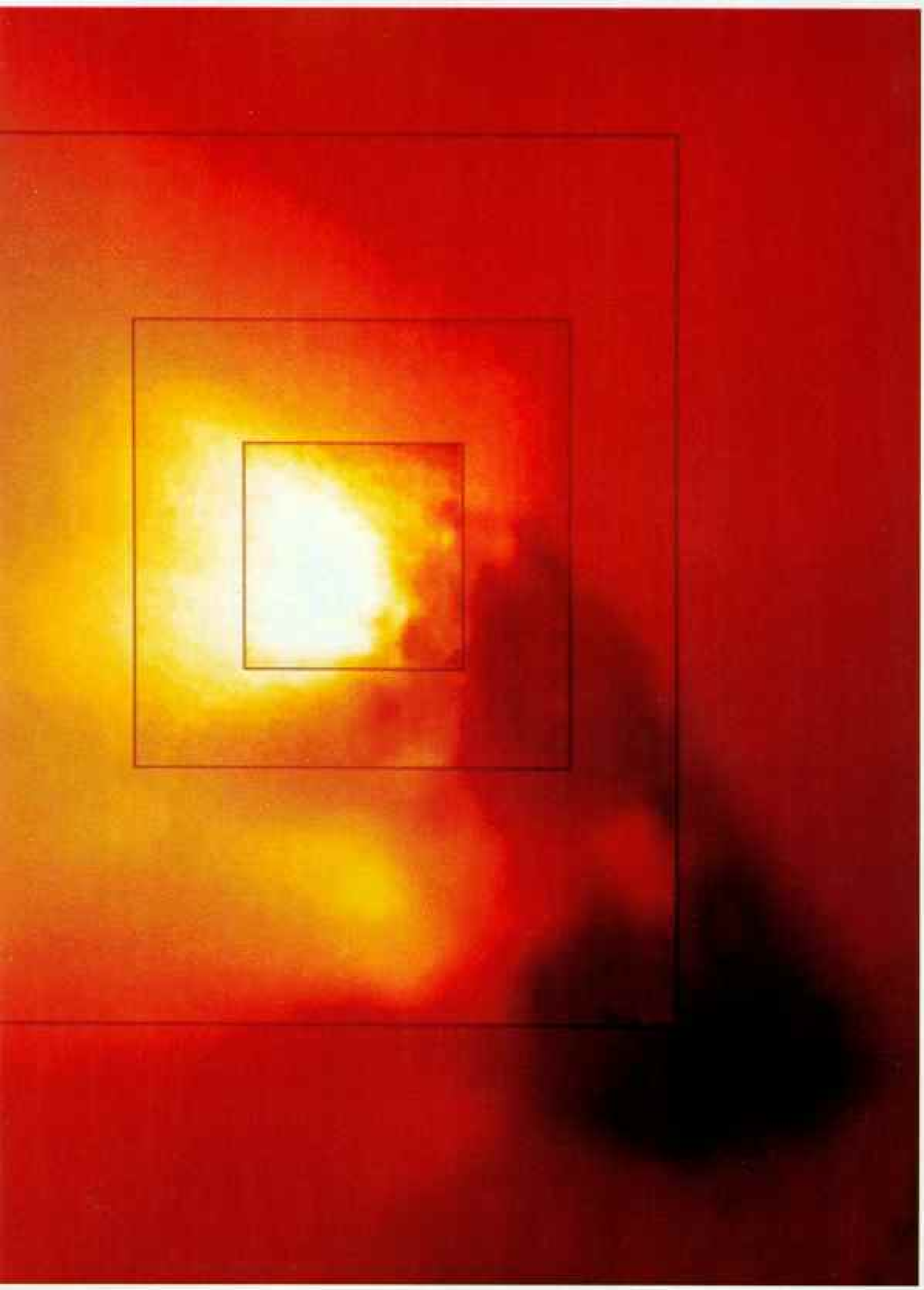
HALLEY'S COMET '86

By RICK GORE
ASSISTANT EDITOR

IN THE MID-1940S the bare, icy nucleus of Halley's comet was drifting in dark silence far beyond the planet Neptune. Its glory extinguished by deep cold, the comet was feeling gravitational tugs from the distant sun, tugs that would pull it back, ever accelerating, into the inner solar system.

Four decades later, in January 1985, the comet was passing Jupiter, hurtling toward the asteroid belt at 18 kilometers a second. At Hawaii's Mauna Kea Observatory a man who was not even born when the comet made its turnaround was sitting cold and tense at the eyepiece of a 61-centimeter (24-inch) telescope. Breathing oxygen to improve his concentration at Mauna Kea's heady summit, Steve O'Meara (left) was pursuing an improbable dream. He wanted to be the first person in 76 years to lay eyes on the comet on its 30th recorded return.

Others already had located the celebrated itinerant electronically. O'Meara, known to fellow amateur astronomers as the "faint-star wizard," was pressing the limits of human vision. With his naked eyes O'Meara had seen objects 15 times fainter than the distant planet *(Continued on page 765)*



THIS MOSAIC OF IMAGES WAS TAKEN BY THE HALLEY MULTICOLOUR CAMERA ON BOARD THE EUROPEAN SPACE AGENCY (ESA) SPACECRAFT GIOTTO AS IT FLEW BY HALLEY ON MARCH 14, 1986. THE CLOSE-UP (CENTER) WAS MADE DURING CLOSEST APPROACH, JUST BEFORE THE CAMERA WAS KNOCKED OFF TARGET. JONATHAN BLAIR, WITH IMAGE PROCESSING BY K. WICHELM.

A cosmic celebrity blazes across the Milky Way above Australia, a prime viewing arena for the 1986 visit of Halley's comet. Ever since Edmond Halley in 1705 predicted the comet's reappearance every 76 years, each visit has found man more knowledgeable about his universe. Most scientists believe comets are fragments left over from the creation of our solar system 4.6 billion years ago. And comets may have seeded earth with organic molecules that make up the building blocks of life.

Technology finally met a comet face-to-face in 1986. History-making images of Halley, taken as one spacecraft sped to within 605 kilometers of the nucleus, reveal a peanut-shaped snowball 16 kilometers long. The jets of sunlit dust and gas had been expected, but many scientists were startled by the size of the nucleus—much larger than predicted—and the color of its granulated crust—darker than the blackest paint on earth.

AKIRA FUJII

1 *The planets of our solar system accreted from a rotating disk of dust and gas. Far from the newborn sun, trillions of small icy leftovers —comet nuclei— orbited in a great mass of cometary material called the Inner Oort cloud.*

2 *The gravitational pull of Uranus and Neptune catapulted Halley and other comets from the plane of the solar system outward into an enormous sphere— the outer Oort cloud —still faintly in the grip of the sun's gravity.*

A cometary odyssey

Halley's spectacular journey through our solar system is a homecoming of truly cosmic proportions. According to current theory, as our solar system was forming, the comet was ejected, along with trillions of other icy nuclei, to the far frontiers of the sun's gravitational field. There it remained in an interstellar deep freeze called the Oort cloud (for Dutch astronomer Jan Oort) until a passing star nudged it from its fragile orbit and sent it plunging toward the inner solar system. Jupiter's gravity deflected it into its periodic solar orbit.

3 *If the two distant and diffuse Oort clouds could be seen, the entire solar system might look like this: a gigantic outer sphere enveloping an inner disk surrounding a tiny dot. That dot represents the sun and its nine planets.*

4 *Several times every million years on average, a star wanders near the outer Oort cloud, sometimes even penetrating it. The star's gravity in effect drills a hole through the cloud, scattering comets in all directions. Some —perhaps fifty million— are launched toward the inner solar system.*

PAINTING BY DAVIS MEITZER FROM DATA PROVIDED BY PAUL WEISSMAN, JET PROPULSION LABORATORY

5 *A very few comets passing through the solar system, including Halley, are deflected by Jupiter's gravity into orbits that bring them periodically past the sun. The outer limit of Halley's orbit lies between the orbits of Neptune and Pluto.*


HALLEY'S COMET

BOTH BY JONATHAN BLAIR

Wooden good-luck piece *was given to David Dale* ***(above)****, British manager of the European Space Agency's Giotto mission, by Dr. Roald Sagdeev* ***(left)****, head of the Soviet mission to Halley called VEGA. Sagdeev, revealing a T-shirt he wore during the VEGA encounter, also shared vital data about the location of the nucleus. VEGAs 1 and 2 had flown within 8,000 to 9,000 kilometers of the comet a week earlier.*

(Continued from page 758) Uranus—invisible to most viewers. Even Uranus was brilliant compared to Halley's comet, which was bedeviling the professional astronomers working next door that night with electronic detectors on a large 224-centimeter instrument.

"The comet is 300,000 times fainter than the faintest star you could see with the unaided eye," said University of Hawaii astronomer Dale Cruikshank. "Detecting something so small is like being in New York City and trying to see a penny in St. Louis," calculated his colleague Bill Hartmann.

O'Meara's night began badly. Using a sky chart, he visually star-hopped to where Halley should be, but he found only stars that were not on his chart. When, after a two-hour search, he sought help, Cruikshank pointed out that he had forgotten to compensate for the longitude difference between Hawaii and his home in Massachusetts.

Next, O'Meara had trouble opening the telescope slit enough to focus on the correct patch of sky. Moreover, subfreezing winds were picking up, threatening to shut down observations. When he finally focused the eyepiece, he noticed three faint stars arrayed in a triangle. Two were not on his chart. Fifteen minutes later he glanced back at the triangle, only to find that it had become a straight line. The star on top had moved. A few minutes later it had dropped farther, forming an inverse image of the original triangle. That was no star, O'Meara realized. The faint-star wizard had found Halley's comet in flight.

LOOKING FOR HALLEY'S comet this time around wasn't easy for anyone. Astronomers had warned the public that the comet's 1986 apparition would be history's worst. Orbital vagaries kept Halley much farther from earth than on its last visit in 1910. Then its tail practically grazed the planet.

"Nature has played a nasty trick on us," I overheard a small boy complain after viewing the anemic comet from a 200-dollar-a-seat jet flight over Australia. He could have been speaking for much of the world.

But if Halley's comet did not dazzle the public eye in 1986, it gave science a bonanza. A flotilla of spacecraft flew past the comet, and across the world armies of scientists observed its every whim for months. Thanks to Halley, our understanding of comets is being dramatically revised.

I first saw Halley's comet, like Steve O'Meara, from Mauna Kea. But I needed the electronic eyes of the Infrared Telescope Facility. Cruikshank, Hartmann, and fellow astronomer David Tholen had attached to the telescope the same kind of detectors used on heat-seeking missiles. Still it took more than an hour to home in on the infrared energy reflected by the cold, faint wanderer. No matter. I knew that in the months ahead, as I tracked this mysterious fossil of the solar system's genesis, the views would improve.

On this night Halley's coma—the huge

The Halley flotilla

A once-in-a-lifetime chance to study Halley's comet sent a space-age armada to rendezvous with the comet some 150 million kilometers from earth.

First to encounter Halley, the Russian-built duo of VEGAs 1 and 2 sent back data on its physical and chemical makeup. Next the Japanese probe Suisei passed close enough to confirm that the comet's huge hydrogen coma (bottom left, as seen from NASA's Pioneer Venus) seems to "breathe" once every 53 hours, supporting theories that the nucleus rotates at that interval.

The final encounter, ESA's Giotto plunged into the coma at 249,000 kph, snapping pictures every four seconds and studying material streaming from the comet's hilly, cratered nucleus (facing page, lower right).

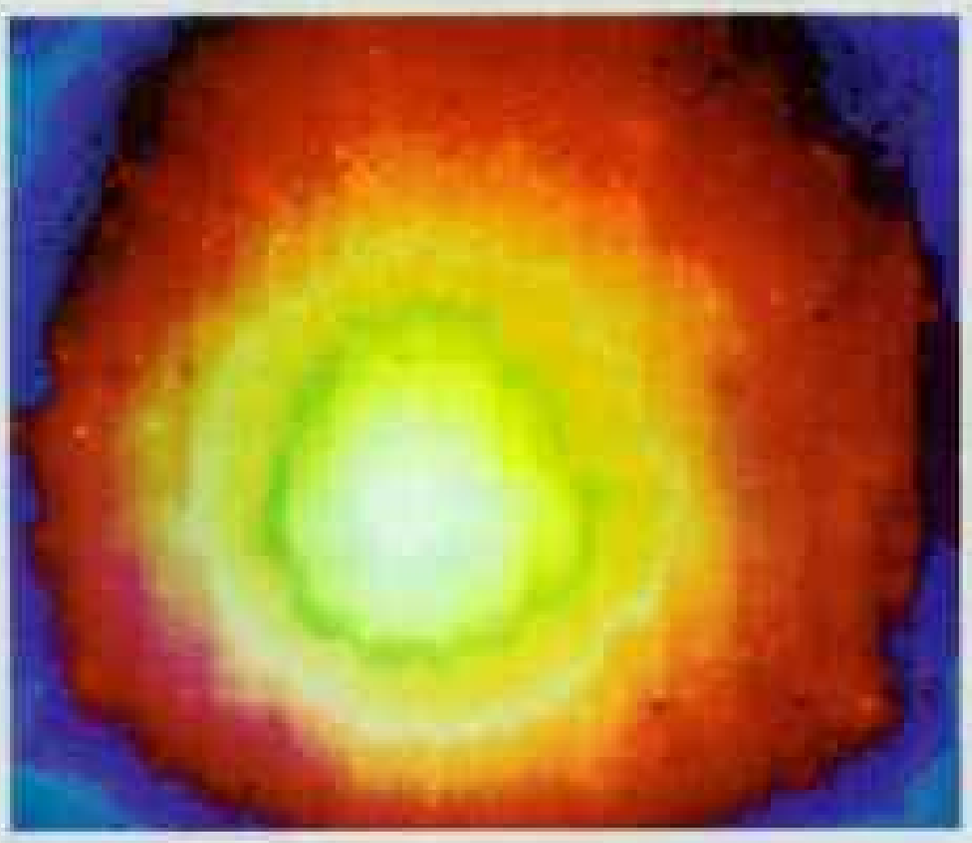
The size of Manhattan (far right), the nucleus is but a tiny speck within a white blob in a false-color image of Halley's 105,000-kilometer-wide dust coma, as seen by a ground-based telescope (facing page, lower left). The comet, in all its glory, was captured with a Schmidt camera in Australia (below right).

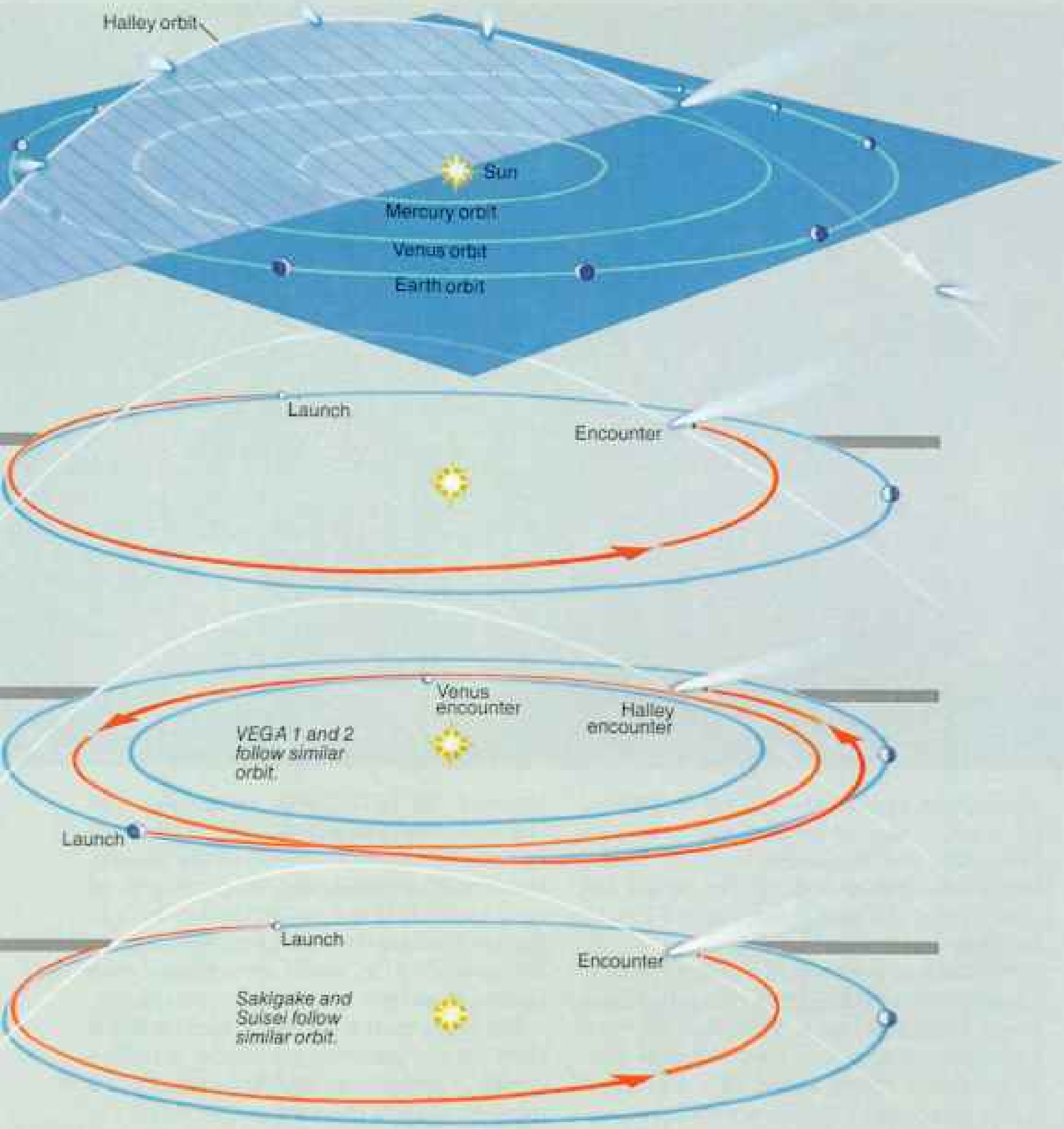
HALLEY
Halley's elliptical orbit takes it in the opposite direction and in a slightly different plane from the planets. Probes were timed to pass the comet as it crossed this plane in early March.

GIOTTO
Daredevil of the encounters, Giotto was launched July 2, 1985, on what some believed was a suicide mission to brush past the nucleus on March 14, 1986. Giotto may encounter another comet in 1992.

VEGA 1 AND 2
After a trip to Venus, the Soviet probes journeyed to Halley's nucleus on March 6 and 9, finding its surface surprisingly hot (100°C) and its inner coma rich in dust and water vapor.

SAKIGAKE AND SUISEI
Dual heroes of Japan's first interplanetary mission, Sakigake monitored solar wind from a distance, while Suisei closed to within 150,000 kilometers on March 8 to map Halley's hydrogen corona.





MANHATTAN DRAWN TO SCALE OF HALLEY NUCLEUS (LEFT), WHICH IS 16 KM LONG.

PAINTING BY DAVID MELTZER. PHOTOGRAPHS (LEFT TO RIGHT): NASA/AMES RESEARCH CENTER; AKIRA FUJII; STEVE LARSON AND SANTIAGO TAPIA, UNIVERSITY OF ARIZONA; JONATHAN BLAIR. WITH IMAGE PROCESSING BY R. KRAHN. © 1986 MAX-PLANCK-INSTITUT FÜR AERONOMIE.

atmosphere of gas and dust that evaporates off a comet core as the sun warms its surface—was just beginning to form. Before the comet clothed itself in that bright obscuring fog, the astronomers hoped to take readings of its "naked nucleus."

No one had ever seen a nucleus. In fact, not until 1950 did scientists recognize that a comet had a solid core. That year Harvard University astronomer Fred Whipple proposed that a "dirty snowball"—ice mixed with a smattering of dust—lay within a comet coma. His theory soon became gospel.

Whipple's frozen nucleus would have coalesced in the cold outer regions of the solar nebula, the giant cloud of gas and dust that gave birth to the sun and planets about 4.6 billion years ago. Trillions of comets probably formed near Uranus and Neptune. The gravity of those planets pulled in many comets, while hurling others sunward to bombard the inner planets. This rain of ice may well have brought enough water and gases to our dry young planet to form the oceans and an atmosphere.

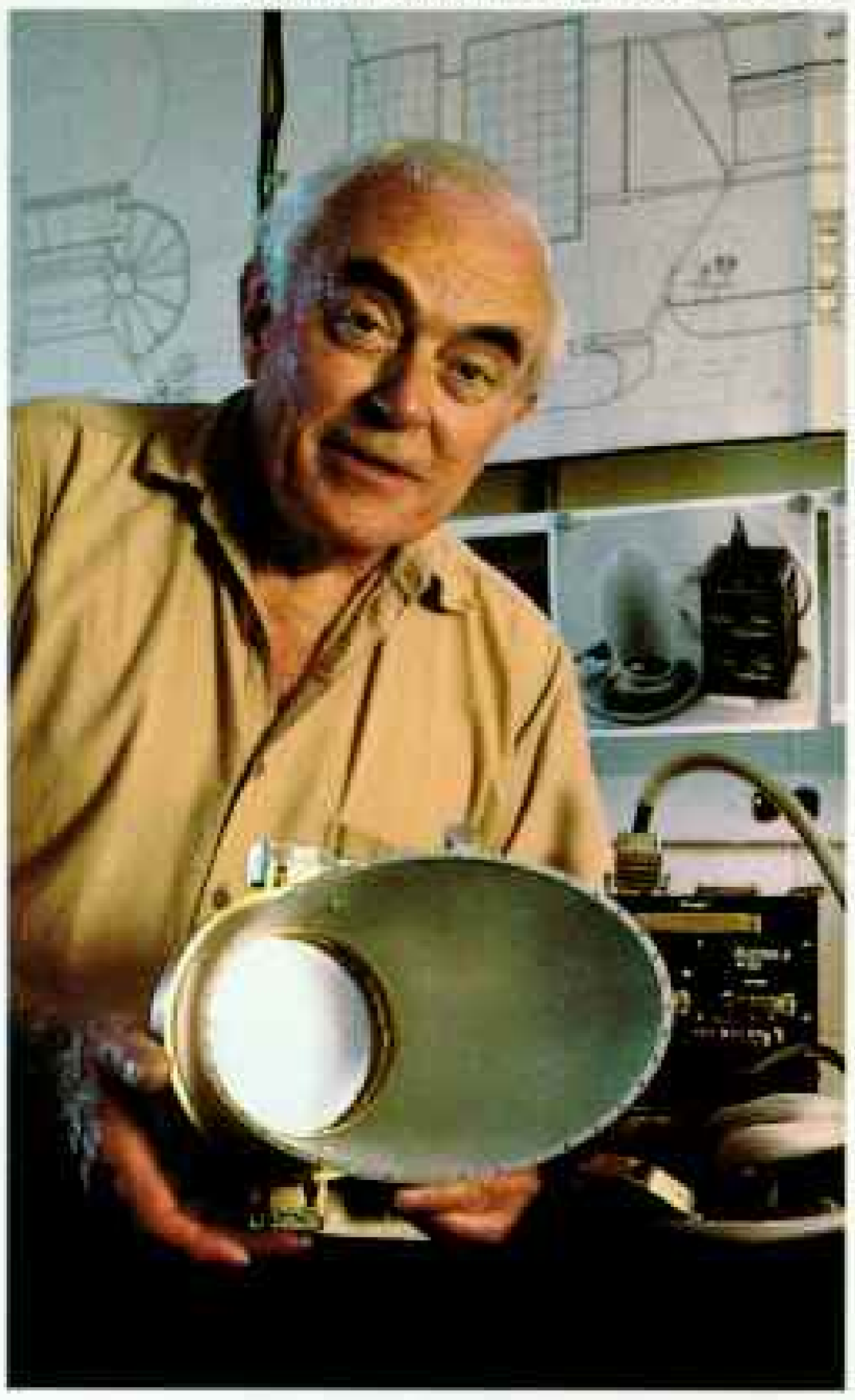
Many of the snowballs were also ejected outward. In 1950 Dutch astronomer Jan Oort theorized that a great shell, or cloud, of comets still remains far beyond the planets. On occasion a passing star flings a shower of them inward. If one passes close enough to Jupiter, that giant planet's gravity can warp the snowball's trajectory, entraining it, like Halley, in an eccentric orbit around the sun.

For years most scientists thought a single Oort cloud, containing perhaps a trillion comets, ranged from 20,000 to 100,000 astronomical units (AU) away. (An AU is the distance between the sun and earth.) Recent evidence indicates that there might also be an inner Oort cloud. Beginning just beyond Neptune, it would hold at least a hundred times as many comets as the outer cloud.

"There may be more mass in comets than in all the planets," says Jet Propulsion Laboratory (JPL) theorist Paul Weissman.

If so, that inner reservoir holds profound implications for earth. Once every 500 million years on the average, Weissman estimates, a star will pass within 3,000 AU of earth, flinging a billion comets across our orbit. As many as 20 could collide with earth.

JONATHAN BLAIR (FACING PAGE); JAMES A. SUGAR, BLACK STAR



Moment of truth *for VEGA scientists came as their spacecraft, bristling with instruments, began sending back data about the comet's physical makeup. At Moscow's Space Research Institute, a team of Soviet, Bulgarian, French, and Czechoslovakian scientists (**left**), led by the institute's Dr. V. A. Krasnopolsky, center, study data from their experiment showing comet gases high in H_2O and the fragment hydroxyl (OH), produced as water molecules tear apart.*

*The lone American to send an experiment on VEGA, Dr. John Simpson of the University of Chicago (**right**) holds his NASA-financed dust collector, which counted and measured particles streaming off Halley's nucleus. "The collaboration worked out beautifully," he says.*

The result could be catastrophic mass extinctions, such as the one that erased the dinosaurs and most other species on earth about 65 million years ago.

But the trajectory of Halley's comet suggests it got tossed out of the outer Oort cloud several million years ago. Since Halley's orbit takes less than 200 years, it is called a short-period comet. Long-period comets, such as Kohoutek, the famous dud of 1974, may take millions of years to return.

About a thousand comets have been recorded; five to ten new voyagers are discovered each year.

No one knows the fate of comets. Some, like the comet West in 1976, break into big chunks. Some may even strike the sun. Some fizzle out and completely disappear—even when relatively far from the sun.

"Eventually a comet may run out of gas," suggested Bill Hartmann, noting that with each passage a comet probably blows off enough water to shrink its radius by a meter. That could explain why many short-period comets are so much fainter than Halley. Halley is still fresh and volatile—able to shed ample vapor and dust. Others may have gone around often enough to nearly exhaust themselves.

STILL, in early 1985 the science of comets was mostly conjecture. Theory said Halley's nucleus should be small, with a diameter about the length of New York City's Central Park. It should be twice as reflective as the brighter regions of the moon. That is not what Cruikshank and Hartmann found on the night I was with them on Mauna Kea.

Their measurements suggested, to the skepticism of most colleagues, that Halley was much larger—perhaps 20 kilometers across, or about the size of Manhattan.

