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NATIONAL GEOGRAPHIC

SOME MONTHS before the Polish workers' strikes of last summer captured world attention, I had the opportunity to visit their country. After days of traveling by car and bus and talking with dozens of citizens and officials, I felt I had learned something about their society. Still, I was unprepared for the richness and the insight in Yva Momatiuk's account of her return to a mountain village in southern Poland she had known as a girl.

It is the kind of reporting that distinguishes our approach to topics of current interest—behind-the-headlines, personal statements that deal with the lives of people on the familiar daily level. While Yva and her husband, John Eastcott, report on discontent with the economic situation several months before the strikes, they also note much else that escaped the news accounts—the pride and character of the people, their loyalty to the land.

Our commitment to in-depth reports is nowhere better displayed than in the lead article of this issue. We are aware of your interest in the Mount St. Helens cataclysm; many of you wrote to ask why we had not published. Rather than rush into print, we opted to wait until we felt we had the most complete and best documented account of the eruption and its aftermath. I hope you will agree the wait has been worth it.

Author Rowe Findley, while working on another assignment in the area, became aware of the restiveness of Mount St. Helens weeks before its massive eruption and was there to witness the drama and tragedy. Only because he interrupted his volcano-watching for a Sunday visit with friends did Rowe avoid the certain death that claimed his friend Reid Blackburn, who stayed to man his radio-fired cameras. Ten photographers were assigned to cover various aspects of the eruption, but eventually the work of 21 photographers was brought together in this article. Among the most unforgettable images are those of a free-lance photographer, Robert Landsburg, who was killed by the explosion.

In the 64 pages that follow, you will find the results of a team effort that has produced a memorable and lasting look at a stupendous event.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 159, NO. 1

January 1981

ERUPTION OF
MOUNT ST. HELENS

COVER: *Clouds of ash billow above a flowering hawthorn in Ephrata, Washington, on May 18, 1980, three hours after Mount St. Helens' eruption 145 miles away. Photograph by Douglas Miller.*

ST. HELENS

MOUNTAIN WITH A DEATH WISH

A gleaming white peak in the Cascades blasts away the top 1,300 feet of its crest in a massive eruption that takes dozens of lives, perils thousands of others, devastates 200 square miles, triggers destructive floods and mudflows, and sends ash clouds rolling across the Northwest.

ROGER WERTH, WOODFIN CAMP (OPPOSITE); KEN WHITMIRE, IMAGES WEST

Twenty-one photographers capture the cataclysm in broad scope and stunning detail, and Assistant Editor Rowe Findley writes an intensely personal, three-part account of this first volcanic event in the contiguous 48 states in 63 years.

TOWERING WALL OF DESTRUCTION—*searing gas, ash, and rock—races toward Bear Meadow at 200 miles an hour. As photographer Gary Rosenquist fled in his car, along with other campers, he snapped this final frame of a remarkable sequence that begins with the foldout on the following pages.* GARY ROSENQUIST, EARTH IMAGES

The mountain blows its top

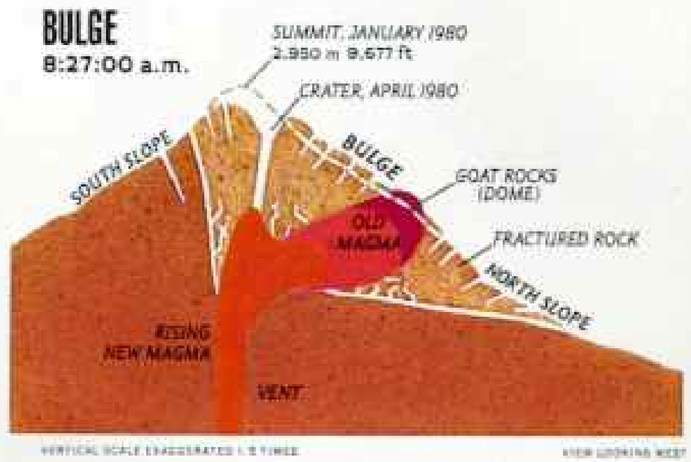
*NO ONE expected so hellish a blast. Scientists had warned that a menacing 320-foot bulge (**diagrams and adjacent photographs**), expanding five feet a day, might trigger a great avalanche or an eruption. Yet no one could predict St. Helens would explode with the fury of a ten-megaton bomb.*

It began with a jolt at 8:32 a.m., May 18. A magnitude 5.0 earthquake unhinged the sagging north slope, hurling some two cubic kilometers of debris toward the North Toutle River in a landslide. Hot volcanic gases and steam rocketed out horizontally through the fractured mountain, scouring ridges and leveling forests as far as 17 miles away.

*At the same time, a hot, bubbly spray of glassy ash and pulverized rock blasted into the sky, an explosive deposit of water-soaked ash ballooned toward the surface, and sticky, molten rock called magma rose from the depths. Blast after blast ripped through the mountain, launching fist- to truck-size boulders and blocks of ice. Pressurized groundwater flashed into steam, and gas-filled rock blew into dust (**facing page**), throwing 400 million tons into earth's atmosphere.*

Streams of superheated gas and volcanic ash called pyroclastic flows soon followed down the horseshoe-shaped gash, paving the buried valley with a surface that heaved like a caldron.