A team led by Michael A'Hearn of the University of Maryland, recently observing two nearly extinct comets, had found that they too were surprisingly large. Not only large but also dark. Perhaps comets accumulate a crust of dark dust that falls back on their surfaces after each passage around the sun. Old comets would lack the gas to blow that crust away as they next approached the sun, whereas a vigorous comet like Halley would quickly blast off any residue. However, Cruikshank, Hartmann, and Tholen had been finding a black core within most comets—young and old—they had studied. And in February of 1985 they proposed that Halley had a heart of darkness as well.

By late October 1985 Halley's comet left the realm of the telescope and could be

seen—barely—through binoculars under very dark skies. Far more obvious, however, was the public hoopla the comet had begun to provoke.

In 1705 Edmond Halley predicted that a comet that lit up London skies in 1682 would return 76 years later. He asked that "posterity . . . acknowledge that this was first discovered by an Englishman."

Appropriately, the English inaugurated the Halley hoopla with a gala welcome-back party. Before Princess Anne and a crowd of several thousand formally attired Londoners, West End musical stars sang 1910 tunes, dancers from the Royal Ballet did the Halley's Comet Rag, and celebrated actors recited how writers from Plato to Shakespeare had described comets. Most readings reflected the awe and terror that these "long-haired stars" provoked in less scientific eras.

Comets appear abruptly, almost willfully. To generations that saw fate in the stars and took comfort in the predictable patterns of the planets, such fiery intruders could only portend fateful changes, such as plagues or the fall of kings. Perhaps Martin Luther best described this pre-Halley perception by calling a comet "a bastard among planets. . . . haughty and proud."

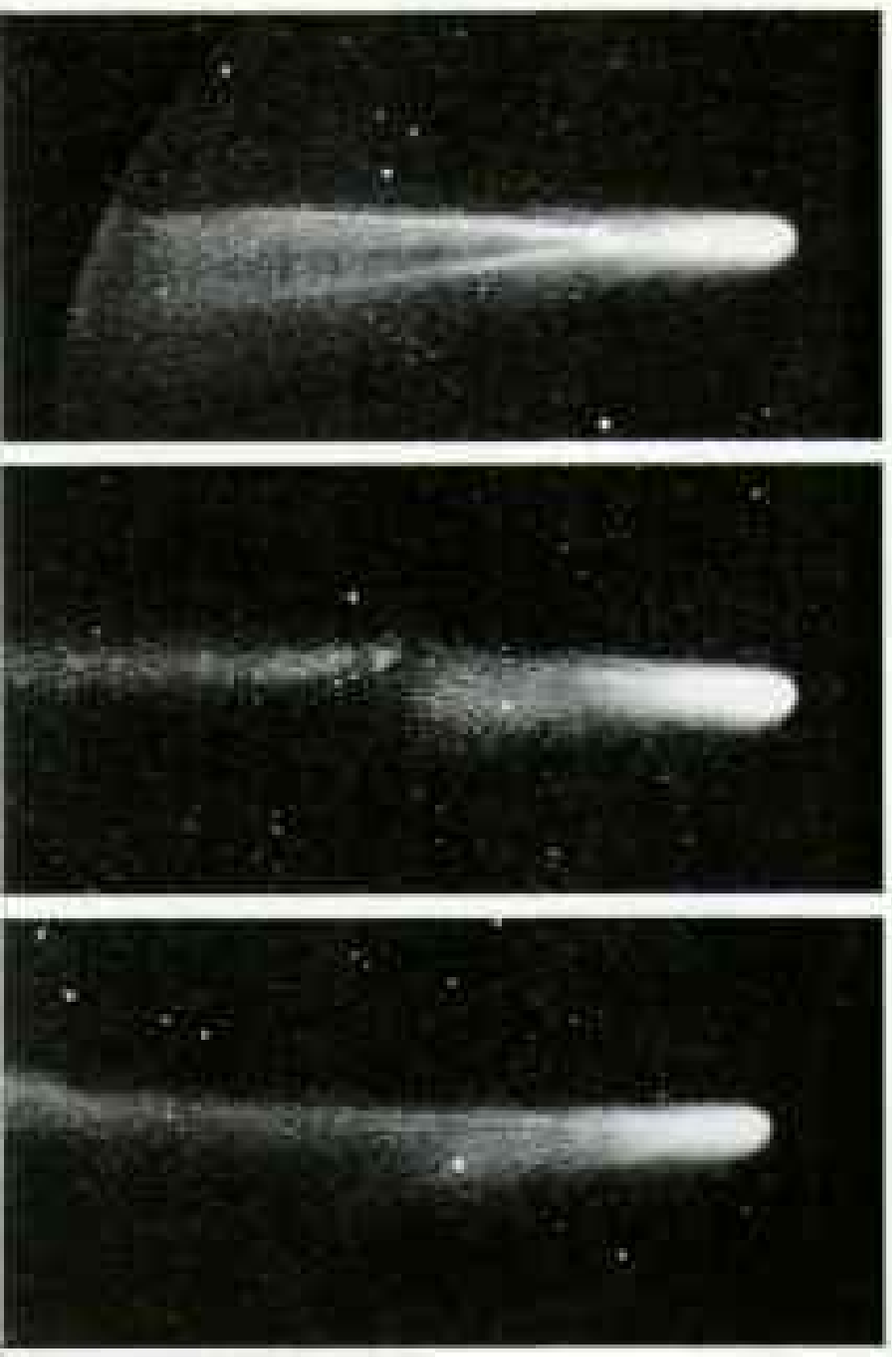
KINDER WORDS were spoken on November 2, 1985, in Utah, where some 250 people who had seen the comet in 1910 gathered at Salt Lake City's Hansen Planetarium.

They came in, some with children and grandchildren, bearing memories of a time when superstition strongly colored our lives.

JAMES A. SUGAR (LOWENS), DAVID ROBERT AUSTEN

Comet-crazy *Japanese, perhaps the world's most avid amateur sky-watchers, flocked to Australia for a look at Halley under more favorable skies. Chartered jets and railway cars brought hundreds (**above left**) to Bathurst, New South Wales. In nearby Newhaven Park, Mrs. Hisae Endo (**above**), with daughter Tateha, takes her turn at a telescope.*

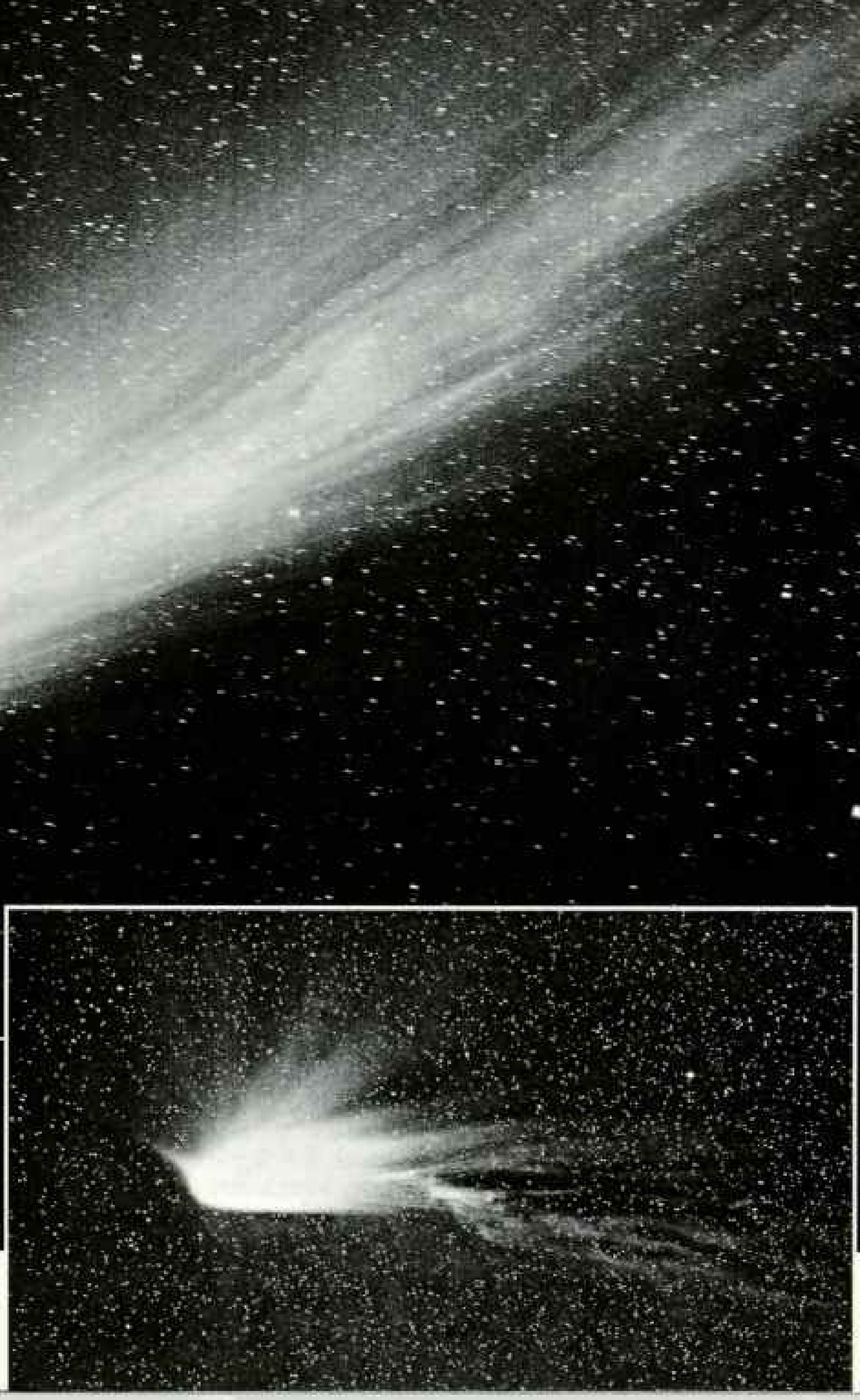
*In Tokyo scientists (**left**) savored the success of their Halley probes. Their data portray a rotating nucleus, buffeted by solar wind, that "puffs water vapor like a living thing," according to project director Minoru Oda, second from left.*



"*Long-haired stars*" *to the ancient Greeks, comets can wear two tails—and both invariably point away from the sun, even preceding a comet as it leaves the inner solar system. Halley displays both* (**right**). *The top half makes up the dust tail, which forms as tiny particles leave the nucleus and are pushed away and illuminated by sunlight. Below stretches the ion tail, which forms as gases vaporizing from the nucleus are broken apart and electrically charged by ultraviolet rays, then pushed by the solar wind—a storm of charged particles streaming away from the sun at 500 kilometers a second—into a long, often wavy formation.*

Magnetic disturbance of the solar wind may cause the ion tail to knot, swirl, or even fall off, as in the sequence of Halley (**above**) *taken on successive days in March. Dust tails can become multiple tails* (**inset right**), *possibly as dust particles of differing mass are pushed away from the nucleus. A rare anti-tail can be seen pointing backward toward the sun at left.*

ROBERT P. THICKSTEN, CALIFORNIA INSTITUTE OF TECHNOLOGY (ABOVE LEFT); ROYAL OBSERVATORY, EDINBURGH



"We were scared up in Idaho," recalled Ebby Jones, who was 17 in 1910. "We'd never heard of Halley's comet. We thought maybe the world was coming to an end."

"I was livin' in Oklahoma—Indian territory," said P. R. McIntire. "Dad took us out night after night. It was so pretty."

Everyone had a special recollection.

"It was like a great big moon with a fiery tail like a sparkler. . . ."

"My parents said some Salt Lake people committed suicide because they were afraid of what would happen when the comet hit earth. . . ."

"In San Francisco people sold their property. . . ."

"Comet gas was going to poison us all. . . ."

But they bore more than tales. Halley is the people's comet. Its orbit approximates a human lifetime. And as these survivors gathered for a group picture, with their canes, wheelchairs, hearing aids, and the tremendous luck of longevity, they were celebrating the continuity of human life.

"I was awakened by my father carrying me," said Dorothy Buchanan. "It's the only time I can remember him doing that. We went out onto a landing. My mother was wearing a long black skirt and a shirtwaist. Overhead was this bright streak—like a piece of the Milky Way. I sensed in the way my father held my hand that this was important. For those moments the three of us were compressed under the spell of the comet. I've been compelled to live to see it again."

ALL THROUGH November and December I pestered my family, dragging them out on freezing nights to try to find the comet with binoculars. There was simply too much light pollution over my house near Washington, D. C. But I was determined.

On January 3 I flew with my daughters to Los Angeles for a special children's party at the Griffith Observatory, where there were telescopes, comet games, and a time capsule in which children could deposit their pictures. In 2061, when Katie is 84 and Sara 82, they will be invited to return to reclaim their photographs and see the comet again.

On the observatory's front lawn children and parents lined up along an imaginary ellipse about a football field long. For us it approximated the orbit of Halley's comet.

"The comet has become the biggest thing in the solar system," said observatory spokesman John Mosley. "Imagine a Q-tip. The coma is about the size of the cotton swab; the tail compares to the stick. For scale the sun is about the size of an aspirin."

The comet was at its best to the north, beyond the glow of Los Angeles, in the San Gabriel Mountains. There we met Steve Edberg of the International Halley Watch and a group of dedicated amateurs.

With my binoculars I star-hopped down from the Great Square of Pegasus to the Water Jar, and there it was—a glowing smudge. I showed Katie. "Neat," she said politely and ran off to romp in the dark with her sister. But Rick Shaffer, who had brought his homemade 19-inch telescope, salvaged the night. He invited her to the eyepiece, which turned the little smudge into a bright, shimmering fairy cloud with a tail reaching across the abyss. "My word . . . my word," said the eight-year-old slowly.

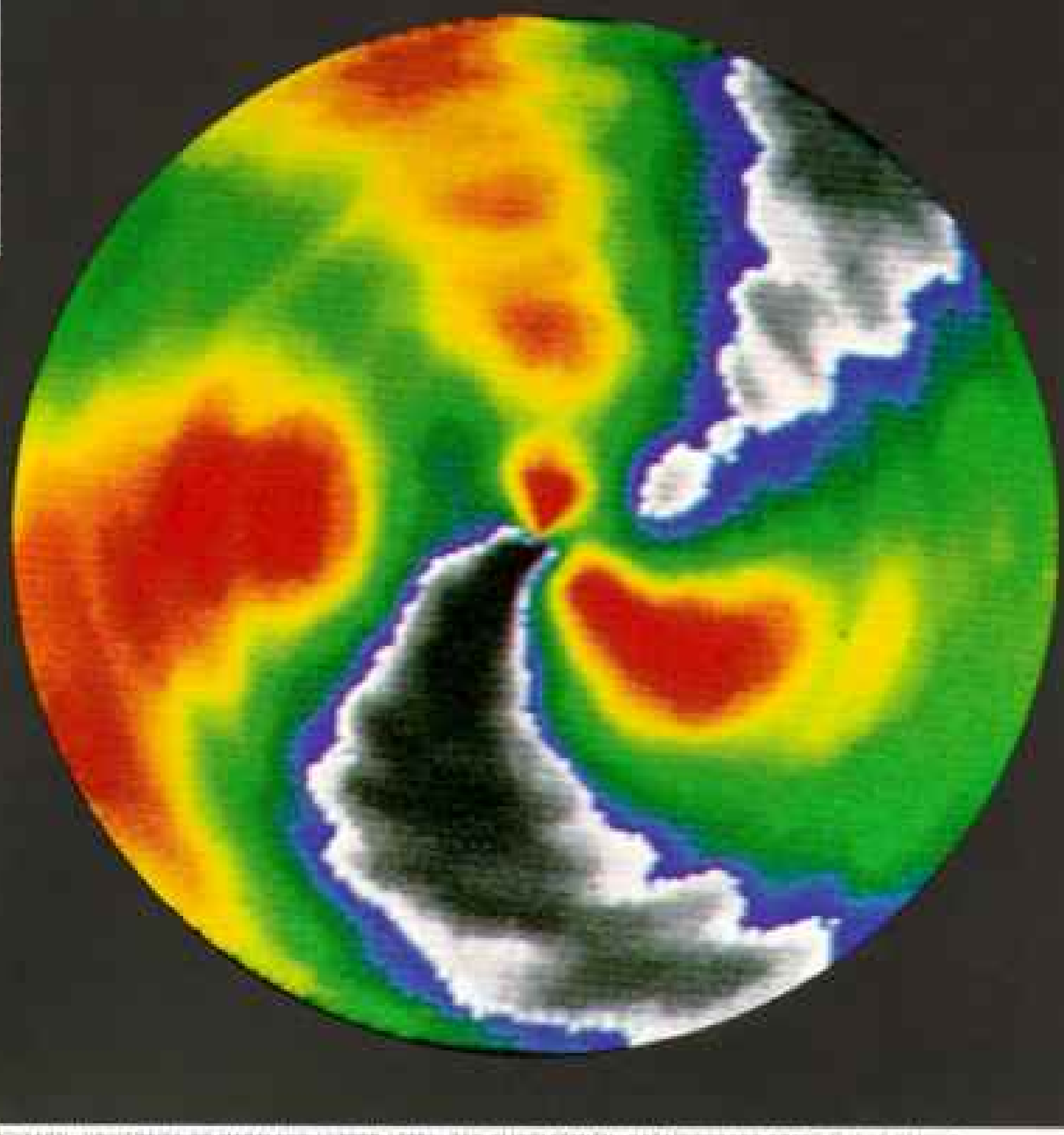
Several nights later on a dark beach on Hawaii's Big Island we saw the comet easily with the naked eye. Compressed under its spell, we sought out every constellation on our chart and talked of what the world might be like in 2061 when Katie shows her grandchildren the comet.

ON JANUARY 6, when I was comet-gazing in Hawaii, astronomer Steve Larson from the University of Arizona and his associate David Levy noted an exceptional jet of dust flaring tailward from the comet.

Jets, observed since 1682, had only recently been given much attention, thanks to Larson and Zdenek Sekanina of JPL. Enhancing 1910 photographs of Halley, they found the coma to be alive with pinwheels and spiral jets of dust. They mapped these features, analyzing day-to-day changes. The jets seemed like geysers, turning on as sunrise struck their source (page 780).

By January 23, as Halley neared its closest approach to the sun, the comet was exploding with dust features. In their Tucson observatory Levy handed me a picture with five distinct jets. "You can imagine how I felt when I saw this," he said. "None of

Jets of cyanogen, an organic compound present at the most basic levels of life, were discovered in the inner coma using special filters on a ground-based telescope.



Adding false colors to define areas of heavy concentration, astronomers isolated strong jets of cyanogen (orange) streaming out some 60,000 kilometers amid lighter concentrations (yellow to blue). Dark gray indicates areas of weakest occurrence.

Previously thought to be a trace gas released as ice vaporizes, cyanogen in jets suggests it is shaken loose from complex organic dust particles from Halley's nucleus. The pinwheel effect results from rotation of the nucleus.

MICHAEL F. A'HEARN, UNIVERSITY OF MARYLAND (UPPER LEFT); DAN KLINGLESMITH, NASA/GODDARD SPACE FLIGHT CENTER

those jets were apparent the night before."

"Most comets look the same each night," added Larson. "Few have this much dust. That's what makes Halley so exciting."

Six weeks later and half a world away at the Space Research Institute in Moscow, I met Larson again. He was consulting with scientists overseeing the imminent Halley encounters by Soviet and European spacecraft. One goal of those flybys was to take the first pictures of a comet nucleus.

"We did not appreciate the jets," explained a worried Roald Sagdeev, director of the two Soviet VEGA probes that would fly within 8,000 to 9,000 kilometers of Halley on March 6 and 9. The VEGA cameras were designed to focus on the brightest object they detected. Designers had presumed that would be the nucleus. But the Soviets had lately realized that a strong jet might be brighter; it could shunt the cameras away from the nucleus. Now a simulator was letting the Soviets program the VEGA computers to recognize and reject jets.

Even if the cameras failed, other instruments would analyze molecules spewing off the comet, thereby helping determine precisely what Halley is made of. Dust counters would measure impacts by tiny particles expected to bombard the VEGAs.

The spacecraft would also analyze plasmas—diffuse soups of ions and other electrically charged particles. Waves of plasma blow off the sun at speeds of about 500 kilometers a second, creating the so-called solar wind. The comet was also making its own plasmas, largely as solar radiation broke up molecules streaming off its nucleus. When they meet, these intensely energized plasmas can reach temperatures of a million

Riddles of the nucleus

Scientists theorize that in the comet's youth its icy surface was vaporized by the sun's heat **1** *and the leftover dust formed a black, insulating crust* **2**. *On each pass near the sun, energy trapped in the granular particles warms it to some 100°C (212°F), vaporizing the ice beneath. This pressure ruptures the crust* **3**, *allowing pockets of gas and dust to escape in explosive, jetlike streams.*

The Whipple model suggests that the nucleus is essentially an "irregular dirty snowball," with jets shooting not from cracks but from large patches heated by the sun.

The rubble-pile model portrays the nucleus as a frozen agglomeration of house-size chunks of ice or Whipple-style snowballs, loosely bonded and crusted over. Jets emerge from the spaces between the snowballs.

The icy-glue model proposes that the comet nucleus is composed of many boulders glued together by the dusty ice coating they acquired during the formation of the solar system. Jets emerge from the ice-filled gaps between them.

PAINTING BY DAVIS MELTZER

A dirty snowball *dominates the Harvard classroom of astronomer Dr. Fred Whipple* ***(below)****, whose 1950 theory of comet anatomy was essentially confirmed in 1986. "To see the actual nucleus after all these years was really something," says 80-year-old Whipple, an honored observer at both VEGA and Giotto missions. "It's not the nice oval thing we envisioned."*

Dr. Dale Cruikshank ***(right)*** *of the University of Hawaii had an inkling of Halley's true colors in 1985, when infrared observations of the approaching nucleus revealed something like "a small black asteroid." Here he illustrates comet mechanics using charcoal and crushed ice dipped in liquid nitrogen.*

JONATHAN BLAIR (ABOVE AND BELOW)

BOTH BY BOB SACHA

Sending a message *to the year 2061, children from around the world contributed letters* ***(left)****, videotapes, and computer discs for a time capsule to be opened on the comet's return. Joseph Laufer* ***(right)****, of Vincentown, New Jersey, issued the call in his* Halley's Comet Watch Newsletter. *The 5,000 replies included a letter from Alaska schoolgirl Amy Ranaldi, who asks, "Can cancer be cured? . . . Is time travel fun? . . . Will the world be around . . . in 2061?" Laufer's ten-year-old son, Kris, promises to supervise opening of the capsule in the town library.*

degrees or higher—even though a single atom-scale particle may occupy a baseball-size volume of space.

"Ninety-nine percent of the matter in the universe is in plasma form," said Sagdeev. "The comet creates a unique event: dust, charged particles, magnetic fields, and the solar wind all reacting with one another. Understanding these complex interactions could help us explain other processes, such as how galaxies form and how our solar nebula behaved in its early days."

The VEGA mission posed the Soviets' strongest challenge yet to American dominance in planetary exploration, particularly since the United States had decided it could not afford a mission to the comet. "A repartition of duties in space," Sagdeev termed it.

VEGA also represented a great personal risk to the energetic Sagdeev. He had strong-armed the complex mission through the Soviet bureaucracy with surprising swiftness. He had invited a host of Western scientists to participate in the project. And now he opened his institute to U. S. journalists, granting us freedom to prowl the halls. No Soviet mission had courted such national embarrassment should it fail.

THE DAY BEFORE VEGA 1 soared past Halley, a surge of spring struck Moscow. The city's evaporating, soot-encrusted snowbanks resembled nothing so much as one of Fred Whipple's dirty iceballs. But the thaw was trivial compared with the climatic shock the comet was experiencing. VEGA would soon find temperatures on the comet's surface averaging 50°C to 100°C (122°F to 212°F), quite traumatic for a body that spends all but an eye blink of its time at minus 210°C (−346°F).

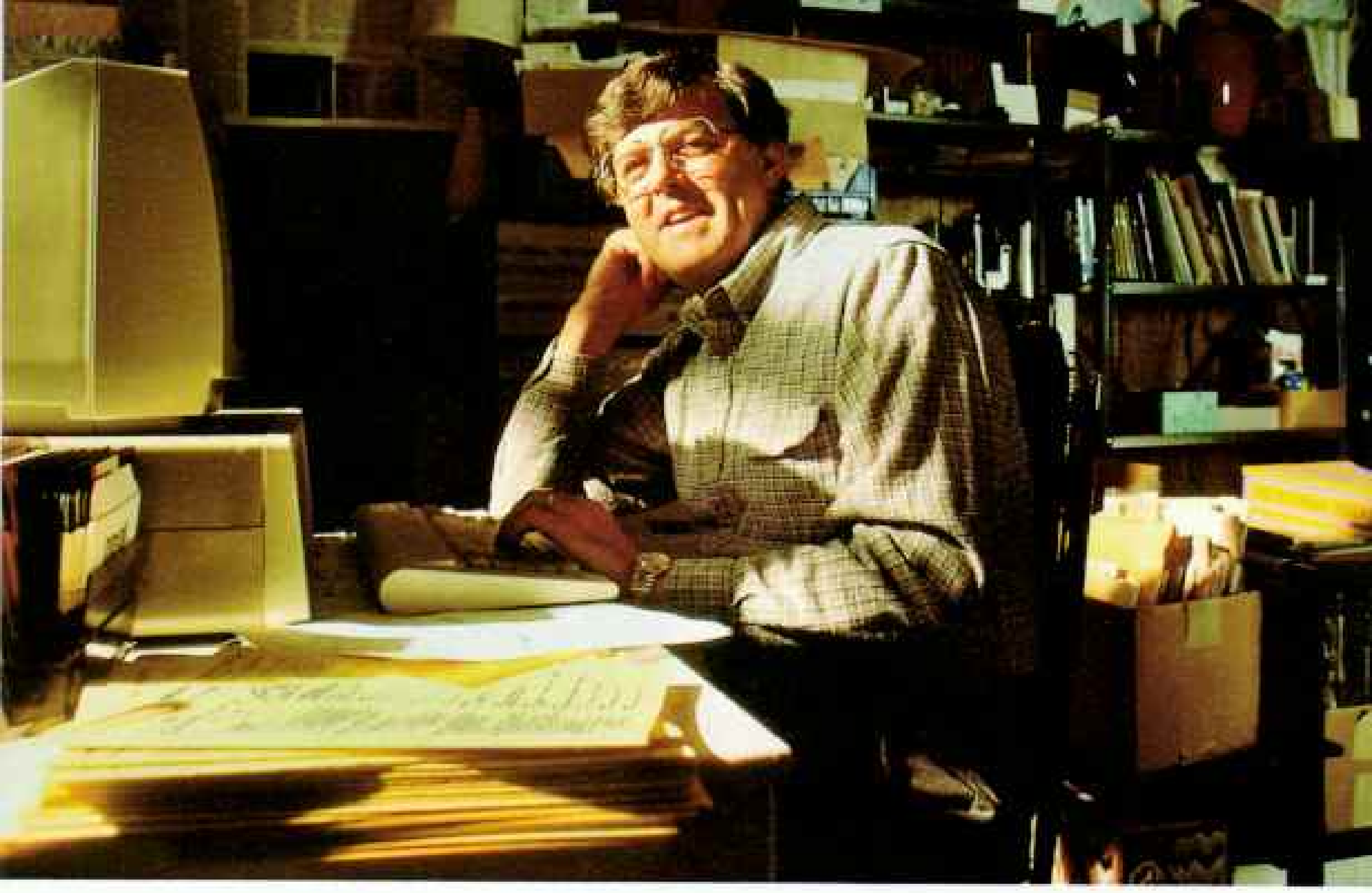
The robust, 80-year-old Whipple, reverently referred to by younger scientists as the "comet pope," had brought his own coma of gusto to Moscow. I joined him and Rüdeger Reinhard, project scientist for the upcoming European Space Agency (ESA) Giotto mission, for lunch.

"Well, Fred, tomorrow is your moment of truth," said Reinhard.

"Yes," laughed Whipple. "Things are going to get truthier and truthier."

The next morning, as VEGA 1 closed in on the truth, I sat in a dark, red-carpeted data-display room with about a hundred scientists and dignitaries. Graphs and colorful computer-generated images flashed onto the screens. Soviet scientists, their voices shrill with tension, rapidly reported the arcane data rushing in. With earphones I listened to translations of the frenzy.

"The plasma character has changed . . . more and more solar-wind particles are flowing into the cometary plasma. . . . 38,000 kilometers from the nucleus . . . now the comet is retarding the solar wind. . . . 12,500 kilometers. We don't see sharp boundaries of a nucleus. Apparently the



coma is too thick . . . 11,000 kilometers. . . . Now there is a bright red region three to four kilometers across. Evidently that is the nucleus."

Applause filled the room.

But it was premature. At closest approach—8,890 kilometers—VEGA detected a second bright region. Debates quickly developed. Had VEGA revealed two nuclei? Were the bright regions jets? Did a cocoon of dust enshroud the nucleus?

Nor did VEGA 2's flyby three days later clarify matters. It also saw two bright spots. Much image processing lay ahead.

VEGA's other instruments were more definitive. Not only did they measure a surprisingly hot nuclear region, but VEGA 1 also detected a sharp increase in dust impacts near closest approach. The spacecraft had flown through a strong dust jet.

VEGA also showed that a comet's dustiness lies in the eyes of the beholder. Away from the jets, Halley's coma contained less dust than the clean rooms that spacecraft manufacturers use to assemble satellites. A cup filled with coma at closest approach would have but one chance in 25,000 of capturing a single grain. In a jet, chances would increase to one in a thousand. And VEGA's dust experimenters were excited by how dusty a comet Halley was!

NOW ALL EYES turned toward Darmstadt, West Germany, where in four days data from ESA's Giotto spacecraft would be monitored. Giotto was on what many thought a kamikaze course, aimed to fly a mere 500 kilometers from the nucleus, about the distance between Manhattan and Pittsburgh. Data from the VEGAs aided the precision navigation. Giotto would approach Halley head-on at about 70 kilometers a second. Like a top, it would be spinning once every four seconds to stabilize itself in flight.

Striking at a quarter of a million kilometers an hour, a rice-size dust particle—relatively rare and gigantic—would carry the momentum of a speeding subcompact car. If struck by even a much smaller particle away from its bulletproof dust shield, Giotto could be destroyed. More likely, an impact could cause Giotto to wobble. The antenna would no longer point toward earth, and its data would be sent irretrievably into deep space.

If Giotto survived—and if the dust

BRAD SMITH AND ESTEBAN MORENO, UNIVERSITY OF ARIZONA (ABOVE); G. W. RITCHEY, MOUNT WILSON OBSERVATORY (BELOW LEFT); STEVE LARSON AND DAVID LEVY, UNIVERSITY OF ARIZONA (BELOW RIGHT)

Geysers of gas and dust *erupting from Halley's nucleus* ***(above)*** *may eventually cause its demise. Losing perhaps a meter of material on each orbit, scientists believe it will either break apart or crust over completely and flicker out in thousands of years.*

As this VEGA 2 image shows, a large part of the nucleus is inactive; other observations suggest that jets turn on as the rotating nucleus exposes fissures to sunlight.

Astronomers Steve Larson and Zdenek Sekanina computer-enhanced a 1910 photograph of Halley ***(below left)*** *and analyzed an unusual jet resembling one seen in 1986* ***(below right)****. This suggests that some jets may spew from the same source during consecutive orbits.*

around Halley's nucleus were not an obscuring fog—it would send back high-resolution close-ups of the nucleus. If it succumbed, science would debate what lay at Halley's heart for another 76 years.

WHEN Roald Sagdeev traveled from Moscow to Darmstadt to present the first VEGA results the day before the Giotto encounter, he brought a small piece of wood.

"I always kept this in my pocket as a good-luck charm," he said, giving it to Giotto's project manager, David Dale (page 765). "I touched it when things got bad. Now Giotto needs it."

VEGA 2's flyby had found more large dust particles than expected close to the nucleus. And Suisei, one of two Japanese spacecraft monitoring the comet from afar, had been jolted by two particles within 151,000 kilometers of the nucleus.

"I fear you won't make it," Sagdeev told Dale as they drove to Darmstadt from the Frankfurt airport.

"My gut feeling is that we are going to lose Giotto," Dale told me later that day.

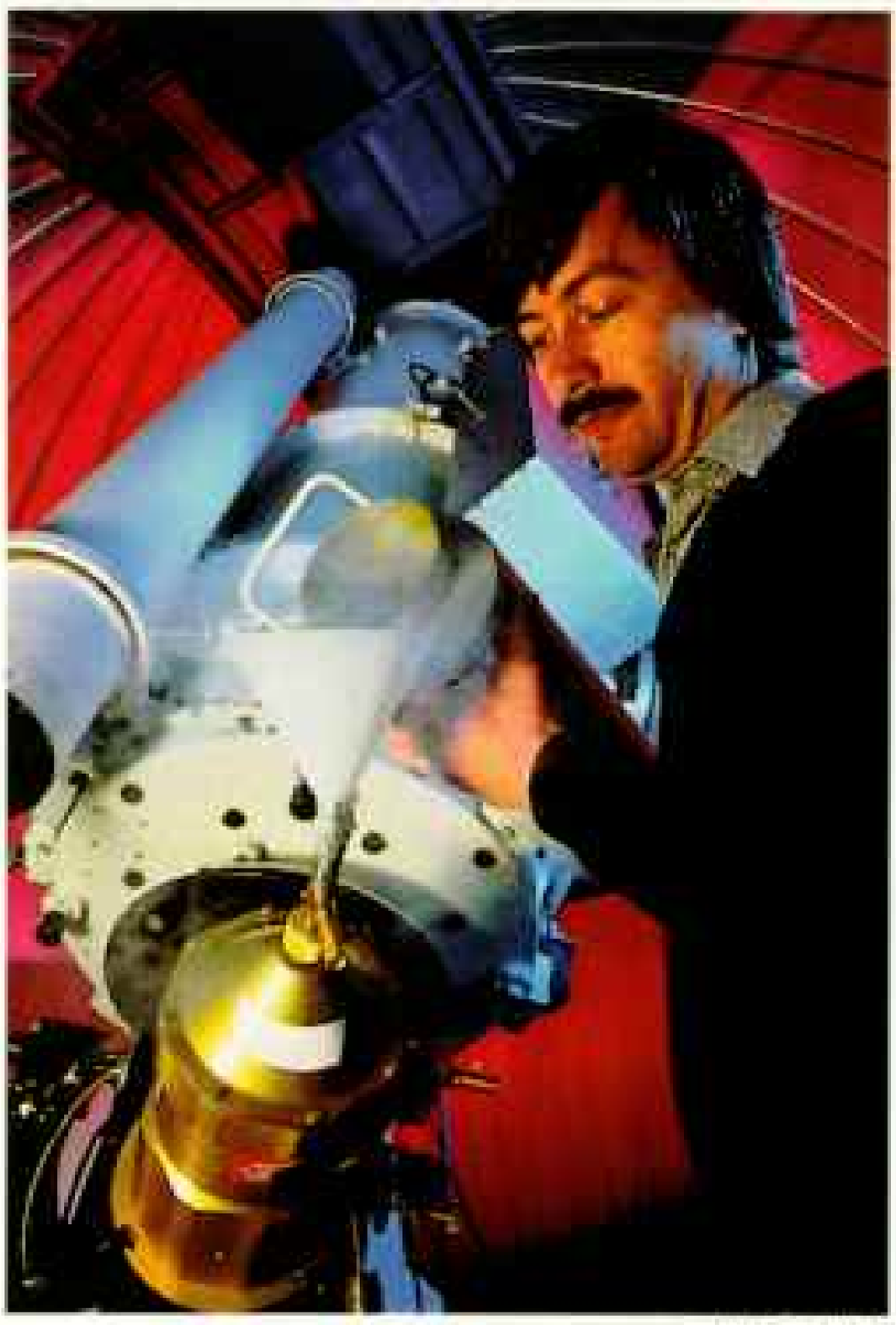
Shortly before midnight on March 13 Giotto encountered the first dust from the comet—287,000 kilometers out and scarcely an hour before closest approach. A group of journalists had set up a pool to bet when Giotto's camera would fail. I drew five minutes before closest approach.

As Giotto closed in and every four seconds a more detailed image appeared on the monitors, I prayed to lose. I got my wish: 20,000 kilometers away and the pictures kept coming. But would the next one be the last? Not since waiting for the Viking spacecraft to safely land on Mars in 1976 had I felt such tension at a mission.

At 8,000 kilometers and less than two minutes from closest approach, dust was pummeling Giotto. A minute later engineers detected trouble. Particles were pitting the camera's mirror, and a bright jet was diverting the automatic tracking from the center of the nucleus. About a thousand kilometers from closest approach, the screens went blank. Moments later came the announcement: "Data indications are bad." Giotto's antennas had been knocked off target.

Soon the spacecraft righted itself, and most instruments resumed sending data. But for the camera it was a noble suicide. The next day imaging scientists brandished striking pictures. Sixteen kilometers long, shaped like a peanut, and blacker than coal, Halley's nucleus had finally been revealed.

As the Mauna Kea astronomers had forecast more than a year earlier, this comet was a surprisingly big and remarkably dirty snowball. At least two bundles of jets flared from the nucleus. One close-up revealed a small mountain and craterlike regions, perhaps the collapsed vents of jets.



JAMES A. SUGAR

The big chill, *liquid nitrogen is poured by Steve Larson (**above**) into a charge-coupled device (CCD) on a telescope at the University of Arizona observatory. The CCD substitutes electronic charge detection for light-sensitive film, improving resolution on long exposures to study jetting of Halley.*

FOR LAYMEN the peak period for comet-viewing was just getting under way. Halley was to be at its brightest in early April. But only from the Southern Hemisphere, where the comet would be overhead all night, were views

*"**Two-timers,**" those who saw Halley in 1910 and 1986, and their offspring were honored at California's Griffith Observatory (**facing page**).*

*In Marshall, California, Dr. Edmund P. Halley (**below**, far left)—believed to be a distant relative of Edmond—ceremoniously passed custody of Halley to his great-grandchildren, potential two-timers in another 76 years.*

JAMES A. SUGAR (ABOVE); JONATHAN BLAIR (FACING PAGE)

supposed to be prime. Northerners would have to look low on the horizon, through thicker atmosphere, and get up several hours before dawn.

Nevertheless they rose to the occasion. An estimated 40,000 New Yorkers mobbed Jones Beach one clear night. Comet-gazers created predawn traffic jams in the mountains east of Los Angeles. "We've never had so many visitors," said a naturalist at Joshua Tree National Monument.

Probably the best views came from the Everglades and Florida Keys, self-proclaimed as "Comet Country USA," where I took Katie right after returning from the Giotto mission.

"We're selling out nights in April, which we never do," said Gary Sabbag, manager of the Flamingo Lodge in Everglades National Park. A card on the restaurant tables promoted a Mr. Halley's Comet Cocktail. "See some stars," enticed the card.

At 4 a.m. on March 21 we joined hundreds of comet-watchers along the bridges of the keys. As my eyes adapted to the dark and the comet emerged, it was like seeing an old friend. Much brighter than in January and with a tail as broad as ten full moons, the comet filled me with high expectations for the next moon-free viewing window in April. Then, when the comet would be closest to earth, I would join thousands of tourists heading below the Equator.

APRIL 5. Rotorua, New Zealand. I could not believe my eyes. The comet was fading.

"Yeah, it's dropped its tail," said Mike Smith, proprietor of the Binocular and Telescope Shop, in downtown Sydney, Australia, two days later. "It's doing exactly what comets do. It's being unpredictable."

Despite Halley's poor showing, hordes of Sydney residents had been driving out to dark spots on the city's outskirts. Small outback towns became sudden meccas for throngs of overseas sightseers. The Alice Springs airport was a bazaar of tourists in Halley T-shirts browsing comet memorabilia. I could find few who were disappointed. As one amateur astronomer said, "People may not be happy with what they saw, but most are very happy to have seen it."

On April 10, the day the comet came closest to earth, I headed for Ayers Rock. It had become the international hub for Halley-watchers. That night I lay back on a picnic table and looked up. The southern sky, so filled with nebulae and other galactic wonders we never see in the north, was brilliantly clear, and the Milky Way stretched like a great comet tail from horizon to horizon.

That is what I shall remember decades from now. A mild night in the desert, watching Halley rise over the rock, an ancient monolith that has witnessed every passage of the comet. A gentle night when people who seldom look at the sky discovered its beauty. That night Halley was wonder and awe, mystery and unpredictability—the traits of nature itself. What drawing power this comet had, to pull so many so far.

BY SUMMER of 1986 Halley's comet had receded into the abyss, leaving scientists to struggle with their data. What had they learned?

"It's more than a simple dirty snowball,"

JAMES BALOG (ABOVE); BOB SACHA (FACING PAGE)

explained Uwe Keller, the chief imaging scientist for Giotto. "We know now the comet has a permanent crust. It's remarkably dark. The blackest paint we can make on earth reflects more light. I think the crust must be made of fluffy particles, possibly left behind as the dirty snow evaporates. Light rays get trapped in between and can't be reflected."

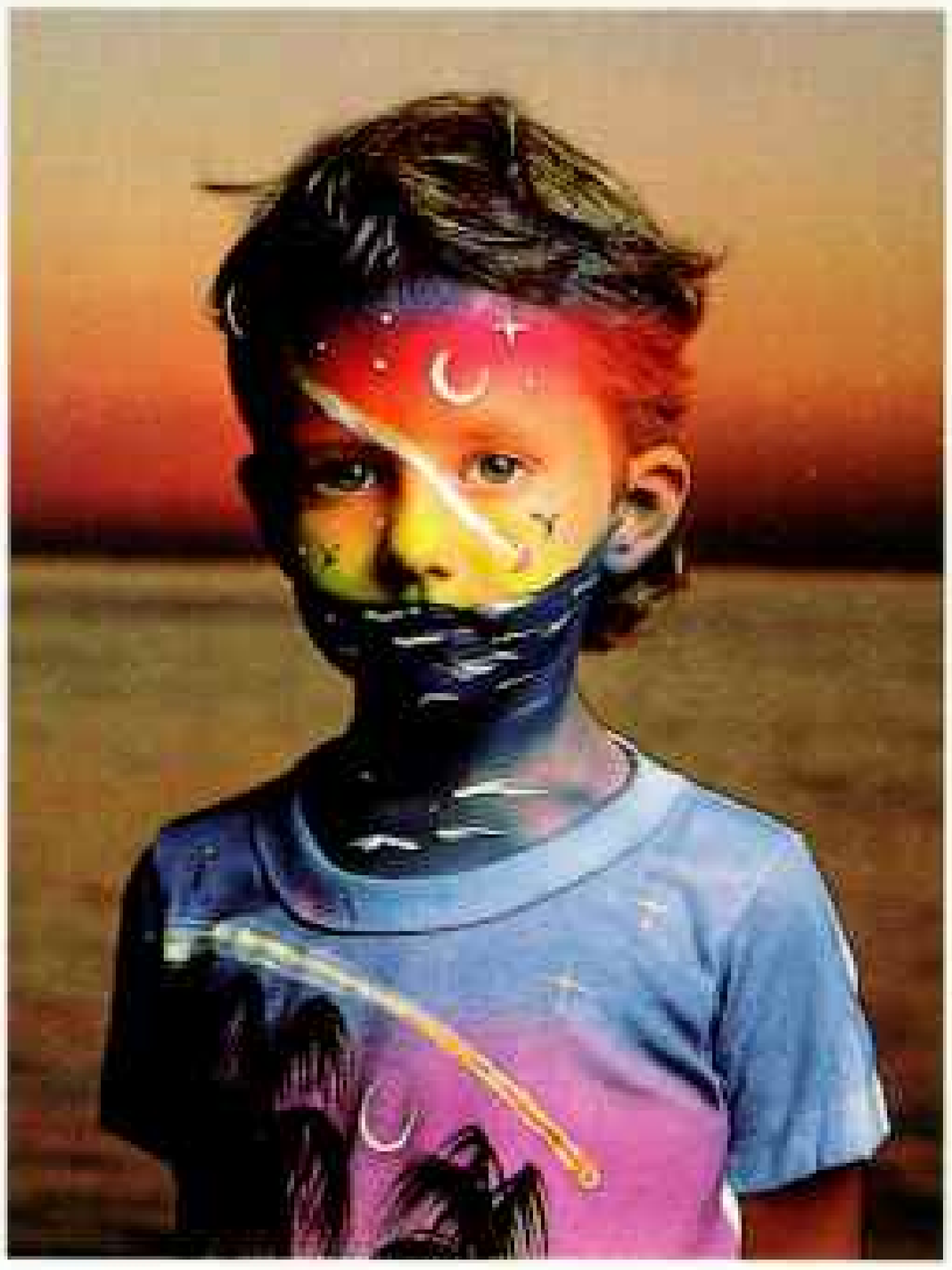
That absorbed energy heats the top of the comet's black crust to beyond the boiling point. But the granulated crust must be a superb insulator, because just beneath it Halley's ice remains colder than Antarctic glaciers in winter.

Such deep cold was verified by an infrared telescope aboard NASA's Kuiper Airborne Observatory (KAO), a converted C-141 jet that flew for one of the few American projects dedicated to Halley. (Three spacecraft launched by NASA years earlier for other purposes provided months of coverage of Halley's daily behavioral changes from afar.) Flying above most of the atmosphere, the KAO repeatedly measured the properties of molecules and dust in the coma. Among its many results, the KAO found that the water in the coma came primarily from ice only 32 degrees above absolute zero—far colder than expected.

This supports Giotto and VEGA indications that most of Halley's water vapor comes not off the surface but from jets shooting out from the comet's colder depths. Steve Larson believes that the jets emanate from the cracks and fissures that crisscross

***A passing clue** to the mysteries of life, Halley's comet lights the sky above the stone faces of Easter Island (**left**, in double exposure). With the 1986 closeup studies, scientists are beginning to recognize that comets may hold more answers for us than anyone could have possibly imagined in 1910.*

*What will astronomers learn from Halley's next visit? Solaris "Buddy" Gregory (**right**) of Key West, Florida, sporting comet face paint courtesy of his artist father, may find out. He will be 81 years old in 2061, when Halley returns.*



the comet. Such cracks would be generated by the great temperature differences between the hot crust and the cold within. Not everyone agrees.

"Frozen mudballs," is how JPL's Paul Weissman now describes comets. He sees them as primordial rubble piles—house-size chunks of ice and dust loosely bonded and crusted over. The jets would occur when one chunk breaks away and exposes fresh ice to sunlight, or when light hits a thinly crusted region, or when enough pressure builds beneath the mantle to burst through the crust.

A more radical idea has been suggested by VEGA scientist Tamas Gombosi of Hungary and American colleague Harry Houpis. They think Halley is an assemblage of boulders held together by "Whipple glue"—the dusty ice that Fred Whipple described. Most of the comet's surface would thus be the tops of boulders, which Gombosi calls "black frozen sponges without the water." Jets would stream only from the Whipple glue that fills the pores between the boulders.

SCIENTISTS will argue over Halley's nucleus for years. But some now doubt that comets eventually burn out by running out of gas. A comet's fate instead may be to crust over completely and suffocate. Some of the dark asteroids that ominously cross earth's orbit in fact may be encrusted comets. In late May one of these earth crossers passed about 12 moon distances from us—cosmically speaking, a close call.

What is the black material in the crust? Spacecraft and ground observations indicate it is rich in a variety of hydrocarbons. This backs up those who have contended that the evolution of life on earth got a big helping hand from frequent comet impacts early in the planet's history.

"Comets could carry traces of amino acids, DNA bases, or the more complicated organic molecules that have been found on meteorites," said Toby Owen of the State University of New York at Stony Brook. "They could have put some of the building blocks of life in earth's primordial soup."

Support for the presence of complex organic compounds comes from cyanogen jets that astronomer Mike A'Hearn and colleagues unexpectedly discovered when analyzing their ground-based Halley images. They contend that the cyanogen—a simple molecule—must come from the breakdown of abundant and far more complicated chemicals in the dust jets.

Though Halley has gone, not so the aura of global cooperation that marked the entire year of the comet. At meetings last summer, scientists from East and West talked of an international mission to fly alongside and even land on another comet.

Halley was indeed the people's comet. However briefly, it brought us together. As Roald Sagdeev put it at a U. S. Embassy reception for VEGA in Moscow: "We acted like one family: the family of mankind." □

Best shots

Serg. Browne
Worthy
Corpl Hamilton
P. L. Wells
Wallace
Moore
Patricy
O Neill
Brinkerhoff
Rogers
Hanahan
Seaffurman
Dose
Kilfoyle

Custer and the warriors of the plains

Ghosts on the Little Bighorn

By ROBERT PAUL JORDAN

Photographs by SCOTT RUTHERFORD

As the Seventh U. S. Cavalry headed west from Fort Abraham Lincoln, Dakota Territory, that foggy dawn of May 17, 1876, the band struck up Lt. Col. George Armstrong Custer's favorite battle tune, the stirring "Garryowen." Then it tendered a poignant salute to wives in the doorways waving sad farewells: "The Girl I Left Behind Me."

Twenty-six were seeing their husbands for the last time. Far across the Great Plains roamed thousands of Sioux and Cheyenne "hostiles," as the government called them. The Seventh Cavalry was spearheading a major campaign to drive them once and for all to reservations.

Forty days and 400 hard miles later the colorful, controversial Custer led a battalion of the Seventh along a stark ridge above the Little Bighorn River in Montana Territory. The Indians they were looking for came out and slaughtered them to the last man.

From that day to this Custer and the Battle of the Little Bighorn have held the public imagination captive. More has been said about this brief struggle than any other battle in American history save perhaps Gettysburg. Argument and speculation swirl about it, partly because Custer remains an enigma and mysteries obscure the course of the fight. Those who rode with him to the end left only death's mute testimony. Indian accounts varied, generally were long in coming, and often conveyed what the white man wanted to hear. Even today Indian resentment lingers at terms such as "hostile" and at the mythology surrounding Custer.

Lately, exciting new details have been uncovered to help trace the battle's ebb and flow and what befell individual soldiers and

Confident and undefeated *at age 36, Lt. Col. George Armstrong Custer was soon to die with some 260 of his men while attacking a camp of Sioux and Cheyenne Indians in June 1876. A Cheyenne took this Seventh Cavalry roster book from the Montana battlefield, and warriors used it to illustrate their triumphs—here in a fight with the Shoshone. New excavation sheds light on the controversial contest on the Little Bighorn.*

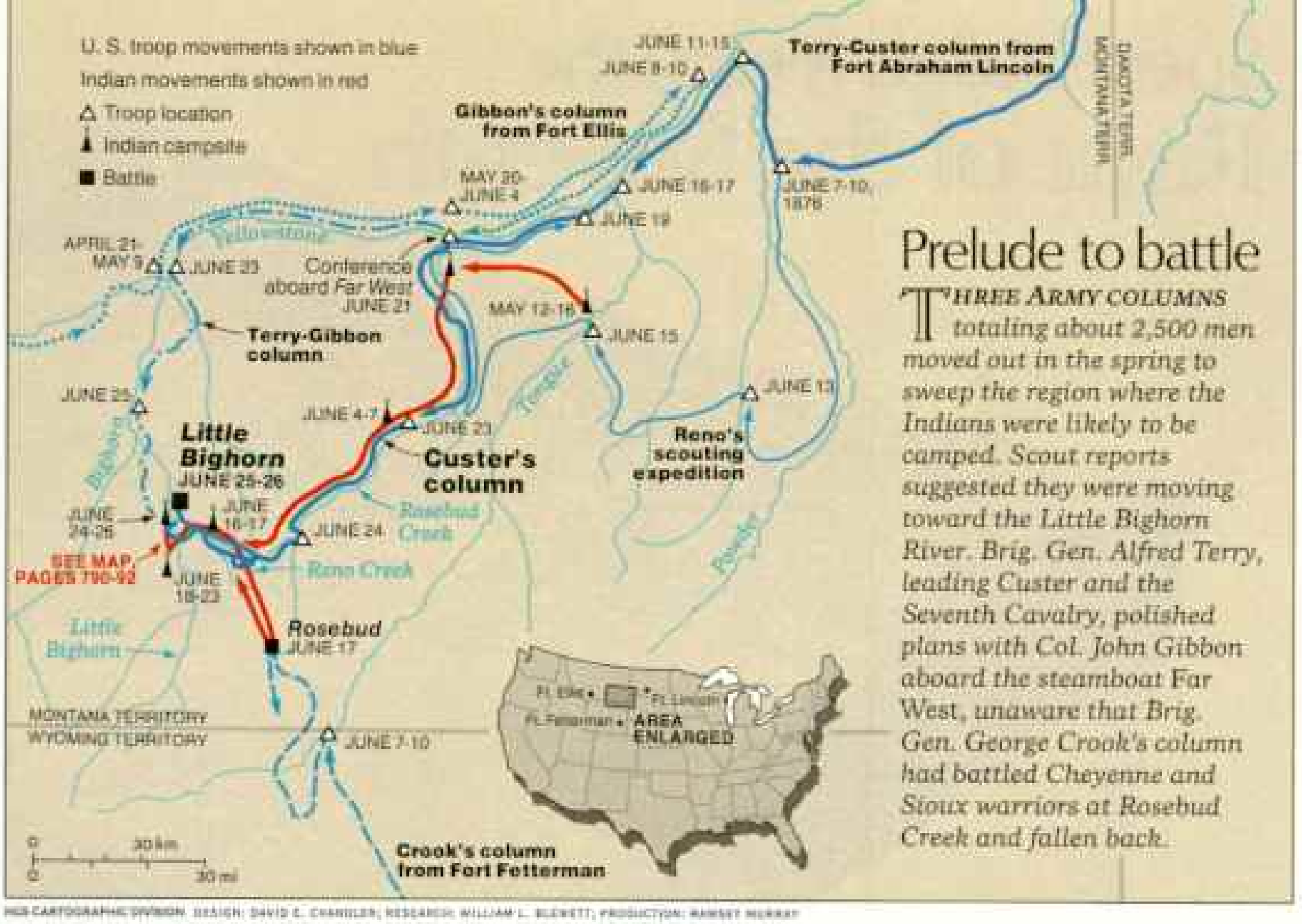
DOUBLE TROPHY ROSTER BOOK, HEYE FOUNDATION, MUSEUM OF THE AMERICAN INDIAN, NEW YORK CITY. PHOTOGRAPH BY JAMES E. VAN HOOSE (LEFT); DARRYL LYONS COLLECTION, MAYFIELD HEIGHTS, OHIO

U. P. BARRY PHOTOGRAPH FROM THE U. S. ARMY MILITARY HISTORY INSTITUTE, CARLISLE BARRACKS, PENNSYLVANIA (ABOVE AND ABOVE LEFT)

***"The only good Indians** I ever saw were dead."*
Lt. Gen. Philip Sheridan's infamous 1868 comment reflected the sentiment of many Americans eager to push west after the Civil War. A treaty that year created the Great Sioux Reservation around their sacred Black Hills in today's South Dakota. But rumors of gold, confirmed by an 1874 survey led by Custer, prompted encroachment by whites.

*"We have been running up and down this country, but they follow us from one place to another," said Sitting Bull, a leader of the seven bands of Lakota, or Western Sioux. He and other "hostiles," including Cheyenne, were on their Montana hunting grounds when ordered to report to the reservation by January 31, 1876, or face military action. Hunkpapa Sioux warriors Crow King (**above left**), Gall (**left**), Sitting Bull (**above**, with female relatives and infant son), and other chiefs ignored the order. In June, the Moon of Making Fat, their numbers were strong and defiant. And in a vision Sitting Bull saw soldiers falling upside down into his camp.*

U. P. BARRY PHOTOGRAPH, THOMAS HESKI COLLECTION, CANNON FALLS, MINNESOTA



Prelude to battle

THREE ARMY COLUMNS totaling about 2,500 men moved out in the spring to sweep the region where the Indians were likely to be camped. Scout reports suggested they were moving toward the Little Bighorn River. Brig. Gen. Alfred Terry, leading Custer and the Seventh Cavalry, polished plans with Col. John Gibbon aboard the steamboat Far West, unaware that Brig. Gen. George Crook's column had battled Cheyenne and Sioux warriors at Rosebud Creek and fallen back.

NGS CARTOGRAPHIC DIVISION. DESIGN: DAVID E. CHANDLER; RESEARCH: WILLIAM L. BLEWETT; PRODUCTION: MARGET MURRAY

braves. In 1983 a prairie fire swept the undulating heights and wrinkled draws where Custer met his doom, burning off the grass and sagebrush cover. On this naked ground archaeologists and a small army of volunteers have toiled with metal detectors, trowels, and sieves for two seasons. The results are astonishing.

LOVELY AND DEVOTED Elizabeth Custer accompanied her dashing cavalier on the first day's march. The lifting mist revealed a column almost two miles long. A bugle sounded "Mount" and "Forward," and the procession moved out, Custer buoyant at taking the field, his cavalry regiment platooned behind with guidons streaming. Infantry followed, then 40 Indian scouts intoning their war dirge, pack mules, a battery of artillery, and a line of heavy white-hooded wagons.

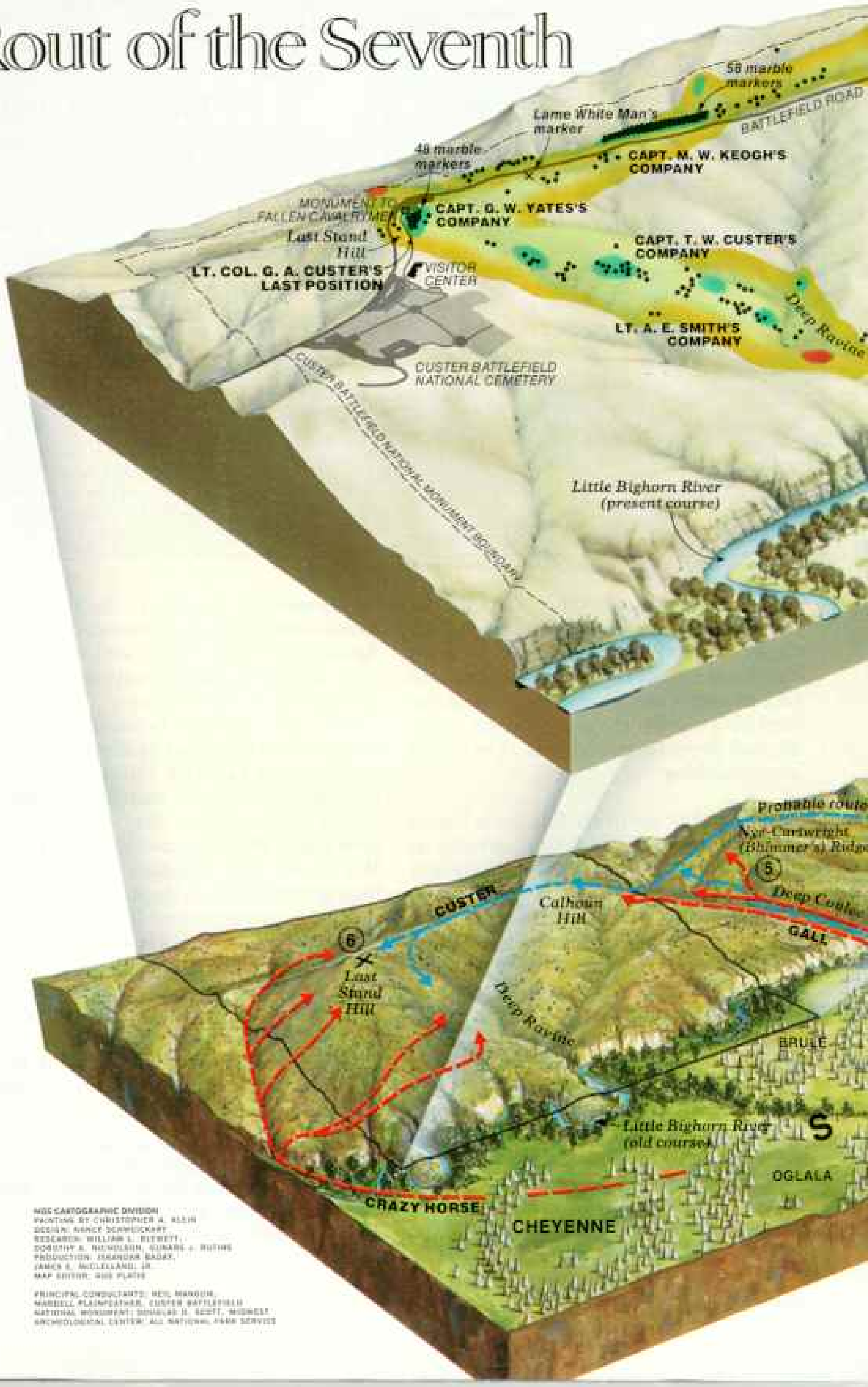
The general, so called by courtesy, constantly glanced back to admire his command, Elizabeth tells us in her book *Boots and Saddles*. He was a West Pointer (last in the class of 1861), and his audacious feats in the Civil War had catapulted him to brevet major general at 25. Harder on himself than on his troopers, fearless in the charge (11 horses were shot from under him), he was at Appomattox when Grant took Lee's surrender—and carried away Grant's signing table as a present for Mrs. Custer.

The "boy general" became a national hero. In those glory days he affected yards of gold braid on his black velveteen uniform and golden curls to his shoulders. A fellow officer said he looked "like a circus rider gone mad." His nicknames included Yellow Hair, Long Hair, Ringlets, and, perhaps from his tirelessness in the saddle, Iron Butt.

When he departed Fort Lincoln, Custer's locks had been shorn. He wore a red tie, fringed buckskins, and a broad-brimmed campaign hat. Now 36, an experienced and ruthless Indian fighter, he was smarting under President Grant's disfavor. A successful strike against the warriors of Sitting Bull and Crazy Horse could reverse his fortunes.

Robert Paul Jordan retired as a senior assistant editor of NATIONAL GEOGRAPHIC last August. This is his 19th article for the magazine. Free-lance photographer **Scott Rutherford**'s work has appeared in a number of Society publications since 1984.

Spent bullets record the Rout of the Seventh



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PAINTING BY CHRISTOPHER A. KLEIN
DESIGN: NANCY SCHWECKHART
RESEARCH: WILLIAM S. BURNETT, DOROTHY A. NICHOLSON, GUNARS J. RUTHS
PRODUCTION: JHARANDAR BAGAY, JAMES E. McCLELLAND, JR.
MAP EDITOR: ROSS PLATH

PRINCIPAL CONSULTANTS: NEIL MANGUM, MARDELL PLAINFEATHER, CUSTER BATTLEFIELD NATIONAL MONUMENT; DOUGLAS D. SCOTT, MIDWEST ARCHEOLOGICAL CENTER, U.S. NATIONAL PARK SERVICE

Custer battlefield today

Of the some 260 of Custer's men who died at the Little Bighorn, 252—including those who perished at the Reno-Benteen site—are commemorated with marble markers, most indicating a death site.

- Marble marker
- Area of artifacts indicating positions
- Concentration of Army artifacts
- Concentration of Indian artifacts

Battlefield 1876

Battle movements and depiction of the Indian camp are based on varying historical accounts as well as artifacts found by collectors and archaeologists over the past century.

- Known Army movement
- Inferred Army movement
- Known Indian movement
- Inferred Indian movement

Scale varies in this perspective view.
Last Stand Hill to Reno Hill: approximately four miles

ON THE EVE of the U. S. Centennial, the Seventh Cavalry suffered its humiliating defeat on the Little Bighorn, shocking a nation in celebration. How had the Indians routed U. S. soldiers? "They made such short work of killing them, that no man could give any correct account of it," said the Miniconjou Sioux warrior Hump.

Studying patterns of spent ammunition and other artifacts found in 1984-85 at the battlefield, archaeologists have added clues to the way the battle was fought. They now know that the Indian warriors—who vastly outnumbered Custer's forces—were well armed with 41 types of guns. But questions about Custer's judgment, his precise movements, and the role of his personality in the battle will always be open to argument.

On June 22 Terry ordered Custer to take his men—about 600 soldiers plus packers and Indian scouts—up Rosebud Creek to the southern end of the Little Bighorn Valley. Terry and Gibbon hoped to reach the northern end by June 26. "Don't be greedy, Custer, but wait for us," Gibbon told the younger officer, courteously addressed as general for his Civil War brevet rank. Custer replied enigmatically: "I won't." Citing Custer's "zeal, energy, and ability," Terry gave him leeway to depart from his written orders for "sufficient reasons."

When trail signs and scout reports indicated a major Indian village, Custer detoured, and at midday Sunday, June 25, he prepared to attack. He expected as many as 1,500 Sioux and Cheyenne warriors. But largely blocked from his view by bluffs, trees, and the haze of a hot dusty day, the village spread for perhaps three miles along the river. Its population is now estimated to have been more than 7,000, with as many as 2,000 warriors—"plenty as the leaves on the trees," said the warrior Crow King.

In a decision still debated, Custer divided his command. Capt. Frederick W. Benteen was sent to scout for Indians to the southwest. Maj. Marcus A. Reno took about 140 men with orders to attack the southern end of the village **1**. *Custer continued north along the bluff* **2**, *sending a messenger back to hurry the packtrain with 26,000 rounds of ammunition. Each soldier carried 100 rounds for his Springfield 1873 carbine and 24 for his Colt revolver.*

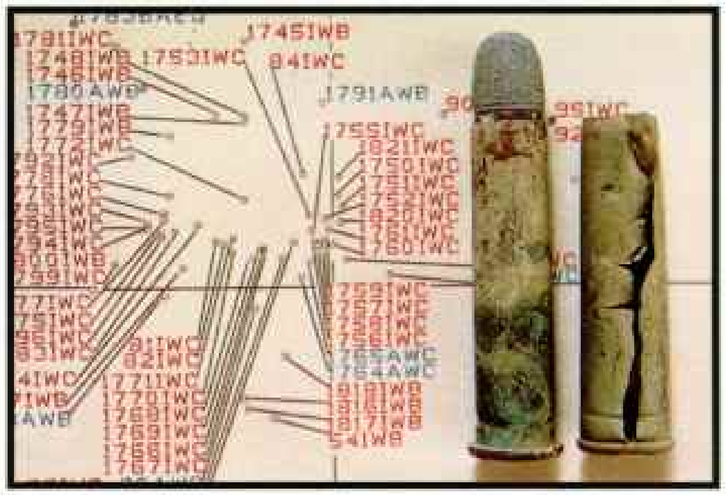
Reno charged about three o'clock **3**, *catching the village by surprise, but a fierce counterattack drove him back to the trees. In his last communiqué Custer* **4** *sent a courier to locate Benteen; his own battalion probably was under attack* **5** *by 3:45.*

Gall fought with a vengeance. Reno's charge had killed two of his wives and three children. "It made my heart bad," he said. "After that I killed my enemies with the hatchet." Sheltered by the hilly terrain and sagebrush, most warriors picked off soldiers with guerrilla-style tactics. But combat was hand-to-hand on Last Stand Hill **6**, *where the famed Oglala Sioux warrior Crazy Horse may have helped deliver the final blow.*

The battle lasted perhaps an hour and a half; Custer and all the men with him—about 210—perished. The warriors then intensified their attack on Reno's troops, who were frantically digging in on the bluff after a chaotic retreat **7**. *Benteen's return about 4:15 had strengthened Reno's forces* **8**.

Warriors turned back Capt. Thomas Weir's attempt **9** *to join the Custer battle, visible only as a smoky, dusty cloud. Besieged until the Indians broke camp, the surviving men on the Reno-Benteen site learned of Custer's fate only when Terry and Gibbon arrived on June 27 to "a scene of sickening, ghastly horror."*

***Plotting** spent ammunition reveals battle scenarios. Many Indian weapon cartridges and bullets (IWC, IWB) lay about 300 feet from Lt. James Calhoun's position. Some Army weapon cartridges (AWC) may actually represent Indian use of captured ammunition. Firing a 45/55 carbine cartridge in an Indian's larger caliber weapon caused the case to split, far right.*



Disaster proved a blessing *when a 1983 fire burned off 600 acres of vegetation on the Custer battlefield* ***(above)****, clearing the ground for a systematic investigation. The course of Custer's fight had been first surmised from where the bodies lay. Hastily covered on June 28, the bloated, mutilated corpses were difficult to identify. Officers' remains were shipped to their families in 1877; the rest were reburied in 1881 in a mass grave on Last Stand Hill, at lower left. A national cemetery, lower right, holds veterans from the Indian Wars to Vietnam.*

The more than 4,000 artifacts found include ***(right)*** *brass blouse buttons, iron pants buttons, and hook-and-eye fasteners from shirts and hats. Round lead bullets from Indian rifles and cylindrical Army Springfield bullets are numerous, but few iron arrowheads remain, most having been picked up in a century of souvenir collecting.*

Excavation shows Indian accounts to be generally accurate. Cheyenne warrior White Bird drew this panorama on muslin ***(far right)*** *19 years later. Bullets zip past Indians besieging Reno-Benteen troops on the right; Custer, in buckskin jacket, and his men fight on the left.*

Some believe he had the Presidency in mind.

The general sought to comfort Elizabeth with his customary cheerful parting. "He was sanguine," she wrote, "that but a few weeks would elapse before we would be reunited." In her heart she knew better. For as the rising sun played on the mist, a mirage had taken form and translated some of the Seventh Cavalry into ghostly horsemen in the sky. Libbie sensed a premonition of disaster as never before.

While the regiment trailed across the empty Northern Plains, Sitting Bull, preeminent of leaders and revered medicine man, had a prophetic vision that gave his followers new hope and resolve. He saw soldiers falling into the Indian camp upside down.

ON SUNDAY, JUNE 25, Custer looked down on the valley of the meandering Little Bighorn. Tepees of a huge Indian village stood for miles along the river, largely hidden behind towering bluffs —an encampment later estimated at 7,000 or more, with great numbers of warriors.

Custer misjudged the Indians' strength and truculence. He divided his regiment. Three companies under Capt. Frederick W.

◀ THIS PAGE FOLDS OUT

AT 8 BY INCHES. WEST POINT MUSEUM COLLECTIONS

Benteen, about 115 troopers, trotted off on a futile scouting foray. Three companies under Maj. Marcus A. Reno, some 140 troopers, forded the river, attacked the village's southern end, panicked, and were routed. Forty men died, 13 were wounded, many were missing. Benteen returned to find a badly shaken Reno and his shattered remnant scrambling up the heights above the river and frantically digging in with cups, spoons, and knives. Most of the shovels were an hour behind with the packtrain.

While Reno was being mauled, Yellow Hair with five companies, about 210 men, had ridden north a few miles out of sight along the ridge paralleling the village. At some point the Sioux and Cheyenne swarmed in force—estimates range as high as 2,000—across the river and up the sheltering ravines. They crept ever closer to hastily formed skirmish lines, surrounding them. From defilade they popped up and down to pick off exposed targets. They rained arrows in deadly parabola on pockets of soldiers and shrieking horses.

In an hour or so Custer and his five companies were annihilated.

These are the minimal facts of what was a

comparatively minor clash. Only 12 years earlier, for example, Union infantry had frontally assaulted a strongly fortified six-mile Rebel line at Cold Harbor, Virginia, and about 7,000 Federals perished. The affair lasted less than half an hour. Measured against the ongoing interest in Custer and the Little Bighorn, Cold Harbor is a footnote to history. It occurred in the Civil War's waning days, after years of bloody horror. Looking at the bristling trenches they must storm, northern soldiers wrote their names on pieces of paper and pinned them to their blouses, not wanting to die anonymously.

The Little Bighorn was something else. News of the debacle arrived immediately after July 4, as 46 million Americans, most of them living in the East, were celebrating the nation's Centennial. Disbelief, shock, anger rent the United States. How could it happen? Who was to blame? What would be done about the "Indian problem"?

STRONG LIGHT has now been shed on the battle as a result of the fire in 1983 that laid the field of combat bare. "It was a blessing in disguise," said archaeologist Richard A. Fox, Jr., doctoral candidate at the University of Calgary whose home is in the nearby town of Hardin. "Some of that land was impenetrable before the fire."

Urged on by James V. Court, superintendent of Custer Battlefield National Monument, and chief historian Neil Mangum, Fox planned a new kind of archaeological survey. He and Dr. Douglas D. Scott, of the National Park Service Midwest Archeological Center in Lincoln, Nebraska, then supervised the painstaking work. They are elated by what turned up and the interpretations made possible by the finds.

More than 4,000 artifacts were unearthed: bullets and cartridge cases in great number, iron arrowheads, pieces of firearms, buttons, a watch, horse trappings and bone, and much more. Human bone also was discovered, including an almost complete skeleton and, elsewhere, a finger bone encircled by a brass wedding ring with traces of silver plating still on it.

This marked the first time a battlefield has been systematically plotted into a grid to chart a fight's progress. The first time, too, that modern ballistic techniques have been applied to a field of combat. And one of the few times that precise locational information has been recorded for every relic found.

The work began with a phalanx of volunteers sweeping electronic sensing devices over the ground. "Pinners" followed, tagging the site of each find with a small plastic flag. Then trowelers gently probed for the object and exposed it. Finally, recorders collected each artifact, noting its exact position, and coded into a computer the specimen number assigned to every relic. This led to a computer map detailing battle events.

"The bullets and cartridge cases were most important in helping us see how the battle was fought," Scott said. "We coded Army ammunition in blue numbers, Indian in red. This showed us how the forces moved against one another. Thanks to the distinctive markings left by each weapon, we could even chart the paths of individuals."

The archaeologists learned that the soldiers were relatively stationary, while the Indians moved freely about as they overran one position after another.

A handful of codes on a computer printout, for example, suggests the tragic scenario of a trooper who may have been the last man to die. The archaeologists, reading the codes on the map, speculate that he tried to escape as the battle waned. The Indians saw him dash across a gully called Deep Ravine. They fired at him with at least six different weapons, some of them Army carbines. Bullets from six guns were found where he fell.

Drawing fire from so many Indians may indicate that the fight was nearly over—they could give full attention to this one man. When he dropped, they rushed to his side and hacked away with knives and hatchets. Bone fragments from his shallow grave bear the marks. A severed neck vertebra testifies to decapitation.

The teams excavating ground around memorial tablets to fallen soldiers were led by Melissa Connor, then a senior research archaeologist of the University of Nebraska. In addition to bones and bullets, they uncovered clues to the regiment's garb.

"From the number and kind of pants buttons we found, we deduced that most men wore regulation trousers," she said. "Glass and mother-of-pearl buttons signified underwear and shirts. Tunic buttons told us

that soldiers had blouses. At least one trooper wore a kepi rather than a broad-brimmed campaign hat."

In minutely charting the flow of battle, the researchers were assisted by Dick Harmon, on loan from the U. S. Geological Survey in Lincoln; he is a specialist in frontier firearms. Harmon, Scott, and Fox came up with overwhelming evidence that the Sioux and Cheyenne outgunned the soldiers.

The Seventh Cavalry fought with Springfield single-shot carbines and Colt six-shot revolvers. Ballistic studies indicated that more than a third of the 1,500 Indians (a generally accepted conservative estimate) were armed with at least one of their 41 different kinds of firearms. Perhaps 200 carried 16-shot repeating Winchester and Henry rifles. As the Sioux and Cheyenne overran cavalry positions, they also gained Army weapons and ammunition.

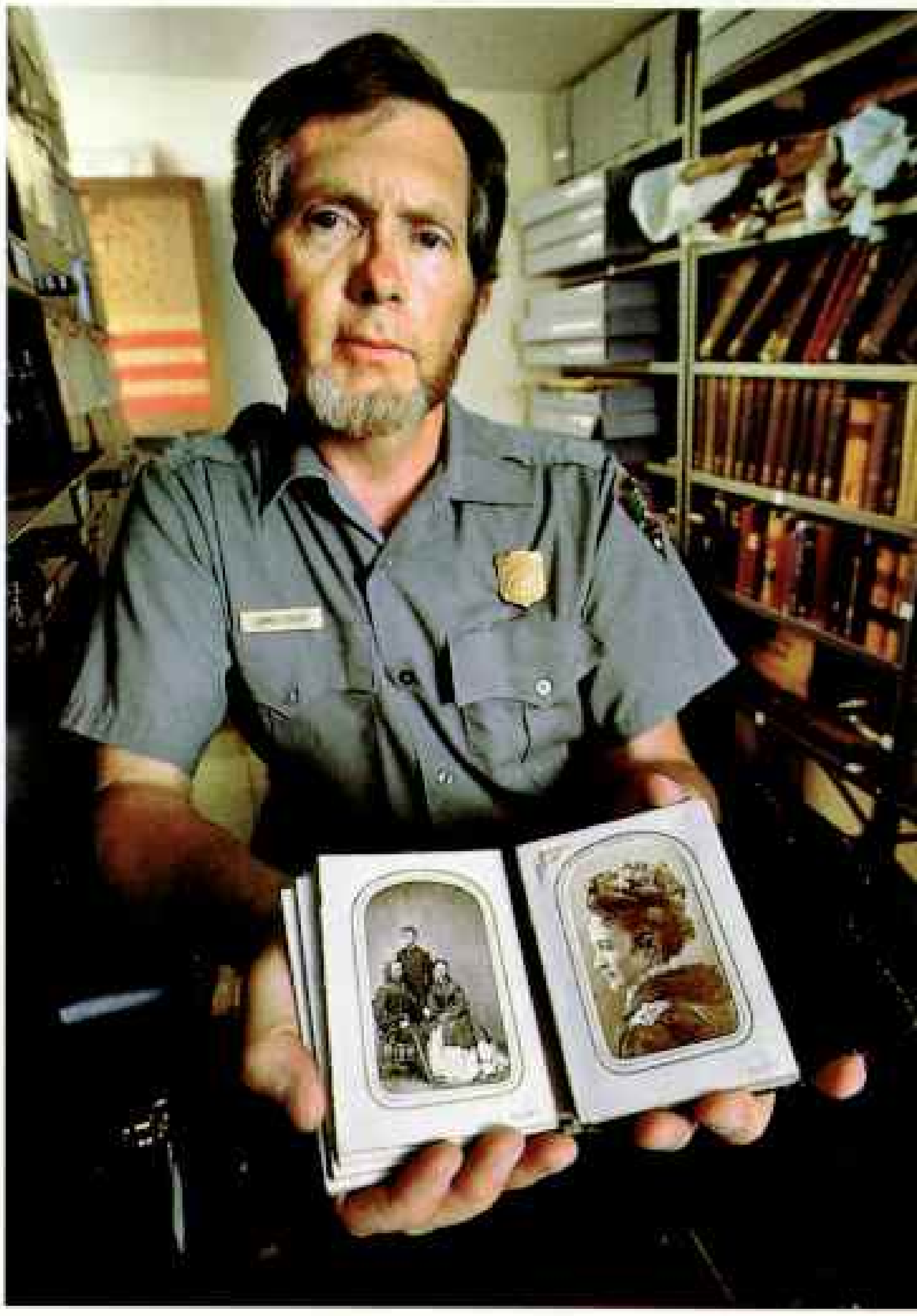
The investigators' interpretation: "With the relative lack of cover available to Custer and the dispersed deployment of his command against superior numbers of Indians with greater firepower, the reason for the outcome of the battle can no longer be significantly debated."

AS THE PATTERNS of cartridge cases and bullets reveal Indian and cavalry positions, so they affirm that the legend of Last Stand Hill is rooted in truth. On this highest point of the long ridge above the Little Bighorn gathered the doomed survivors of Custer's five companies. One by one they dropped in the gunsmoke and confusion, sprawling among the bodies of horses slain for breastworks.

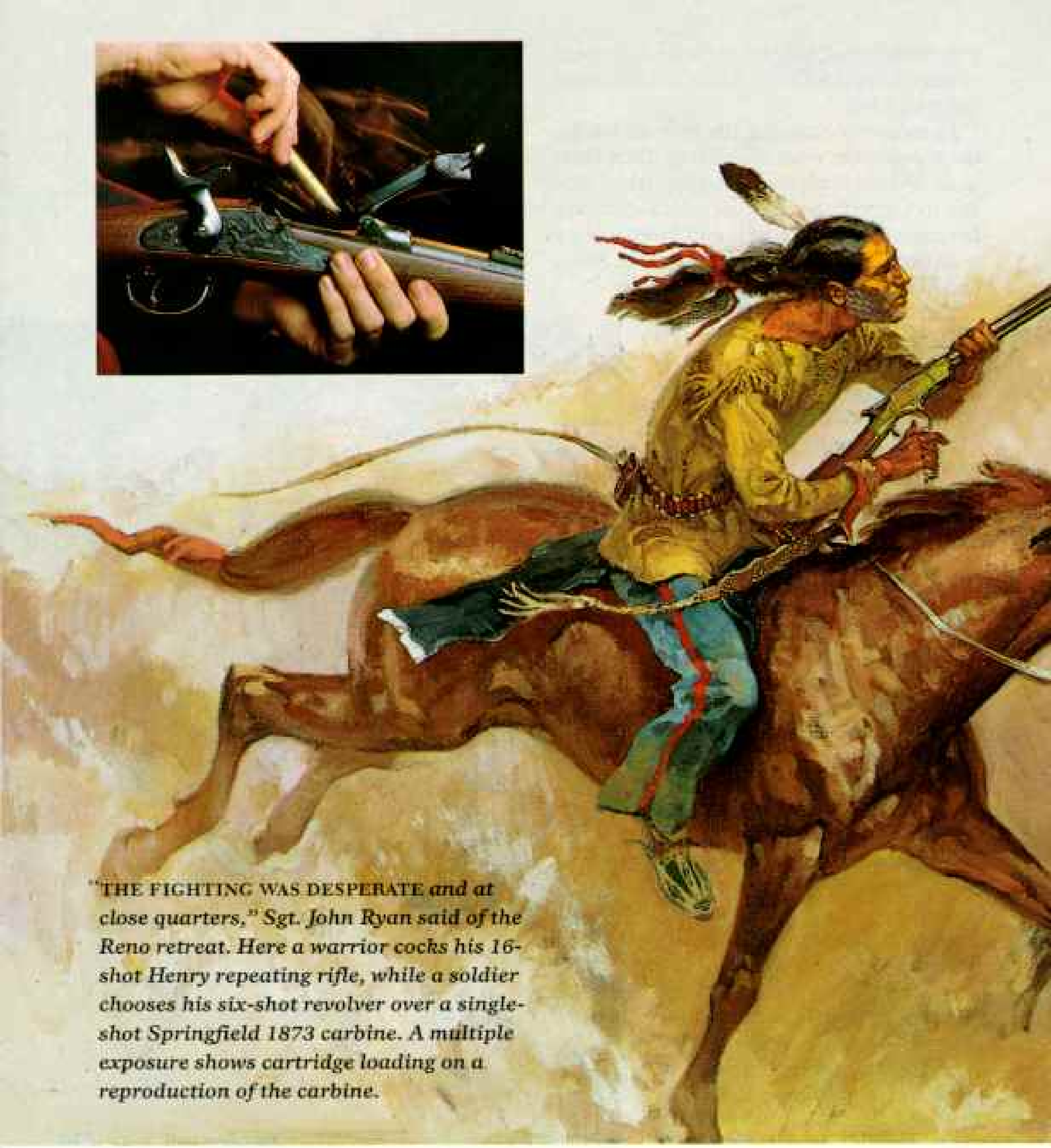
The wounded could only wait, some feigning death. When the troopers' fire dwindled away, the warriors rushed them, using rifles, bows, clubs, hatchets. Indian women participated in finishing them off. Arrows pinned some bodies to the earth.

George Custer was found there, shot through the temple and left side and stripped naked (as most of the soldiers were). Who killed him? No one will ever know. The Indians were unaware they were fighting him.

Nearby lay his horribly mutilated brother, Capt. Thomas W. Custer of Company C, twice winner of the Medal of Honor in the Civil War. He could be identified only by the tattooed initials on his arm. Another



"Do not be anxious about me." *Elizabeth Custer preserved her husband's words in books and promoted his memory until her death in 1933. In an album held by battlefield superintendent James V. Court, she appears opposite an 1865 portrait of the couple with brother Capt. Thomas W. Custer. He, too, died at the Little Bighorn, as did a younger brother and a nephew who rode along for the adventure.*



"THE FIGHTING WAS DESPERATE *and at close quarters," Sgt. John Ryan said of the Reno retreat. Here a warrior cocks his 16-shot Henry repeating rifle, while a soldier chooses his six-shot revolver over a single-shot Springfield 1873 carbine. A multiple exposure shows cartridge loading on a reproduction of the carbine.*

brother, young Boston Custer, a civilian guide, met death a short distance away, as did their 18-year-old nephew Harry Armstrong Reed. He had come along for the ride.

In the forefront of the search for deeper understanding of all this is Dr. Clyde Collins Snow, an internationally known forensic anthropologist. He is working closely with archaeologist Melissa Connor. At the state medical examiner's office in Oklahoma City, where he is a consultant, Snow examined the skeletal remains found on the battlefield. Most are fragments. "Mike," however, is almost a complete skeleton.

"He was between 19 and 22 years old and a healthy specimen," Snow told me, "though he had a defect in the fifth lumbar vertebra that must have caused pain. I'll bet his back was sore that day. Those boys had been riding hard. He was probably swearing he'd never re-up in the cavalry."

Forensic techniques indicated that Mike

PAINTING BY ROY ANDERSEN

was about five feet eight, an inch above average, stocky, weighing 150 or 160 pounds, and likely was right-handed. If only 19 or 20, he had falsified his age to join the Army; minimum enlistment age in those days was 21. "I suspect quite a number of Seventh Cavalrymen were in their teens."

What befell Mike?

His bones reveal his destiny. At or around the time of death, the application of massive blunt force fractured his skull and sheared off his teeth—"possibly with a rifle butt or a war club." He was shot twice in the chest, and a bullet fragment is still embedded in his left wrist. Gashed thighbones evidence six chopping blows, perhaps an attempt at dismemberment with "a heavy-bladed instrument such as a hatchet."

"My guess," the anthropologist went on, "is that maybe 10 percent of the men were killed instantly. The rest lay there wounded but alive. Like Mike. If you were to choose

an 'unknown soldier' of the Seventh, he would fit the mold. Here's this young kid, this trooper with a sore back and now lying there with those terrible wounds. What was going through his mind? He could hear the Indians yelling. He knew they were coming. That strikes me as particularly horrible."

Clyde Snow doesn't know Mike's identity. His remains were discovered near a memorial marker in Square M: M for Mike. The other skeletal fragments also must forever be labeled "unknown."

A LITTLE MORE than four miles south of Last Stand Hill, troopers under Major Reno and Captain Benteen were digging in on the river bluffs. With the Indians in their face, the aid Custer had

desperately sought of them by messengers would not be forthcoming. The men were crying for water, especially the wounded.

When the Sioux and Cheyenne finished their work with Custer, they joined the attack on Reno and Benteen, laying siege much of the following day. Then, abruptly, aware that a fresh Army column was approaching, they struck their tepees and departed, trailing south toward the distant Bighorn Mountains.

It was over. But most of all it was over for the Indians. These people of the plains long had been doomed by the white man's inexorable westward expansion. The Army had perpetrated cruelties in earlier Indian battles as savage as any inflicted on Custer's men. But in thrashing the Seventh Cavalry, the Indians sealed their own fate. Within a year the Army hounded most to the hated reservations. Like the vanishing buffalo, their way of life was no more.

Today visitors to the Custer battlefield gaze out on a spare and lonely land still little changed. Daisies and mariposa lilies perk up the sere slopes and ravines, and tiny roses cast a pink-purple haze on the countryside. Unlike many fallow fields of combat, no artillery takes silent aim here—Custer had elected to leave behind the only available large weapons, three cumbersome Gatling guns. But 252 marble tablets poke above the grass in solemn remembrance, most reading simply, "U. S. SOLDIER 7TH CAVALRY FELL HERE JUNE 25, 1876."

There are more markers here than the number of fallen; no one is sure why. For that matter, the precise number of fatalities also is unknown. What happened to the bodies of 28 Company E troopers who died in Deep Ravine? The search last season found no trace of their remains.

Two days after the battle, burial parties with few tools threw a little earth over the bodies or merely covered them with sagebrush; later they were reburied. Remains of officers, originally marked by tepee poles, were reinterred, most in the eastern United States. Custer lies at West Point.

Since 1881 a common grave has held the bones of most troopers. It rests at the base of a large memorial on Last Stand Hill. The shaft is inscribed with each man's name.

There are no official markers for Indian casualties. No monument commemorates their victory. No one knows precisely where Indians fell; by custom they were not left on the battlefield but were carried away. Indian accounts of fatalities on the field range from 30 to 136. A good guess might be 100.

You must search a bit to find the only notice given a fallen warrior. A wooden tablet, painted blue with white lettering, it stands just off the road above the visitor center: "LAME WHITE MAN, A CHEYENNE LEADER, FELL NEAR HERE."

There also is a trenchant inscription on a wall of the visitor center: "KNOW THE POWER THAT IS PEACE." It is ascribed to the Sioux holy man Black Elk, who as a young boy at the Little Bighorn took two scalps during the battle. Occasional demands by

Sifting through the evidence, *archaeologist Melissa Connor and volunteers* ***(opposite)*** *work amid marble markers erected to show where soldiers fell. On one marker rest recovered items: silver five-cent pieces, an aluminum-handled knife, and a gold-plated brass watch* ***(below)****. The Indians were intrigued by timepieces they took off dead soldiers. "I wore it around my neck a long time before I found out what it was and how to make it tick again," recalled the Oglala Sioux Black Elk.*

Researchers analyzed thousands of cartridge cases. From the "fingerprint" firing-pin notches on .44-caliber rimfire cartridge cases, seen next to an unfired cartridge ***(opposite, below)****, they followed an Indian rifle in battle. One case was recovered on the Custer battlefield, one at the Reno-Benteen site.*

Custer buffs that it be removed have failed. So there are two graphic citations on this storied field honoring the Indian side.

IT IS UNDERSTANDABLE that Native Americans feel misused when it comes to Custer and the Battle of the Little Bighorn. They dislike the very name Custer Battlefield National Monument; after all, it was they who won.

At the Fort Peck Reservation in northern Montana, Sioux tribal councilman Caleb Shields suggested a couple of other names. "Sitting Bull National Monument would be more appropriate," he said, "or Little Bighorn National Monument.

"Custer is no hero of ours," he continued, "but he is only a symptom. When people read about the battle, it's *all* Custer. The big problem is national—history books inadequately portray the Indian in his religious, cultural, social, and economic life. The only way Americans are ever going to understand one another is through education."

Indians take little interest in the mythology spawned by the events of 110 years ago —the phenomenon known as Custeriana. Countless prints and paintings essay the Last Stand. Innumerable books and articles examine its whys and wherefores. Scholars disagree. Poets lament. Motion pictures distort. Some Custer cultists name their children after him or Elizabeth; when they gather, some wear homemade cavalry uniforms. Some greet one another in hearty camaraderie: "Garryowen!"

Close by the visitor center spreads a national cemetery, its tall imported conifers

CAVALRY UNIFORM FROM THE JEROME GREENE COLLECTION, DENVER, COLORADO

and rich green grass contrasting vividly with the sweep of sunburned wild pastureland around it. Here rest several Crow scouts who served the Seventh Cavalry. Soldiers are buried in this soil who died fighting Indians in other wars on the plains, as are servicemen of later wars down to Vietnam, including Indians.

Historian Mardell Plainfeather, a Crow and one of four Native Americans helping to interpret the battle, saddens to walk here. She finds injustice in this hallowed place. We paused at a monument to officers and soldiers killed "while clearing the District of the Yellowstone of hostile Indians."

"Hostile Indians," she said with a wry laugh. "It's offensive. As if those troopers were getting rid of a plague. These were people, this was *their* land. They fought for

He was young, *19 to 22 years old, and probably on his first campaign with the Seventh Cavalry. Shot twice in the chest, his skull shattered by a violent blow, he died an unknown soldier. Named Mike by the archaeology team, he bears evidence of hatchet mutilation on his right thighbone* ***(below)****; the remains of his boot cradle his right foot* ***(above left)****. Mike's nearly complete skeleton* ***(above)*** *was reburied last June in the national cemetery, as were other bones found.*

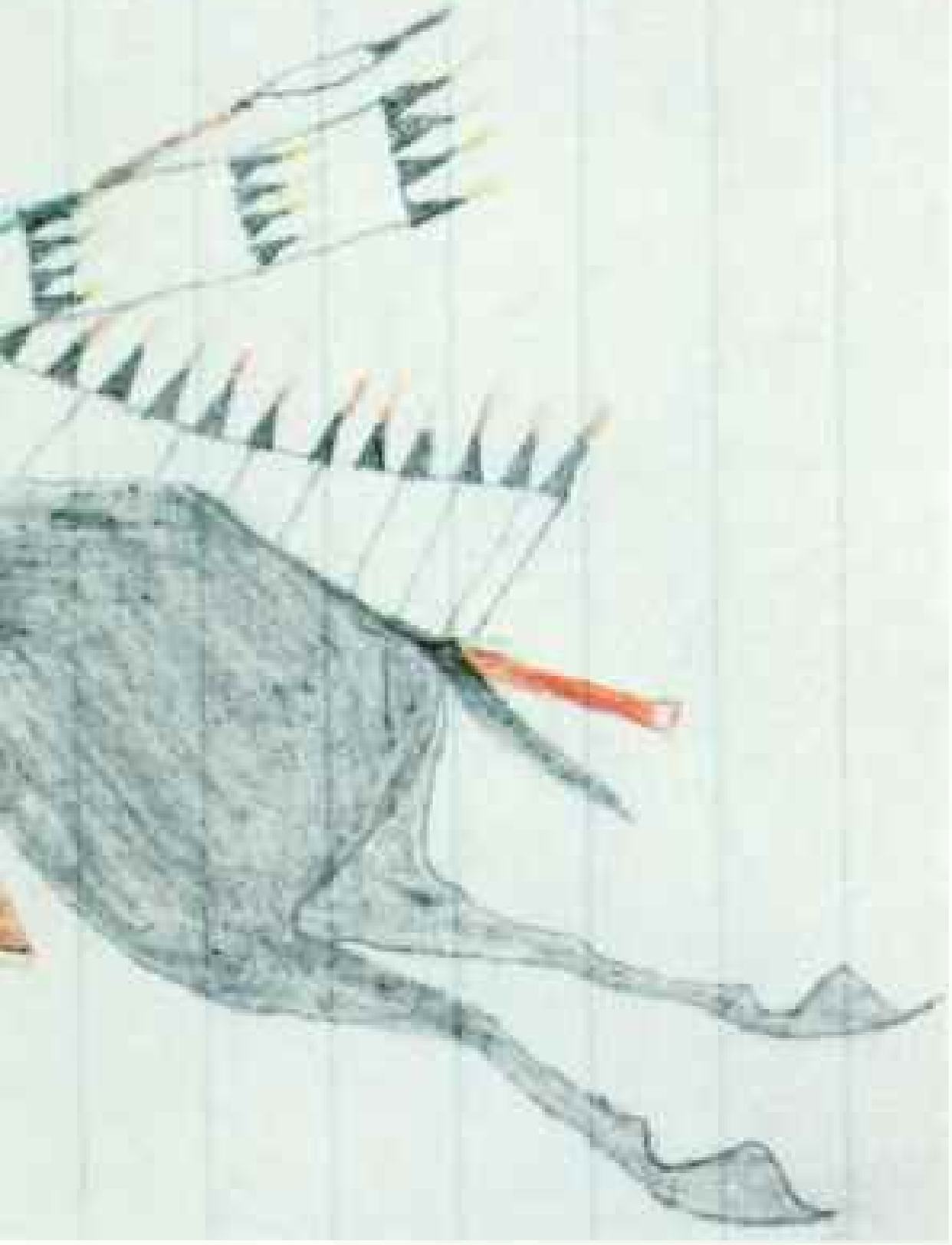
their families, their homes, their culture, their freedom. Visitors who come here forget that when they read something like this. I wish these words could be removed."

NOT LIKELY. But superintendent Court and chief historian Mangum insist that visitors get a balanced presentation of the clash of cultures that occurred here. "Some people think that we are supposed to memorialize Custer," Mangum said. "In fact, this was originally an Army shrine, run by the War Department. Today the battlefield is not just for Custer. It's preserved for both sides."

That is to say, the national monument is preserved: the 600-acre Custer battlefield (including the cemetery) and the 160-acre Reno-Benteen entrenchment site. A winding two-lane road spans the three miles between them. But the conflict swept across some 10,000 acres. Land between Reno-Benteen and the Custer battlefield, as well as the terrain of Reno's valley incursion against the tepee village, occupies around 9,000 acres. All of this is privately owned and within the Crow Indian Reservation, most visitors are surprised to learn.

The nonprofit Custer Battlefield Preservation Committee is seeking eight million dollars to buy the land and give it to the National Park Service. So far the committee has received $200,000 in donations and has bought 80 potentially commercial acres at the monument's entrance.

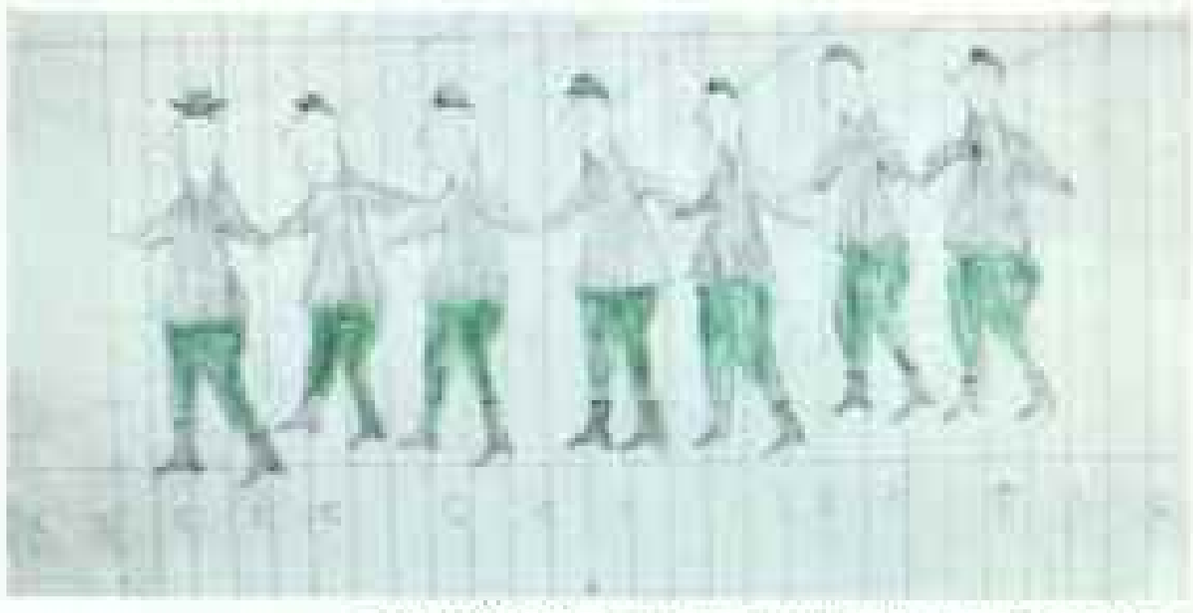
"We want to protect the site," Court said.



"The main goal is simply to preserve the land as it looked in 1876 and give us access for further archaeological work. We are losing a lot of historical material to unauthorized metal detecting. The committee doesn't want to change the present use of the land; grazing is compatible and could be permitted. If some land is not for sale, we'd like to lease it or obtain a scenic easement."

Further archaeology? Much remains to be done. What became of excess equipment Reno and Benteen discarded after the battle? Many horses had been killed; why keep useless saddles and heavy picket pins and chains? Where are the broken firearms? Troopers smashed weapons so that Indians could never use them—too much of that already. Well, the Reno-Benteen dump, a treasure trove, has been discovered and awaits excavation.

A veteran Cheyenne warrior *in his late 20s, White Elk rode into battle on a borrowed pony and brought back a cavalry horse as thanks to the lender. He recorded one of his kills (**left**) in the captured roster book. Drawing hoofprints across the bottom and lines from the heads of soldiers (**below**), Crazy Wolf depicted "counting coup"—the heroic act of touching an enemy.*



BOTH FROM DOUBLE TROPHY ROSTER BOOK, HEYE FOUNDATION, MUSEUM OF THE AMERICAN INDIAN

Many questions about the accuracy of markers to fallen soldiers can be answered by further study. Too, additional excavations around markers are likely to yield more human bone, leading to increased knowledge of the physical appearance and general health of the Seventh Cavalrymen.

And the nagging mystery of Company E's 28 missing men, said to lie somewhere in Deep Ravine, demands renewed search. The scientists believe they are closing in.

ONE OF THE LARGEST NEEDS at the battlefield is a vision, an understanding, of the Plains Indians, whose way of life died here. For generations the Sioux, Cheyenne, Crow, Blackfoot, and other tribes roamed the plains and lived at one with nature. The endless buffalo herds met most of their wants.

A man who speaks passionately of this culture, and the need to call attention to it, is painter, author, and Indian ethnologist Paul Dyck of Rimrock, Arizona. His collection of Plains Indian artifacts, begun a century ago by his father, is valued conservatively at 17 million dollars. It is one of the most complete assemblies of its kind in the world.

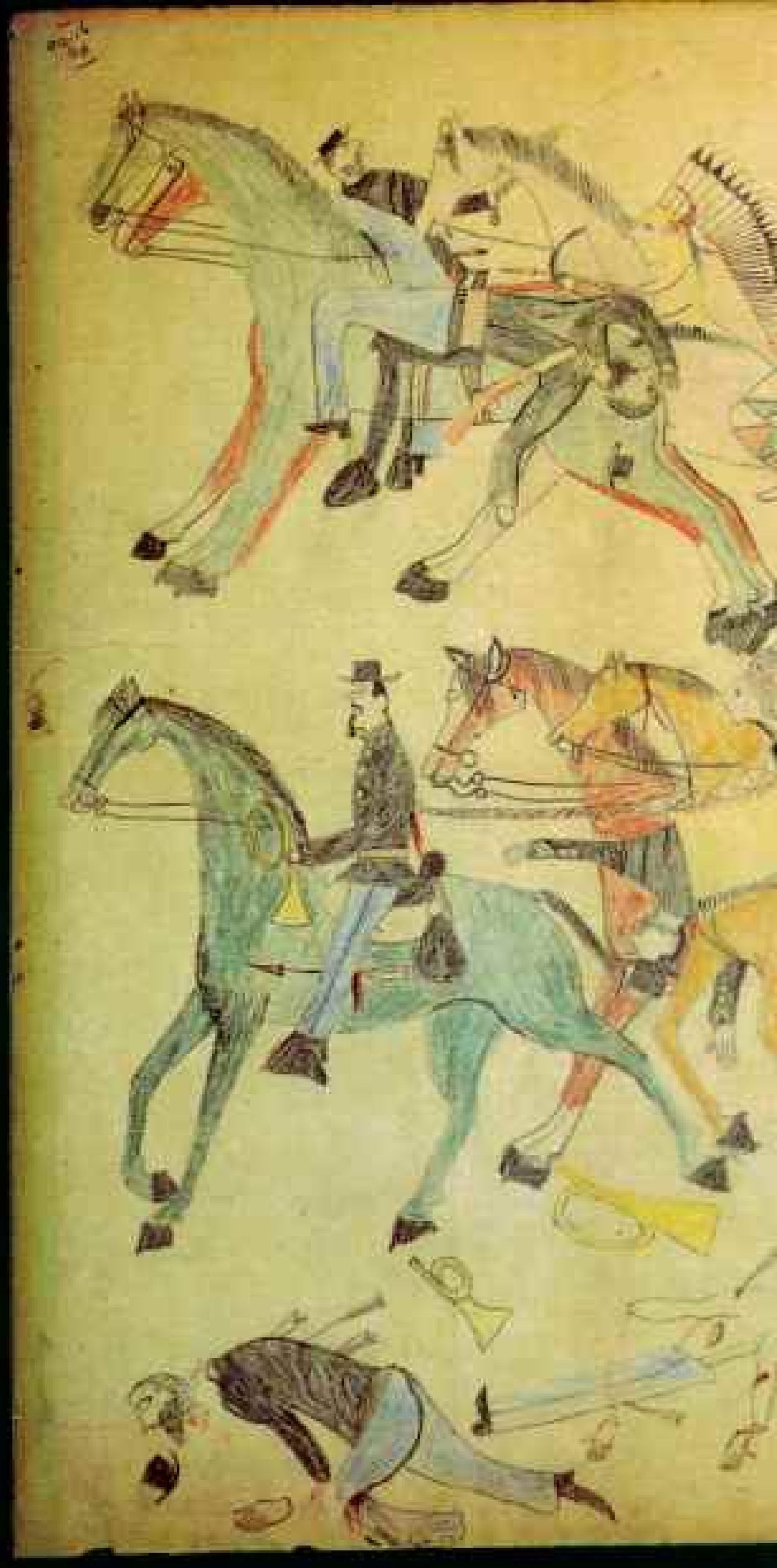
"The Battle of the Little Bighorn," Dyck said, "happens to be the setting where the nation was *(Continued on page 812)*

D. F. BARRY PHOTOGRAPH, THOMAS HEISKI COLLECTION

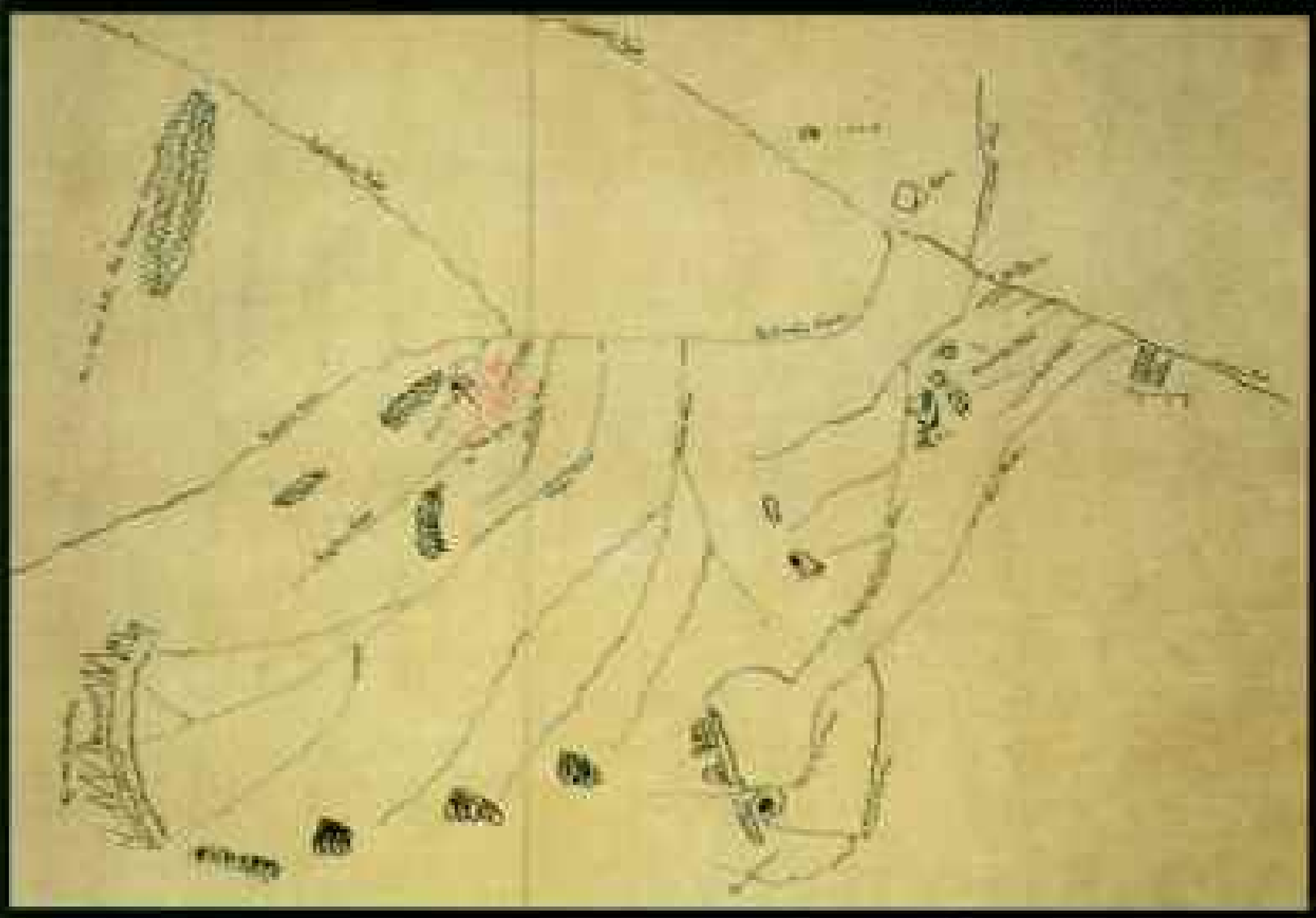
Graphic visions from the winning side

"I WAS A SIOUX CHIEF *in the council lodge,*" *Miniconjou warrior Red Horse (above) told an Army surgeon at the Cheyenne River Agency in Dakota Territory in 1881. He spoke in sign language and also filled 41 sheets of manila paper with colored pencil drawings. They probably reflect personal and tribal memory and are not strictly literal. This view of Custer's troops (above right) is likely not a specific battle scene but a general view of the cavalry's defeat.*

Red Horse was digging wild turnips when Reno's men "charged so quickly we could not talk. . . . The Sioux mount horses, take guns, and go fight the soldiers. Women and children mount horses and . . . get out of the way. . . . After driving these soldiers across the river, the Sioux charged the different soldiers . . . and drove them in confusion; these soldiers became foolish, many throwing away their guns and raising their hands, saying, 'Sioux, pity us; take us prisoners.' The Sioux . . . killed all of them. . . ." He recalled that Custer's battalion "made five brave stands." Crow King said, "They kept in order and fought like brave warriors as long as they had a man left." Sitting Bull, who was in his mid-40s and not expected to fight, judged Custer a "great chief." He also thought he "was a fool and rode to his death."



NATIONAL ANTHROPOLOGICAL ARCHIVES, SMITHSONIAN INSTITUTION (ABOVE AND BELOW)



RED DOTS *mark the Little Bighorn battlefield on Red Horse's map. The Sioux and Cheyenne hunted from the Missouri River, diagonal at top right, to the Bighorn Mountains, bottom left. As the Terry-Gibbon column approached, the tribes left the area, hoping to avoid further conflict.*

"THE SOLDIERS KILLED 136 and wounded 160 Sioux," said Red Horse, though his art depicts only 61 dead. Indian reports of the number of their casualties vary, and the Army count was incomplete. Crow King thought 30 to 50 were killed in battle and later a larger number of the wounded died. Gall believed the death count was 43 and agreed that many wounded did not survive. The Cheyenne said 6 to 12 died, including

Lame White Man, shot and scalped by a Sioux who mistook him for an Army scout on the gunsmoke-shrouded field. "Had the soldiers not divided," said Red Horse, "I think they would have killed many Sioux."

NATIONAL ANTHROPOLOGICAL ARCHIVES

CUSTER BATTLEFIELD COLLECTION, NATIONAL PARK SERVICE

"THE SIOUX MEN *took the clothing off the dead and dressed themselves in it.*" *So Red Horse described the stripping of soldiers. Most were mutilated in rage or to keep them from enjoying the spirit world. The two Indians in the far panel may be Army scouts. Shot in the side and temple, Custer was found naked but not scalped. After years of questioning as to the identity of Custer's killer, several warriors claimed the honor. But at the time the Indians did not know they were fighting the man they often called Long Hair.*

After the battle the Army found a bugle, above, near Capt. Myles Keogh's body. John Patton, Keogh's trumpeter, lay across him. The Indians also picked up some bugles. Besieged on the bluff with Reno, Sgt. John Ryan later reported: "About the middle of the night we heard a trumpet call, and the men commenced to cheer, thinking it was Custer's men who were coming to our assistance."

NATIONAL ANTHROPOLOGICAL ARCHIVES

Filling the vacancy *of an officer granted a delay in stationing, infantry Lt. John J. Crittenden died near Lieutenant Calhoun with Company L.*

Gall described how this group "never broke, but retired step by step. . . . They were shot down in line where they stood." The archaeology confirms this scenario: soldiers trying to hold formation; Indians moving freely about, fighting an offensive battle—which Custer did not expect them to do.

Despite the odds, Custer probably believed he could win when he instructed his adjutant, Lt. William W. Cooke, to send a message (**facing page**) *for Benteen to "Be quick" in bringing ammunition. But that day the Indians won—their last great military victory.*

(Continued from page 805) welded together to try to end the Indian question. Custer merely provided the catalyst. The Little Bighorn is the place where the Indians should be honored."

Dyck has acquired 40 acres adjoining the national monument's entrance and hopes to build a museum "honoring all the tribes who loved this land, and their cultural and spiritual contributions to this nation." He plans to give the collection to the United States to be held in trust for the American people.

There are more than 5,000 cultural artifacts dating from 1700 to 1885. Dyck led me on a fascinating tour: full warriors' costumes, buffalo robes, blankets, horse gear, weapons, buffalo-hide lodges, warrior art, children's toys and dolls, religious material—to name a few items.

"We have the collection," Dyck said, "and we have the land at the best of all locations. What we need is the physical plant. We are trying to raise around two million dollars in private donations. This is an irreplaceable and priceless national heritage. It must find a permanent home."

Eventually the Park Service wants to move from its outmoded visitor center on the battlefield to larger quarters near the monument entrance. There the center and the Dyck museum, all parties agree, can complement one another in many ways.

MEMORIES of the Little Bighorn visit the mind in a thousand, ten thousand, fragments. Walking in the cemetery, where fighting once swirled, it startles you to come upon the grave of Maj. Marcus Reno, who was never the same after his attack on the tepee village. In 1880 he was dismissed from the Army for personal misconduct, a punishment that a later Army board found "excessive, and . . . unjust." Reno lies on a gentle hillside; "BVT BRIG GEN" is inscribed on his tombstone, the rank he won in the Civil War.

Both Reno and Capt. Frederick Benteen —it was Benteen's leadership on the river heights that held the attacking Indians at bay—disliked George Custer intensely, though they served under him to the best of their ability. Benteen retired as a major in 1888, an embittered old soldier who had followed too long the calls of "that brazen

trumpet." In 1890, almost as an afterthought, he was brevetted brigadier general for heroic conduct at the Little Bighorn.

The great Oglala Sioux chief Crazy Horse, veteran of many battles with soldiers, is thought to have led one of the closing charges on Custer, at Last Stand Hill. He was fatally wounded a year or so later in a scuffle while being taken to the guardhouse at Fort Robinson, Nebraska.

Sitting Bull, most influential of hostile chiefs and a leading defender of the old way of life, never fought in the battle with Custer but remained at the village. He then led his band into Canada. Promised amnesty, he returned in 1881. In 1885 he toured the country with Buffalo Bill Cody's Wild West Show, billed in heartless irony as "Custer's killer." In 1890, resisting arrest at Standing Rock Reservation in the Dakotas, Sitting Bull was shot to death.

And sweet-faced, mild-mannered Elizabeth Custer? She died in 1933, just two days before her 91st birthday, one of the last survivors, a widow almost 57 years. As you might expect, she remained George Custer's greatest admirer, brooking no detractions, singing his praises in three books. She described their military life and adventures simply and clearly and with something less than the whole truth. Nowhere in them, as at no time in her long bereavement, did she take note of any imperfections in the general.

Elizabeth lies at West Point beside her shining knight. Fittingly, her modest headstone is overshadowed by Custer's splendid obelisk. She would have it no other way.

THERE IS NO GRAVE for some who rode at the Little Bighorn, Mardell Plainfeather told me. Spirits live there. They appeared to her late one summer evening on a bluff above the river.

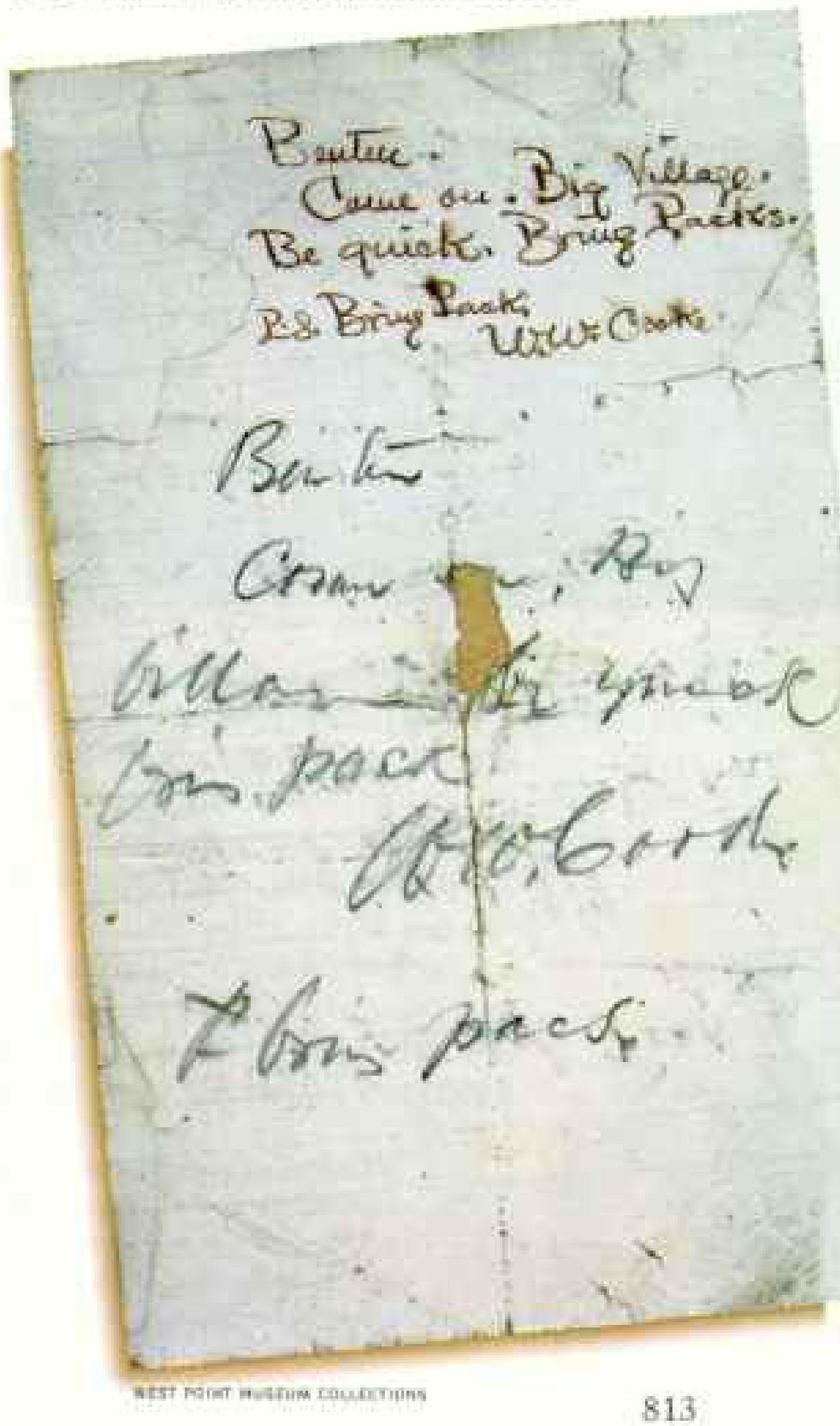
"I saw two warriors on horseback silhouetted against the sky looking down on me," she said. "I rubbed my eyes, looking again to make sure. One had long flowing hair, the other braids. They wore feathers and carried shields. I saw a bow and a quiver of arrows. They were silent and motionless except when one lifted himself higher, seeming to want a better look at me.

"I knew somehow that they meant me no harm. I was not afraid. Any noise would have scared me out of my wits. It was my first and only supernatural experience.

"I think they are there all the time. Next morning I took some sweet sage and left it there. It's used by most Plains Indian tribes for purification purposes. To us it's kind of like having a crucifix in your home.

"People tease me about this. I get a lot of joking. Being a Native American, I believe there are many things that remain unanswered to mankind. The Indian never questions the order of nature. I saw what I saw. Where historic battles took place, and where historic people have lived, spirits linger. In their own way, the ghosts speak." □

For further information on efforts to preserve the Custer battlefield site and artifacts of the Plains Indian culture, readers may write to the following organizations: Custer Battlefield Preservation Committee, P.O. Box 7 NG, Hardin, Montana 59034; and Paul Dyck Foundation, P.O. Box 217, Rimrock, Arizona 86335.



WEST POINT MUSEUM COLLECTIONS

Fly of the Deadly Sleep

Tsetse

ARTICLE AND PHOTOGRAPHS BY
GEORG GERSTER

"AND NOW . . . how about a bite?" Lunchtime it was, but not a luncheon invitation. The keeper of the tsetse fly breeding colony in the basement of Walter Reed Army Medical Center in Washington, D. C., was tempting me with a bite by one of his wards.

"Researchers who have been around tsetse in Africa for years, but have never been bitten, come here and bashfully request a bite," my guide explained. "I oblige them," he reassured me, "with clean flies."

Tsetse flies, when unclean, are hosts for microscopic parasites called trypanosomes, which cause sleeping sickness in humans and transmit the wasting disease nagana to livestock. In forest and savanna south of the Sahara at least 50 million Africans in 38 tsetse-infested countries live with the threat, as do some 40 million cattle and uncounted millions of goats, sheep, camels, mules, pigs, and horses. Game animals also receive trypanosomes, or "tryps," from the fly but do not visibly suffer from them.

GLOSSINA PALPALIS GAMBIENSIS, SIX TIMES ACTUAL SIZE

It was the tsetse and its trypanosomes that a thousand years ago blunted the thrust of Islam into Africa's heartlands: Camels and horses of Muslim missionaries, merchants, and marauders inexplicably died upon reaching the flybelt.

Worried about the future of the hungriest continent, research laboratories worldwide are focusing on the fly and its deadly passenger. Tsetse-control programs are hitting hard in many areas. As a result many Africans look forward to a tsetse-free future, with access to immense tracts of newly opened land. But many conservationists dread such a possibility. Eradicating the tsetse and opening its domain to cattle, they claim, will destroy African wildlife's last great stronghold.

Thus Africa's dilemma.

I declined the offer of an initiation bite. My visit to Walter Reed was only the beginning of a long quest, and surely, down the road in Africa's wilds, a tsetse or two must wait for my blood—clean ones, I hoped.

Africa's 22 species of tsetse flies, members of the genus *Glossina*, all feed

Victims of sleeping sickness, *a child and his mother visit an Ivory Coast clinic; the boy survived, the mother did not. Trypanosomes, the parasites that cause this illness—and a related animal disease called nagana—are spread through the blood-sucking bites of infected tsetse flies. The tsetse* ***(above)*** *has strongly influenced the history of Africa and will help shape its future.*

voraciously on vertebrate blood; their rapier-like proboscis can pierce even rhino skin or a bushwhacker's protective canvas. Tsetse pick up the trypanosomes with blood they ingest from an infected host and transmit them with a later blood meal.

Each year some 20,000 Africans fall victim to sleeping sickness, records show. But a vastly larger number of cases probably go unreported. Earlier in the century the disease killed millions. Today it can usually be cured if detected before entering the central nervous system, when treatment can be as toxic to the patient as to the parasite.

WAR HAS BEEN WAGED on the tsetse since colonial days, with battle lines ever shifting. Control efforts of many nations slackened upon their achieving independence, and often the fly returned with a vengeance. At present no other nation conducts as massive and concerted a tsetse campaign as Zimbabwe.

From Harare, the capital, I flew to Wadze, the front line in an assault on 10,000 infested square kilometers (3,900 square miles) in northwestern Zimbabwe. A few safari tents and an airstrip lost in the bush, Wadze could have been a hunting camp except for its overpopulation of tsetse experts and foolhardy pilots. They were midway through the dry season's aerial spraying—literally a fly-by-night operation designed to take advantage of the nocturnal calm so that minute droplets of insecticide could waft into every nook and cranny of bush.

Chief pilot Mark Kleynhans offered me his copilot's seat during a two-plane sortie. Radar would help keep the craft apart and on track. For altitude—no higher than ten meters above the canopy—the pilots would rely on visual cues as they streaked over rugged terrain in darkness pierced only by the thin beam of our 3.5-million-candlepower searchlight. Airborne, we sought out an array of 39 beacons feebly marking the hilltops. Ahead the lead plane beckoned like a firefly. Often smoke and haze blinded our light as it fingered the bush.

Ahead an escarpment suddenly towered like a black wall; the lead pilot radioed for a flare to light it up, but no ground station

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Georg Gerster, a Swiss photographer-writer who holds a doctorate in philology, has contributed nine other stories to the GEOGRAPHIC.

Forced by drought *to graze cattle in a tsetse fly-infested area, Masai in southern Kenya lose another cow to nagana even as a field researcher examines the herd's blood for trypanosomes. Destroying red blood cells, "tryps" cause fatal anemia unless cattle are treated early with drugs.*

obliged. Ghostly trees rushed by the wingtips on slopes too close for comfort.

To assure extermination, an area must be treated five times, at intervals of about two weeks. This accords with the tsetse's unusual life cycle. Unlike the housefly, which lays a thousand or so eggs in the span of weeks, every nine or ten days the mature tsetse gives birth to a single larva. The larva burrows into the ground to pupate, hatching 30 to 40 days later as a fly (page 820). Thus the need for carefully spaced, repetitive sprayings.

Ground support bolstered the aerial attack. I accompanied oxen and their drivers on morning and evening tsetse rounds, netting flies that landed on the bovine bait. These provided entomologists with clues to populations before and after treatment. With teams wearing knapsack sprayers, I jogged through high, dry grass and thorny bush as they sprayed lower branches and other refuges to prevent reinvasion of areas treated from the air.

"Ground spraying can be a logistical

Outwitting lions and leopards, *Masai build thornbush kraals to protect their homes, cattle, and goats at night. Wise in the ways of the tsetse fly, the seminomadic Masai have traditionally fought nagana and sleeping sickness by avoiding tsetse areas. Now growing population and drought drive them onto range they formerly shunned.*

headache," Brian S. Hursey, director of Zimbabwe's tsetse campaign, told me at our Wadze encampment. "I have 2,000 people and 200 vehicles in the field. You've got to run them like an army."

Teams on the ground spray DDT, an insecticide long banned in most industrial countries; its toxic residue accumulates in the food chain. The aerial spraying relies on low doses of the pesticide endosulfan that leave no residual effects.

Rhodesia (now Zimbabwe) successfully fought the tsetse for half a century, first with the drastic measures of bush clearing and game shooting, later by fencing game-free buffer zones and attacking with chemicals. But during the civil war of the 1970s, the fly made inroads. In places, scarcely one out of every hundred head of cattle survived.

Brian envisions a tsetse intervention force that would be on call to strafe and mop up fly outbreaks. Not in Zimbabwe alone; in Malawi, Zambia, and Mozambique as well. "This part of Africa lends itself to eradication, not just to control. High velds—too cold for tsetse—separate the flybelts, as do other barriers like Lakes Malawi and Kariba." Brian was adamant. "The fly must go."

THE EUROPEAN COMMUNITY in 1985 earmarked 20 million dollars for a three-year study of fly control in Zimbabwe, Malawi, Mozambique, and

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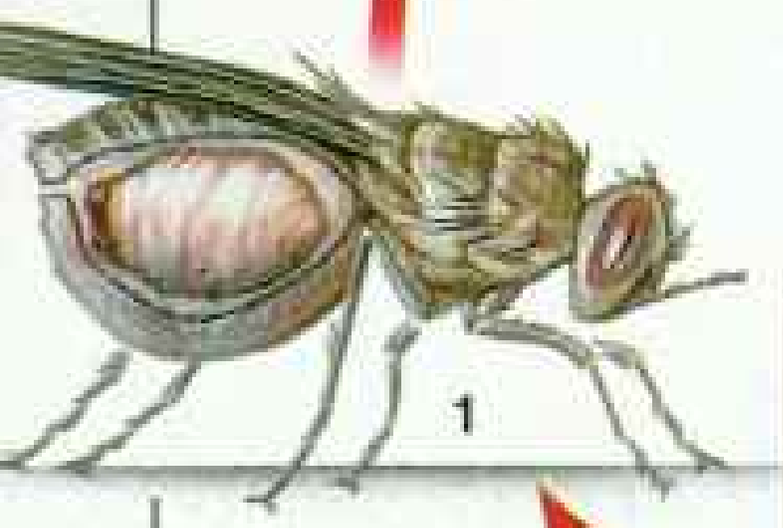
Lethal partners: tsetse and trypanosomes



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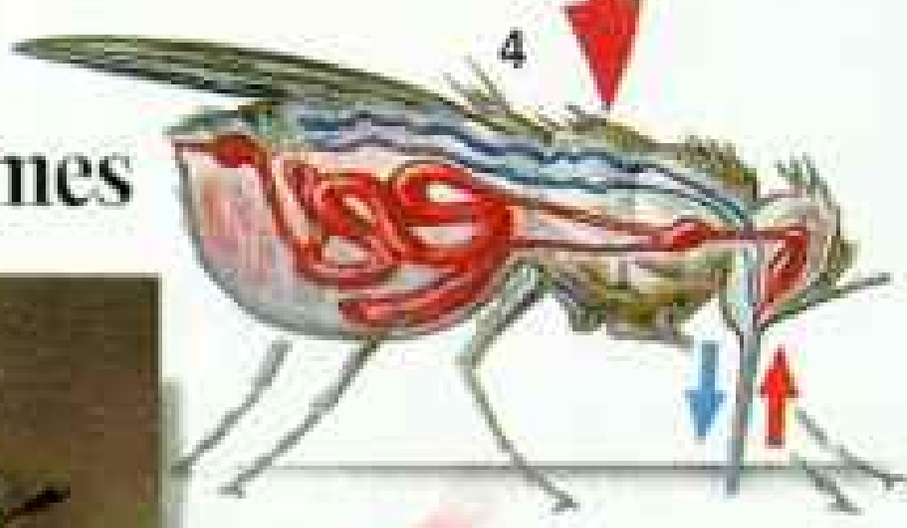

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PAINTING BY
SUSAN SANFORD;
TRYPANOSOME FLAGELLATES
(BOTTOM) PHOTOGRAPHED AT ILRAD
WITH THE ASSISTANCE OF HIROYUKI HIRUMI

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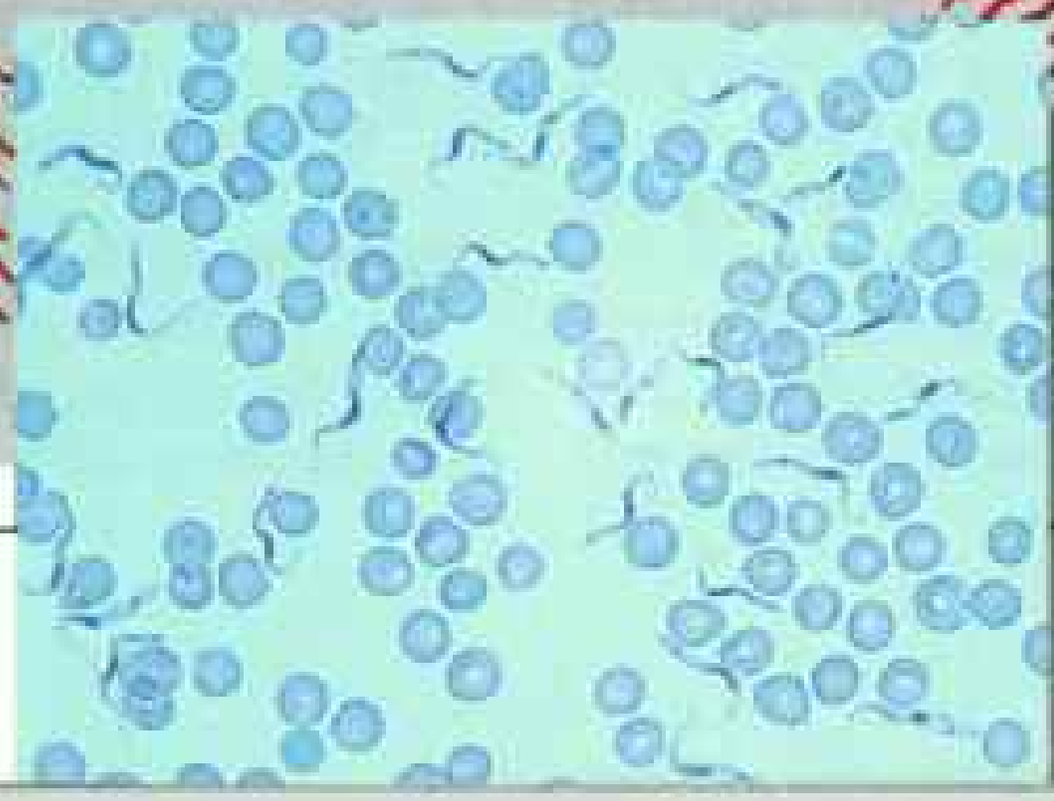


Scourge of a continent, *sleeping sickness, formally named African trypanosomiasis, is known to strike 20,000 Africans a year. Many more cases go unreported. The sequence of fever, lethargy, anemia, seizures, delirium, and finally coma can usually be reversed if countered by antiparasite drugs before the trypanosomes lodge in the central nervous system. A slow-acting form of the disease occurs in western and central Africa. A more virulent strain is found in eastern Africa.*

Nagana, caused by trypanosomes different from those that infect humans, annually kills three million cattle as well as other livestock, depriving subsistence farmers of food, draft power, and manure for crops.

*While most insects lay massive numbers of eggs, a female tsetse nourishes a single enormous larva with milk glands inside her body (**left,** **1**), bearing about ten offspring during a life span of less than six months. Upon birth* **2** *the larva burrows into the ground to pupate. About a month later the fly emerges from its darkened shell* **3**. *Born free of parasites, it picks up trypanosomes as it feeds on the blood of infected animals and humans* **4**. *With a proboscis strong enough to penetrate a rhino's hide, the fly can drink as much as three times its weight in blood, as does this Glossina pallidipes feeding on a laboratory rabbit (**center**).*

As thousands of trypanosomes **5** *enter the victim's bloodstream, antibodies swarm to the defense. But the single-celled trypanosome flagellates—here magnified 800 times among the red blood cells of a mouse (**bottom**)—are masters of disguise. Genetically changing their protective antigen coating* **6**, *they renew the attack. New antibodies evolve, but in vain, as the parasites can create a thousand antigen variations* **7**.

This quick-change artistry has thwarted efforts to produce vaccines against sleeping sickness and nagana. But it makes trypanosomes a valuable research tool for scientists studying genetic change and the nature of human and animal immune systems.

Zambia; it is considering committing at least 150 million dollars. But the EC imposes conditions: that there be environmental monitoring; that insecticides banned in Europe be forbidden; and that tsetse-free lands benefit smallholders, not just the cattle barons. And it advocates that "soft" tsetse control techniques be employed to their fullest.

I met with an apostle of the soft approach, Dr. Glyn A. Vale, in Rekomitjie, a research station in Zimbabwe's Zambezi Valley. At night elephants strolled among the labs and cabins and sipped from the swimming pool. By day choking clouds of tiny stingless bees swarmed in the surrounding woodlands. Evenings were tsetse time—here, the savanna species, *G. morsitans* and *G. pallidipes*.

Soon after I arrived, one landed like a flash on my leg and started pumping blood. Its bite was painful, but Glyn told me not to worry. "Any 'glossinologist' would feel honored to come down with sleeping sickness in Rekomitjie," he said with a smile. "It's so rare here as to be a distinction."

With his Welshman's humor and ever present felt hat, Glyn is a cult figure among the tsetse fraternity. He reigns undisputed as Mr. Trap.

Glyn started researching odor-baited tsetse traps 16 years ago. He already had discovered that flies are attracted primarily to smells, despite their keen vision. Step-by-step he learned that the aromas best suited to draw a fly are contained in an ox's breath.

Glyn regularly shipped ox's breath, held by absorbents, to London for chemical analysis and for testing on the fly's antennae. Three breath components emerged as particularly attractive to tsetse: carbon dioxide, acetone, and octenol. Simultaneously Glyn studied fly behavior around host animals, including reaction to visual stimuli, searching for the perfect trap.

He took me to the yard where he has junked gadgets he built along the way. "A lot of dashed hopes," he remarked as he surveyed a mound of wire and fabric. But then a final triumph. In the noon wind swiveled the fruit of his labor. From a beam on the contraption, bottles of acetone and octenol beckoned to flies downwind. Searching out the odor source, the flies become visually intrigued by a sheet of black cloth resembling a kite. Circling the target, they contact a

net impregnated with insecticide and die.

As an experiment 600 square kilometers of bush are being cleared of the fly the soft way. The first of 2,400 planned targets had been in place barely six months, but on the way to the site Glyn beamed. "Catches are down to one percent of what they were."

Glyn believes the future of tsetse control lies in trapping: more cost-effective than chemical control, safer for personnel and the environment. He and other researchers are constantly fine-tuning their wares. I watched Dr. Einar Bursell, a leading tsetse physiologist, experiment with a trap that exhaled the surrogate breath of a hundred oxen. He hoped its odor plume would lure flies from as far away as four kilometers.

"There is no reason," Glyn said, "why we shouldn't go after tsetse eradication."

MANY EXPERTS doubt that eradication is possible. And many environmentalists question the wisdom of eradication, or even tight control.

"I promote tsetse," Willie van Niekerk told me. Willie is a guide in the Moremi Wildlife Reserve of the Okavango Delta in Botswana. The inland delta of the Okavango River, a maze of swamps and floodplains, fans across 16,000 square kilometers north of the Kalahari Desert. Teeming with wildlife, it has become a battle line in an ideological and economic war between protectors of African wild animals and those

who would graze cattle. For conservationists, the tsetse is an essential cattle deterrent.

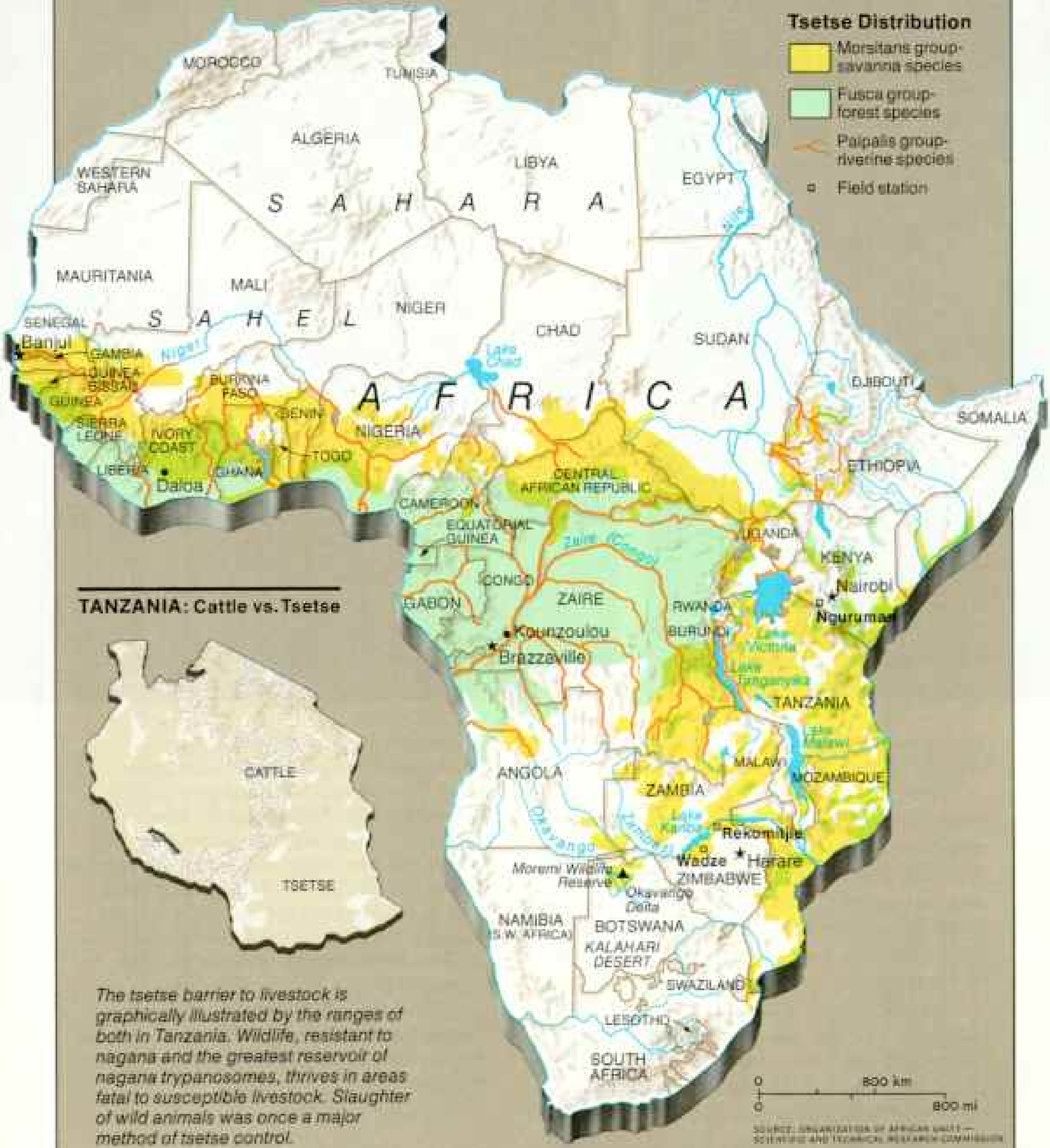
"Eliminate the tsetse and cattle will invade," declared Willie, "and cattle are the despoilers of Africa, bulldozing the continent into one big wasteland." He conceded that before aerial spraying in the Okavango Delta, flies sometimes had been so thick that game drives for visitors were canceled. "The fly must stay."

Tim Liversedge, a pilot and veteran delta ecologist, pointed out from the air a fence separating the delta from adjacent cattle country (pages 828-9). Many places along it supported Willie's fears. Inside the fence the cover of grasses was dense; outside, grazing cattle had bared a dusty desert.

A breakthrough in detection *allows a World Health Organization team in the Ivory Coast to test blood samples quickly* ***(above left)*** *for antibodies that signal exposure to trypanosomes. Early discovery allows effective treatment and aids prevention: Western Africa's form of sleeping sickness may go undiagnosed for months, while the victim is a source for the spread of the disease. Homegrown protection includes the use of pigs to distract flies from people* ***(above)****. But swine also lure more flies to the village and can harbor the western African sleeping sickness trypanosome, once thought confined to humans.*

Range of a killer

"A fine net is being woven remorselessly around him," Winston Churchill wrote of an anti-tsetse campaign in 1907. But the battle is far from won, and the fight is controversial. At least 50 million people and 40 million cattle are at risk in the tsetse belt, an area larger than the United States. The fly blunted the spread of Islam, slowed European exploration, and still stifles economic progress. Some groups seek eradication of the fly to open up pasture for ranching. Others fear this would devastate Africa's wildlife. Their ranges bounded by deserts, the nearly two dozen species of tsetse are grouped by habitat.



TANZANIA: Cattle vs. Tsetse

The tsetse barrier to livestock is graphically illustrated by the ranges of both in Tanzania. Wildlife, resistant to nagana and the greatest reservoir of nagana trypanosomes, thrives in areas fatal to susceptible livestock. Slaughter of wild animals was once a major method of tsetse control.

NGS CARTOGRAPHIC DIVISION DESIGN: NANCY SCHWEICKART; RESEARCH: MICHAEL NICOLLS, WILLIAM BLEWETT, LINDA KRISTE; PRODUCTION: ELLEN LANDEMAR, DEBORAH LINETT

But strong political forces in Botswana favor the expansion of cattle, a mainstay of the nation's economy. "I'd feel better," Tim remarked, "if as a second safeguard of the delta there still were lots of tsetse around."

Makoba Maqumbi, a herder living with his family a stone's throw from the fence, disagreed. I encountered him in front of his mud-and-thatch home. "Why are they freeing us of the fly if they don't allow our animals to feed where the grass is?" he wailed.

I reasoned with him, arguing as ecologists would: that the delta's tempting riverine green would make poor fodder for his cattle. And I spoke of the land's fragile beauty, not to be squandered for short-term relief.

"You speak of beauty while we starve," he chided me. "For a man seeing his cattle and his children die, green is green—fence or no fence."

GLOSSINA OLIGOCENA, ×3

Prehistoric pest: *Fossil records show tsetse flies lived in then subtropical Colorado 35 million years ago, their only known presence outside Africa.*

I FLEW to Nairobi, capital of Kenya and of tsetse research. Here the International Laboratory for Research on Animal Diseases, ILRAD, hosts a staff of 450 scientists and other personnel in facilities unrivaled in the rest of Africa. They study the tryp's nagana-infective mechanism and seek improvements of the host's immune response. The International Centre of Insect Physiology and Ecology, ICIPE, studies the fly itself. The Kenya Trypanosomiasis Research Institute, KETRI, deals both with nagana and sleeping sickness. All maintain field stations.

With Dr. Robert D. Dransfield, a scientist with ICIPE, I headed for the center's Nguruman station in the Rift Valley. We plunged from cool highlands down the escarpment into a sweltering realm of mirages and dust devils where tsetse are rampant.

At the station Bob and his colleagues study fly population dynamics with the ultimate aim of controlling tsetse with traps, so that local Masai, Kenya's staunch cattle nomads, can herd their animals with a minimum of veterinary care.

Months earlier the grasses had withered as one of the worst droughts in Masai memory parched the land. Tribesmen had moved their herds up the escarpment. There pasture still was plentiful; so was the fly.

On their traditional grazing grounds down in the valley, Masai herders know precisely where and when *orkimbai*, the tsetse, is densest and most aggressive; they cunningly lead their herds around trouble spots, sometimes at night. But up on the escarpment they were left with no choices; the fly was everywhere.

At Nguruman a 23-year-old Masai had come pleading for help. Four families who jointly occupied a *manyatta*, or circular encampment, and kept 600 head of cattle were losing an animal a day to the fly.

At the manyatta Joseph Olekobaai, an ICIPE-trained Masai youth, set up his field microscope (pages 816-17). His companions wrestled down animals suspected of being ill. In six of 20 blood smears Joseph discovered tryps. A cow too anemic to stand was carried off for slaughter.

"We Masai are courageous people," remarked Lesalon, an elder at the manyatta. "We spear the lion and face the charging buffalo. We club the black mamba and confront the angry elephant. But with orkimbai? Helpless we are."

Tsetse-wise as herders, the Masai show a lack of understanding for the working of tryp-killing drugs. I have observed them dilute the drug beyond effectiveness in order to treat more animals. Half doses can doom cattle and generate drug-resistant tryps; with good reason the Kenya government permits the use of drugs only under a veterinarian's supervision. But the self-respecting Masai is yet to be found who patiently waits for a vet when his cattle are dying and drugs are available on the black market.

Here, as in the Okavango Delta, doubts cloud the cause of tsetse control—even within the research establishment created to break the fly's stranglehold on African

*"**A wonderful animal,**" says Sir Dawda Jawara, President of the Gambia, of the ndama cow, whose image appears along with his on a Gambian coin (**above**). Descended from cattle brought to western Africa about 5000 B.C., ndama have developed tolerance to tryps. They can harbor the parasites but usually display no symptoms. Small-size ndama until recently were considered less productive than humped zebu cattle, introduced about A.D. 700 and prone to nagana. Projects across Africa now promote ndama, experiment with crossbreeding, and seek clues to tolerance. Several Gambian villages volunteer herds for blood tests, subduing cows by pulling one foreleg over the horns (**right**).*

development. "We must think beyond the immediate benefits," warned a West German veterinarian involved in tryp research. "Hasty, thoughtless expansion of the cattle industry is not in the long-term interest of Africa. We cannot afford to degrade areas that are still reasonably intact, thanks in part to the tsetse. Without a land-use policy, this continent will irreversibly turn into a poorhouse for man and animal."

Far more bellicose was David Hopcraft, who grazes 3,000 antelopes to supply meat to Nairobi hotels. "Game animals use resources more wisely by browsing selectively," David asserted. "They grow and breed faster and need not be penned at night or watered regularly. This is nature's system—and its yield can be higher than cattle ranching. Just look at cattle—ten gallons of water per head a day just to survive! God bless the tsetse if it helps to keep those wasters out."

I took the issue of cattle versus game into the lion's den, ILRAD.

"David Hopcraft should have asked Stone Age man to weigh the advantages of game or cattle," commented Dr. A. Ross Gray, ILRAD's director general. "The bond between man and cattle is thousands of years old, with great expertise accruing from it. We don't have time to develop the same level of competence for game management. Besides, cattle represent more than meat

—they mean milk, draft power, manure."

In Kenya I met Dr. Pieter de Raadt, head of the trypanosomiasis unit of WHO, the World Health Organization. I queried him on the fly's direct assault on man—the scourge of sleeping sickness.

"Its occurrence always has been patchy, with many focuses flickering and flaring," he explained. "Of the 20,000 or so new cases that surface yearly, most occur in Zaire, Angola, Uganda, Sudan, and Cameroon. Even with the probable high number of unreported cases, however, sleeping sickness cannot vie as a killer with diarrhea or malaria.

"But the future could be frightening," Pieter added. "At most only a fifth of the 50 million Africans at risk today are under some form of medical surveillance. If this should be relaxed and fly control grows sloppy, we'd have a new problem."

EAST AFRICAN sleeping sickness, caused by *Trypanosoma brucei rhodesiense*, is virulent. Announcing itself with headaches, fever, and joint pains, it may kill in weeks if untreated. The parasite is ill-adapted to man; it cannot be in its interest to kill the host and thus commit suicide. Researchers speculate that it arrived late, possibly with slavers or early explorers.

By contrast, the so-called Gambian sleeping sickness of western and central Africa,

Illegally herded *to greener pastures, goats shimmy under a fence into a stock-free zone in the Okavango Delta in Botswana* ***(above)****. Built to separate cattle raised for export to Europe from wild buffalo harboring foot-and-mouth disease, the fence also lessened nagana among livestock by separating domestic and wild animals. The wildlife area's healthy dry-season brown contrasts with gray overgrazed land across the fence* ***(right)****. Spraying has virtually eliminated the tsetse fly in the region, and small farmers now want to graze the protected land. Complaining to a tsetse-control official, herder Makoba Maqumbi* ***(below)*** *rails against the arguments of conservationists.*

carried by *T. brucei gambiense*, causes mild or no symptoms in the beginning and may dawdle for years; but untreated, it is no less deadly. Either form can usually be cured by drugs if caught while the tryps are still in the bloodstream. Not so, once they lodge in the central nervous system, where they cause sleepiness and coma.

"In East Africa," said Pieter, "because of the aggressive nature of the parasite, patients check into health centers at their own initiative. But in western and central Africa they must be actively searched out."

I caught up with an active search operation in the Daloa district of the Ivory Coast. With more than 100 new cases each year, Daloa is the country's main sleeping sickness focus. Under a mango tree in the village of Balam, screaming babies, defiant youngsters, and stoic adults lined up to have their fingers pricked for blood samples. Next orderlies palpated villagers' necks for Winterbottom's sign, a warning of the disease. Two centuries ago Thomas Masterman Winterbottom, a British physician-explorer, noted that slavers avoided blacks with the enlarged neck glands known to connote lethargy.

The orderlies started collecting blood samples for the Card Agglutination Trypanosomiasis Test, CATT. This Belgian-developed procedure diagnoses the presence of antibodies to tryps in the donor's blood as an indicator of possible infection—a breakthrough for mass screenings. "Six positives today," stated the team boss, as we sat down to a lunch of rice, chicken, and palm wine offered by the grateful villagers. Soon the six villagers would be examined for the actual presence of the parasite in the body.

Dr. Félix Doua, an Ivoirian and chief physician at the WHO-sponsored Daloa Research Clinic on Sleeping Sickness, had accompanied me to Balam. A live chicken, a

What most attracts *a tsetse fly? Ox's breath, discovered Dr. Glyn Vale of Zimbabwe* ***(right)****, here collecting flies in a hollow tree. To avoid spraying poison, he coats traps with insecticide and lures flies with the breath's chemical components. French scientist Dr. Janick Lancien used traps to wipe out chronic sleeping sickness in the village of Kounzoulou in the People's Republic of the Congo* ***(above)****.*

gift from Balam's headman, fluttered in our car when we returned to Daloa. Félix had critical words on the state of surveillance. "Those teams," he said, "are undermanned, underfunded, underequipped. Each village should be seen every six months, but this visit to Balam was the first in eight years."

While Dr. Doua made his morning rounds at the clinic, I sat at the bedside of five-year-old Kan Félix Kouamé (page 815). In the arms of his mother Kan was uncontrollably shaking, periodically opening his eyes for uncomprehending glances before being conquered again by sleep. From the foot of the bed his father and younger brother looked on in anguish. Not only Kan was ill. His mother and brother had sleeping sickness too; only the father was free of tryps.

"A typical situation," commented Dr. Azodoga Sékétéli, a Togolese who headed WHO research in Daloa. "Men leave at dawn for their fields before the fly becomes active. Their wives, often with the children, bring them lunch at the time when flies are busiest along the bush paths."

NOWHERE on my tsetse travels, not even in Zimbabwe, did I find such expectation of victory as in the People's Republic of the Congo. Here half a dozen areas smolder with sleeping sickness, now and then bursting into flames. And here two organizations seek to control the fires. The National Service of Epidemiology and Endemic Diseases, a legacy from French colonial days, tracks down human carriers for treatment. Pursuing control of the fly itself is ORSTOM, the French Office for Scientific and Technical Research Overseas.

Fly densities in the Congo generally are low, sometimes two or three flies a day per trap—ridiculously low, I thought, remembering Zimbabwe and Glyn Vale's brimming traps. I said so to Dr. Janick Lancien, a medical entomologist with ORSTOM.

"Don't confuse the number of flies with the magnitude of the menace," Janick said. "A single infected fly can wreak havoc. We often find that villages high in disease are low in flies."

Northeast of Brazzaville, the capital, in the long corridor where high plateaus squeeze the river separating the Congo and Zaire, sleeping sickness is endemic. Thirty or so villages dot the Congolese shoreline. In some, Janick suspects, half the population is ill. But not in Kounzoulou, "his" village, where he has trapped out the flies.

When we arrived, Janick got a hero's welcome. We were given rooms in the small hospital; it was unoccupied. Next morning we visited pools where women soaked the tubers of the staple cassava. Fermenting cassava gives off carbon dioxide, a strong attractant for *G. palpalis* flies. But Janick was pleased. All the traps he had placed years before still worked, though many needed reimpregnation with insecticide.

Janick attributes much of his success to the effectiveness of his traps (facing page). He hangs them from low tree branches, doing without supporting metal rods, which are expensive and are coveted by the people for other uses. Simplified trap construction slashes the cost. And the blue and black screens have proved especially attractive to

the tsetse. Already craftsmen in Brazzaville produce traps by the hundreds each month; Janick envisions their use by the thousands in the Congo and other African nations.

Could the tsetse someday be vanquished through biological controls? Researchers in many lands ponder a variety of methods. These include unleashing predators such as birds and spiders, colonizing with tsetse that seem to be genetically resistant to tryps infection, and sterilizing flies either in the lab or in the wild to disrupt reproduction.

Or could the fly be thwarted by trypanotolerant cattle? In western Africa some breeds of cattle—those that arrived in Africa thousands of years ago—mysteriously survive tsetse onslaught. Researchers at Nairobi's ILRAD and at the Center for Research on Animal Trypanosomes in Burkina Faso now look into the biological basis for this resistance to tryps. And in the Gambia, amidst a particularly hardy breed of trypanotolerant cattle called *ndama*, the International Trypanotolerance Center has opened.

Thus the world scientific community tightens the noose on the tsetse—but to what end? Many Africans indict the fly for preventing rational use of the land: When drought in the Sahel expelled cattle from the region, they surged against the flybelt—land that could have eased the pressure. And certainly the fly stifles rural development, menacing the farmer with disease and preventing his use of a draft animal that could increase harvests fivefold. But in other places the fly protects the environment against mindless exploitation, buying Africans time for farsighted choices in land use. Obviously, the fly's presence can cut two ways. Despoiler or guardian? Boon or bane? Both, perhaps. Yet surely, I concluded in a balanced mood, an African dilemma.

On my last day in Africa, near Banjul, the Gambia's capital, I chanced upon a forest fire, illegally set by a prospective farmer clearing land for the coming wet season. The flames leapt from tree to tree and engulfed the dry grass between them; away from the fire, birds flitted in wait for insects fleeing the holocaust. A *G. palpalis gambiensis* landed above my ankle and bored its proboscis into my shin—the nineteenth bite I suffered on my tsetse travels. The pain pierced my equanimity. I cursed the fly. □

Winged hunters *fly in the still air of dusk over northern Zimbabwe, showering the woodland with insecticide* (**above**) *as part of an aggressive government effort to rid 10,000 square kilometers of tsetse flies. The chemical, endosulfan, also kills*

fish, but few rivers flow in the eradication zone, and proponents hold aerial spraying to be the least harmful method of control. In daylight, ground crews fan out to spray with DDT ***(below)****—banned in most industrialized countries. A device resembling a unicycle measures the distance teams cover. To judge the impact of spraying, field workers use an ox as a lure* ***(below left)****, counting the number of flies attracted and netting them for study.*

Key to '86

SAM HOUSTON, Tolstoy, Columbus; Pandas, the Serengeti; Rio Azul, the North Pole; Smell, the Immune System—were these among your favorites in 1986 GEOGRAPHICS?

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JANUARY

Queensland, Broad Shoulder of Australia 2
Freshwater Turtles—Designed for Survival 40
C. M. Russell, Cowboy Artist 60
Switzerland: The Clockwork Country 96
On Canada's Hood River: Clues to a Tragic Trek 128

FEBRUARY

Madrid: The Change in Spain 142
"Grizz"—Of Men and the Great Bear 182
Banaras: India's City of Light 214
Tide Pools: Windows Between Land and Sea 252
South Africa's Ndebele People 260

MARCH

Secrets of the Wild Panda 284
Sam Houston: A Man Too Big for Texas 311
Morocco's Ancient City of Fez 330
Narwhal: Unicorn of the Arctic Seas 354
Tennessee-Tombigbee Waterway: Bounty or Boondoggle? 364
To Scotland Afoot Along the Pennine Way 388
Map Supplement: The Making of America: Texas

APRIL

Rio Azul: Lost City of the Maya 420
Panama: At the Crossroads 466
Under Antarctic Ice 497
Japanese Americans: Home at Last 512
Africa's Flying Foxes 540
Map Supplement: Central America

MAY

The Serengeti 560
Rising, Shining Tennessee 602
When the Earth Moves 638
Eruption in Colombia 640
Earthquake in Mexico 654
Newfoundland: The Enduring Rock 676

JUNE

Our Immune System: The Wars Within 702
The Tea and Sugar: Lifeline in Australia's Outback 737
The World of Tolstoy 758
Tracking the Elusive Snow Leopard 793
Bikini—A Way of Life Lost 813

JULY

Liberty Lifts Her Lamp 2
New York Harbor—The Golden Door 21
The Untamed Fraser River 44
Hope and Danger in the Philippines 76
Corregidor Revisited 118
Model Airplanes: To Dream, to Build . . . And Then to Fly 132
Map Supplement: The Philippines

AUGUST

The Oregon Trail 147
Uranus: Voyager Visits a Dark Planet 179
The Quest for Ulysses 197
Argentina's New Beginning 226
High Road to "Victory": Soviet and U. S. Climbers on Pik Pobedy 256
Marauders of the Jungle Floor 273
Map Supplement: The Making of America: Pacific Northwest

SEPTEMBER

North to the Pole 289
The Intimate Sense of Smell 324
Remnants: Last Jews of Poland 362
Meteorites: Invaders From Space 390
Supplement: Smell Survey

OCTOBER

Are the Soviets Ahead in Space? 420
New Nations in the Pacific 460
The Dutch Touch 501
Wall Against the Sea 526
Red Deer: The Ancient Quarry 538
Studying Scotland's Deer 556

NOVEMBER

Where Columbus Found the New World 566
The First Landfall 572
15th-Century Manuscript Yields New Look at *Niña* 601
Tokyo—A Profile of Success 606
Red Cross: A Little Humanity Amid War's Horrors 647
Sharks at 2,000 Feet 681
Finding a Missing Warplane in Laos 692
Map Supplement: Where Did Columbus Discover America?

DECEMBER

A Long Last Look at *Titanic* 698
Westminster, the Palace That Became Parliament 728
Halley's Comet: More Than Met the Eye 758
Custer—Ghosts on the Little Bighorn 787
Africa's Deadly Tsetse Fly 814
Map Supplement: The Making of America: Northern Plains

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Golden Monkey **Genus:** Rhinopithecus **Species:** roxellanae **Adult size:** Length of head and body: male, 56~83cm; female, 46.5~74cm; tail: male, 61~92cm; female, 51~104cm **Adult weight:** Male, average 19kg; female, 6~20kg **Habitat:** Mountain forests in central People's Republic of China **Surviving number:** Estimated 3,700~5,700 Photographed by George B. Schaller

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

During the bleak winter months in China's mountain forests, the golden monkey searches for food in bands of about 70. In summer, however, when food is plentiful, these arboreal monkeys gather to form groups of 300 or more. The golden monkey does not adapt well to life in captivity; only a few exist in zoos outside China.

For over 1,000 years, golden monkeys were hunted for their beautiful long hair, once prized for making coats. In addition, the species faced a serious loss of habitat. Today, however, the golden monkey is fully protected and reserves have been established to ensure its survival. An invaluable research tool, photography can help promote a better understanding of this little-known primate and the role it plays in its rugged mountain ecosystem.

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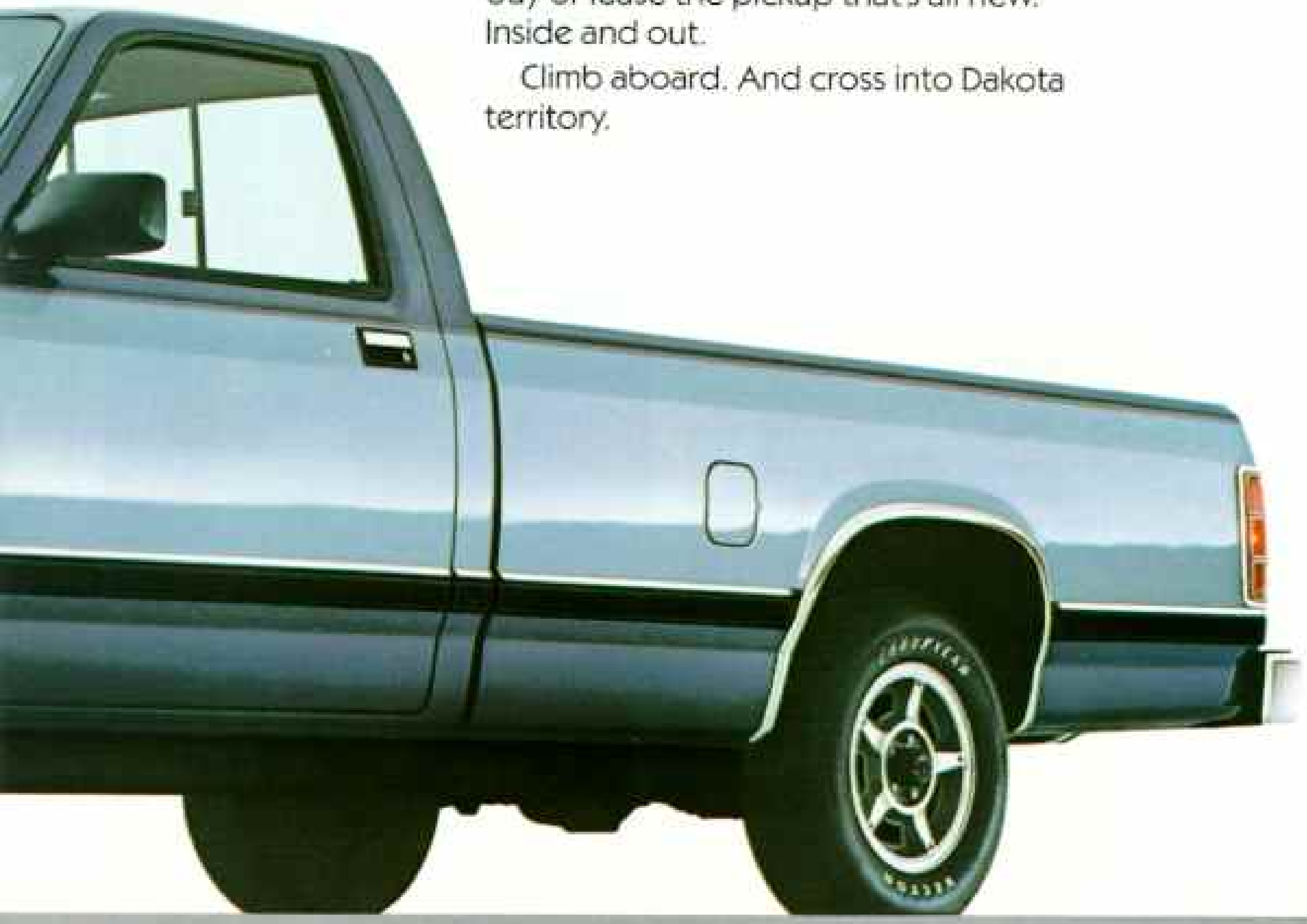

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BUCKLE UP FOR SAFETY.

Remarkable journeys into distant territories

THIS PAST YEAR I have been deeply involved in efforts to prepare the groundwork for improving geographic education in American schools, and the Society has made major commitments of time, talent, and funds. The more than two million dollars we have contributed in 1986 has helped fulfill a promise dating from 1888 that "due prominence will be given to the educational aspect of geographic matters. . . ."

Any reflection on the year past should give due prominence to the Society's other activities—a larger task than it was 98 years ago. We now have in print almost 200 books, more than 100 maps, three atlases, four globes, four magazines, and four indexes.

That is a growing body of geographic knowledge, and a new medium is making its debut. Ten Geographic Videos are now available for home videocassette players. One is a premiere, and seven are classics from our PBS Specials. Two are from our EXPLORER series on Superstation WTBS —whose commitment has allowed the Society to produce two hours of weekly quality programming for cable audiences.

What these lists do not include are entries for the films, videotapes, filmstrips, and other tools for learning we have developed for schools.

At the risk of toting up too many lists (though this is the season for them), I'll mention another one important to the Society's mission. It records research projects accepted for funding by our Committee for Research and Exploration. I estimate that the Society will make about 250 grants to scientists this year with a total budget of five million dollars.

NATIONAL GEOGRAPHIC has made many remarkable journeys into distant territories this year. For me, some of the most memorable have been to the Atlantic depths where *Titanic* rests, to the labyrinths of the body's immune system, to a "lost city" of the Maya,

TENNESSEE GOVERNOR LAMAR ALEXANDER, AT LEFT, AND GILBERT M. GROSVENOR TALK WITH TENNESSEE TEACHERS ATTENDING, WITH OTHERS FROM ACROSS THE COUNTRY, THE SOCIETY'S FIRST SUMMER GEOGRAPHY INSTITUTE (PHOTOGRAPH BY PAT LANZA FIELD).

and to the last bastion of wild pandas.

The magazine has even done research of its own—thanks to your participation—with the Smell Survey that supplemented "The Intimate Sense of Smell."

These memories of 1986 bring me to the exhaustive analyses that Joseph Judge and Luis Marden made to fix the track of Christopher Columbus's first crossing and establish from among the contenders the island where he made landfall on October 12, 1492. Their meticulous detective work led them to Samana Cay in the Bahamas, and their story in the November magazine speaks for itself. It also speaks for the exploring spirit—the heart, the mind, and the will to discover.

Gilbert M. Grosvenor

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY

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Motor Trend.

"Hope doesn't burn brighter than it does for the unveiling of an all-new Accord. Honda Accords are great automobiles, and everybody knows it."
Car and Driver.

"It's improved in just about every way, objectively as well as subjectively." *Road & Track.*

"With the new Accord, and the LXi in particular, Honda has solidified its position among the world's truly fine sports sedans." *Motor Trend.*

"There is a solid, jiggle-free feeling from the new suspension. It makes the Honda Accords

feel almost exactly like Audi's 18-inch longer top line 5000. The ride approaches that of Mercedes 190, which features a much more complex five-link rear suspension." *Autoweek.*

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"Cruising the high-banked oval at the Accord's top speed, passengers in the front and rear carried on hushed conversation in a dead-flat acoustic environment. Wind noise was minimal and road noise was dampened effectively." *Motor Trend.*

"Que será, será." *Anonymous Accord LXi owner.* HONDA

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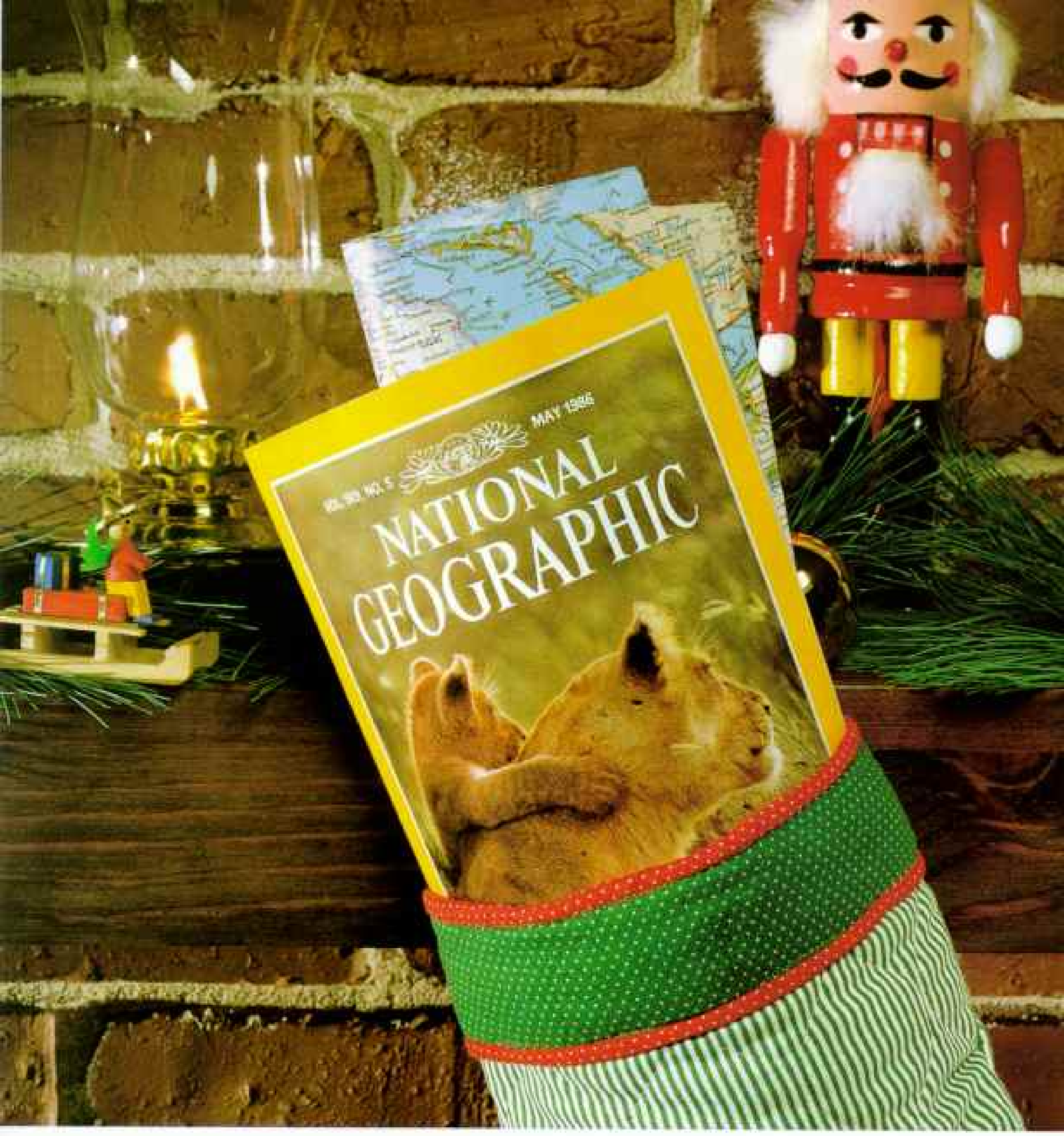

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*For rates outside the U. S., see attached order form. Twelve issues beginning January 1987.

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Members Forum

Oregon Trail

The picture on the cover (August 1986) and on pages 148-9 is of my mother's family in the late 1870s or early 1880s. When I was young, this picture hung for years on the wall of our home. One of the girls was my mother, Emmy A. Steele.

George D. Knox
Portland, Oregon

I believe the family is my grandfather Jackson Livesay, my grandmother, and their children. The photo was taken around 1908, when they were traveling through Colorado or New Mexico.

Norma Baker
Downey, California

The wagons are common farm wagons of a type made by Studebaker and others. My father drove such wagons in Texas during the 1920s and says the tongue and rigging of the wagon on the right are set up for a single team of mules. The mountains suggest the eastern Wichita Mountains in southern Oklahoma. I believe you have a farm family on an outing in the 1870 to 1900 period.

C. F. Eckhardt
Seguin, Texas

There are no grease buckets, lumber for repairs, toolboxes, or chains for locking wheels during steep descents—all necessary equipment for long-distance travel. I suggest a picnic outing.

Glen Dines
Fairfax, California

More than a dozen members thought they recognized the faces in the mystery picture. Others placed it from Minnesota to Wyoming. A few cited books and museum displays. The clothing dates from the 1870s and '80s. Unfortunately, no documented print has been located.

Having lived beside the trail all our lives, my husband and I enjoyed "Oregon Trail" but are disappointed at your failure to mention Narcissa and Marcus Whitman and the Henry Spaldings, the real pioneers of the trail, who helped carve it in 1835-36. A decade later the forty-niners followed the ruts left by these courageous Presbyterian missionaries, who established Christian missions in the Oregon wilderness and guided hundreds over the treacherous terrain from Missouri. Narcissa Whitman and Eliza Spalding were the first white women to make the trip.

Eulalie Langford
Montpelier, Idaho

Gibbons thinks something happened "about 1847" to change the status of Oregon Country. The Whitmans and others died in a massacre at Waiilatpu. Joseph Meek was selected by surviving Oregon settlers to go to Washington to present their case to President Polk. Meek, a cousin of Mrs. Polk, was a welcome guest at the White House. After his arrival President Polk presented a petition to Congress, which acted rather rapidly for a U. S. Congress, and on August 14, 1848, President Polk signed the bill making Oregon an organized territory of the U. S.

Robert E. Moody
Rushville, New York

I was offended by the references to the young woman studying "leisure management." In highlighting the suffering of pioneers, Gibbons demeans dedicated, hardworking people who, in realization of the American dream, make an important contribution to the quality of life in modern society. This new field of study involves far more than merely "jumping in place."

Catherine Curtis
Montreal, Quebec

The comment about the "wacko spouse" strikes a false note. Emigrant travel was always potentially corrosive to mental stability. In addition, many women were on the trail because of their husbands' decision and not their own choice. It frequently happened that men would announce to their families that they had sold the farm and were taking the whole family to Oregon.

Thomas R. Madden
La Grande, Oregon

Uranus

"Voyager Visits a Dark Planet" (August 1986) made fascinating reading. It's great to see NATIONAL GEOGRAPHIC covering not just our world but also the outer solar system. The Voyager mission must be the best value for the money in terms of new knowledge of any unmanned space probe.

Bob Isaacs
Cloyfield, Queensland

Ulysses

Mr. Severin's refreshing suggestions of Greek sites for the principal adventures related in the *Odyssey* (August 1986) will be appreciated by classicists everywhere. He attributes the imputation of Ulysses' adventures to Italian venues to the eighth-century colonization of Magna Graecia, but there is another explanation—the Roman tendency to appropriate Greek antecedents for their legendary heroes.

This practice became imperial policy under Augustus. Virgil in the *Aeneid* grafted the ancestry of the Roman people onto a Greek stem. Like

Ulysses, Aeneas engaged in infernal necromancy, was tossed by seas about the Mediterranean, and landed in North Africa, where Circe and Calypso became Aeneas's dalliance with Queen Dido. This Roman account with Italian setting passed into Western tradition.

Robert L. Delsman
San Francisco, California

The author was remiss in not mentioning better efforts at reconciling poetic license with Bronze Age plausibility. Ernle Bradford's *Ulysses Found* (1963) traces the western Mediterranean route conjectured by Hellenistic rationalists, and Gilbert Pillot in *The Secret Code of the Odyssey* (1969, 1972) argues for a prehistoric tin route to the British Isles.

E. N. Genovese
San Diego, California

Victory Climb

As a former alpinist, I especially appreciate your article "High Road to Victory," by William Garner (August 1986). On the medal (page 256) appears not the popular title of snow leopard but *pokoritel vysočajših gor, S.S.S.R.*, meaning "conqueror of the highest mountains, U.S.S.R."

Viktor Schön
Dvůr Králové, Czechoslovakia

Argentina

The article "Argentina's New Beginning" (August 1986) was very interesting and informative. Bryan Hodgson, however, gives little credit to the Roman Catholic Church for its efforts to expose the "dirty war." The church and its priests were in the forefront in ending the killing of civilians.

John Ryan
Staten Island, New York

Present-day graffiti artists use aerosol spray cans for their work. I am curious how the Toldense of southern Patagonia "sprayed" ocher around their hands on rocks 7,000 to 9,000 years ago.

Willard Haase
Penfield, New York

They blew pigment through a tube to leave negative handprints.

The article on Argentina was nice, but I feel after many trips to South America that the real star is Brazil. From year to year I see amazing changes.

George F. Johnson
San Francisco, California

We plan a major article on Brazil for 1987.

Members Forum

As a 28-year-old, fourth-generation American of Japanese descent, I became incensed at the reader from Michigan (August 1986) who wrote: "We did not treat our resident Japanese as Japanese treated civilians." Many "resident Japanese" were Americans and cannot be held accountable for past, present, or future actions of the Japanese government. My parents and grandparents were fortunate to be in Hawaii, where there was no internment, and witnessed the bombing of Pearl Harbor. They were infuriated with the Japanese for bringing shame upon them; this severed any feeling of kinship and made them more than ever before American patriots.

Vicki Kan Kendrick
Valparaiso, Florida

I am amazed at the gall of former officials who put forth the same propaganda of 44 years ago. Of course the barbed-wire compounds where Japanese Americans were confined under armed guard were not called internment camps, because American citizens were not supposed to be interned. In fact, they *were* internment camps, and native-born Americans were interned contrary to law. Nazi Germany utilized the same technique of linguistic deception, calling their camps relocation centers. In both instances the term was a misnomer, and continued use today amounts to a distortion of history. Internment camp, prison camp, detention camp are correct terms in the American context.

Raymond Okamura
Berkeley, California

President's Page

Our Society is to be commended for its commitment to geographic education (August 1986). As one of the 45 teachers who came to headquarters for four weeks of intensive training this summer, I can vouch for the sound investment. We were led by an outstanding faculty. We shared creative classroom techniques. We left Washington, D. C., with a renewed spirit, encouraged that the Society would undertake such a venture, hopeful that our state education agencies would pick up the challenge, and committed to providing a ripple within our individual communities.

Linda Pybus
Round Rock, Texas

My concern is that your program does not include elementary teachers. I teach first grade, and I feel strongly that students at age six and seven are the ones who should be introduced to basic geographic skills.

Angelo Abby
West Henrietta, New York

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

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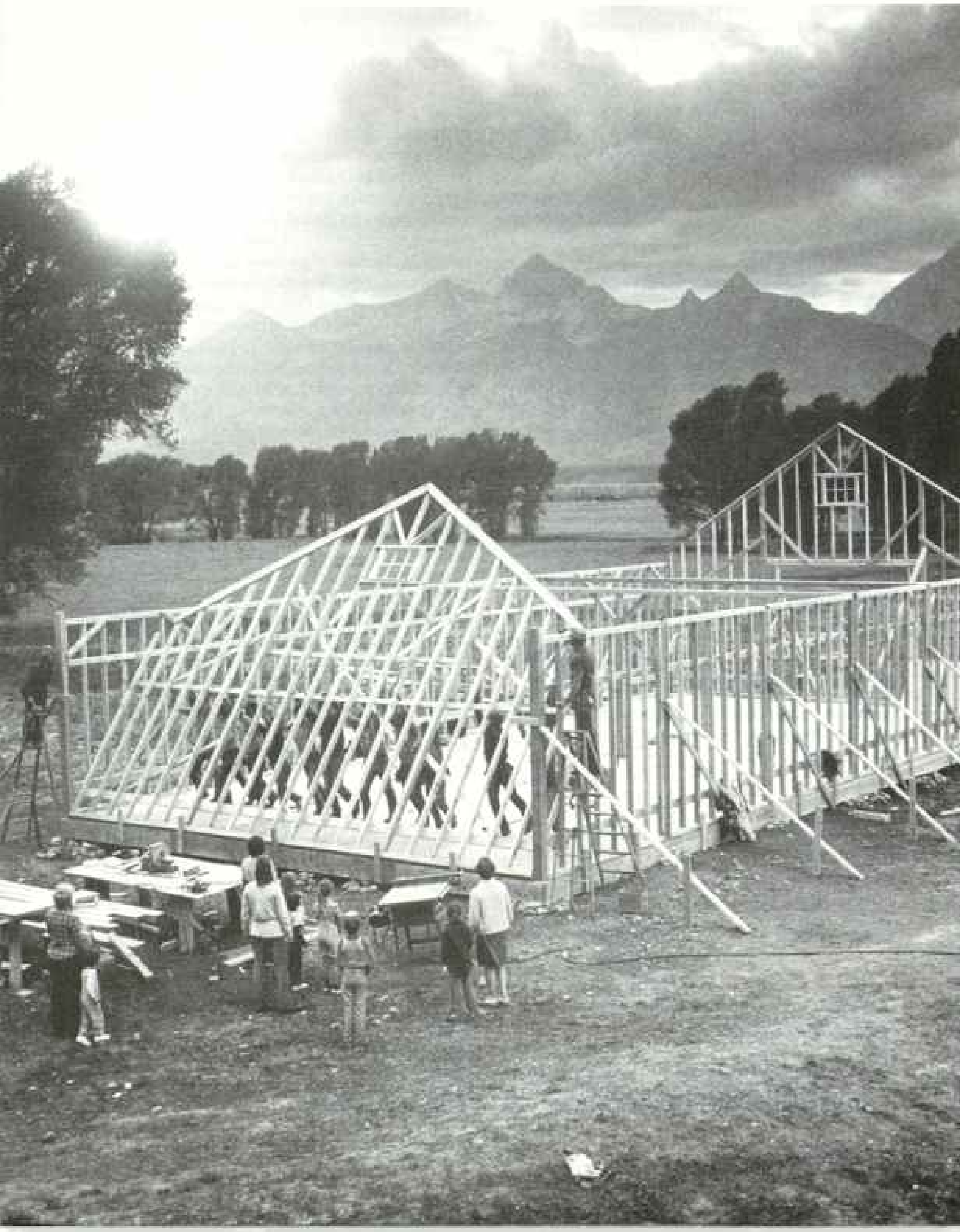

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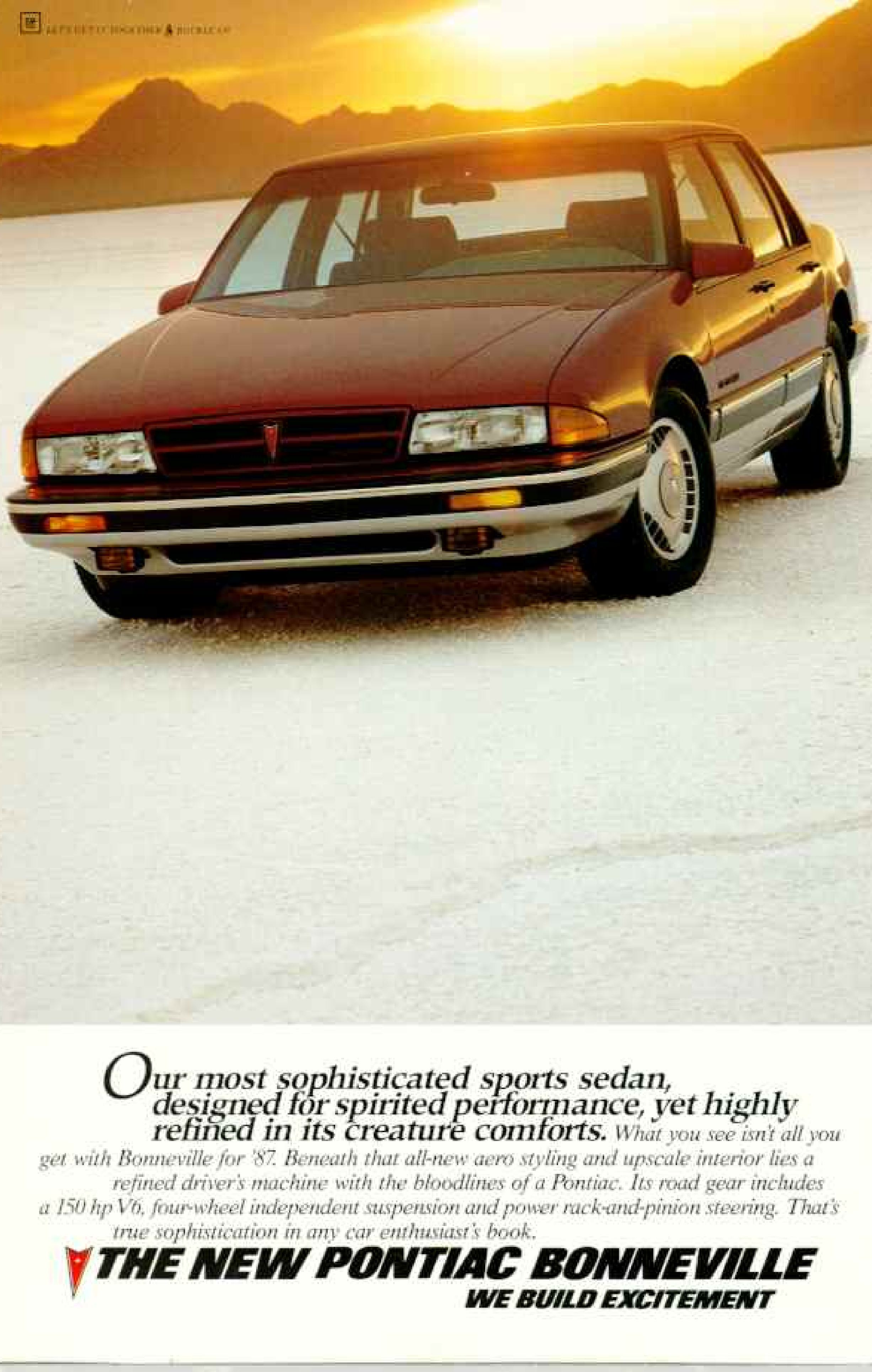

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On Assignment

THREE BRITONS teamed up for the extraordinary coverage of the British Parliament in this issue. Author ***Patrick Cormack*** (***upper right***) is fulfilling a childhood dream by serving in the House of Commons. After two unsuccessful bids, he won election by the largest swing vote from Labour to Conservative in the 1970 election. He has since founded an all-party committee on the arts, has become Parliament's unofficial historian, and edits its magazine.

Working on his 16th article for the magazine, free-lance photographer ***Adam Woolfitt,*** with assistants Etienne Bol and Daphne Wright (***right***), faced the challenge of lighting enormous rooms, "the largest I'd shot since Carlsbad Caverns for the September 1970 issue." Nearly half a ton of gear had to be trolleyed around. Sometimes the equipment blew fuses, bringing an electrician from the basement, grumbling, "You've done it again."

The Society's editorial representative in the United Kingdom, ***Jennifer Moseley*** (***above,*** right) has served as researcher and liaison for 21 years, assisting staff members on hundreds of assignments. For this article she also turned photographer for a day, taking the rare aerial on page 729 during a blimp ride over London. Here Jenny presents Prime Minister Margaret Thatcher with specially bound National Geographic Society atlases in appreciation of her gracious support of the team during the two-year-long endeavor.

ETIENNE BOL (ABOVE) AND ADAM WOOLFITT

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If you settle for less than RCA's new ColorTrak 2000, that's exactly what you'll get. Less picture. Less performance. Less excitement.

Why? Well for starters, each new ColorTrak 2000 is a fully-featured, high-performance video monitor with a built-in stereo receiver. But the biggest reason is RCA's revolutionary new picture tube: The Vista Screen tube.

Unlike conventional round-cornered tubes which cut the corners off their picture, RCA's Vista Screen is perfectly square. So instead of cutting corners, the new ColorTrak 2000 delivers more picture, a walloping 27 inches of picture (measured diagonally).

Not only is the picture bigger than ever, it's truer than ever. Because in addition to being perfectly square, our Vista Screen tube happens to be the flattest 27-inch tube ever produced. In fact, it's so much flatter that it virtually eliminates picture distortion. So all you'll see on its big 27-inch screen is the truth, the whole truth, and nothing but the truth.

Now before you settle for anything less, why not judge the new ColorTrak 2000 for yourself? Just ask your local RCA dealer to show you the best color television that RCA—and possibly anyone else—has ever made.

RCA

TECHNOLOGY THAT EXCITES THE SENSES.

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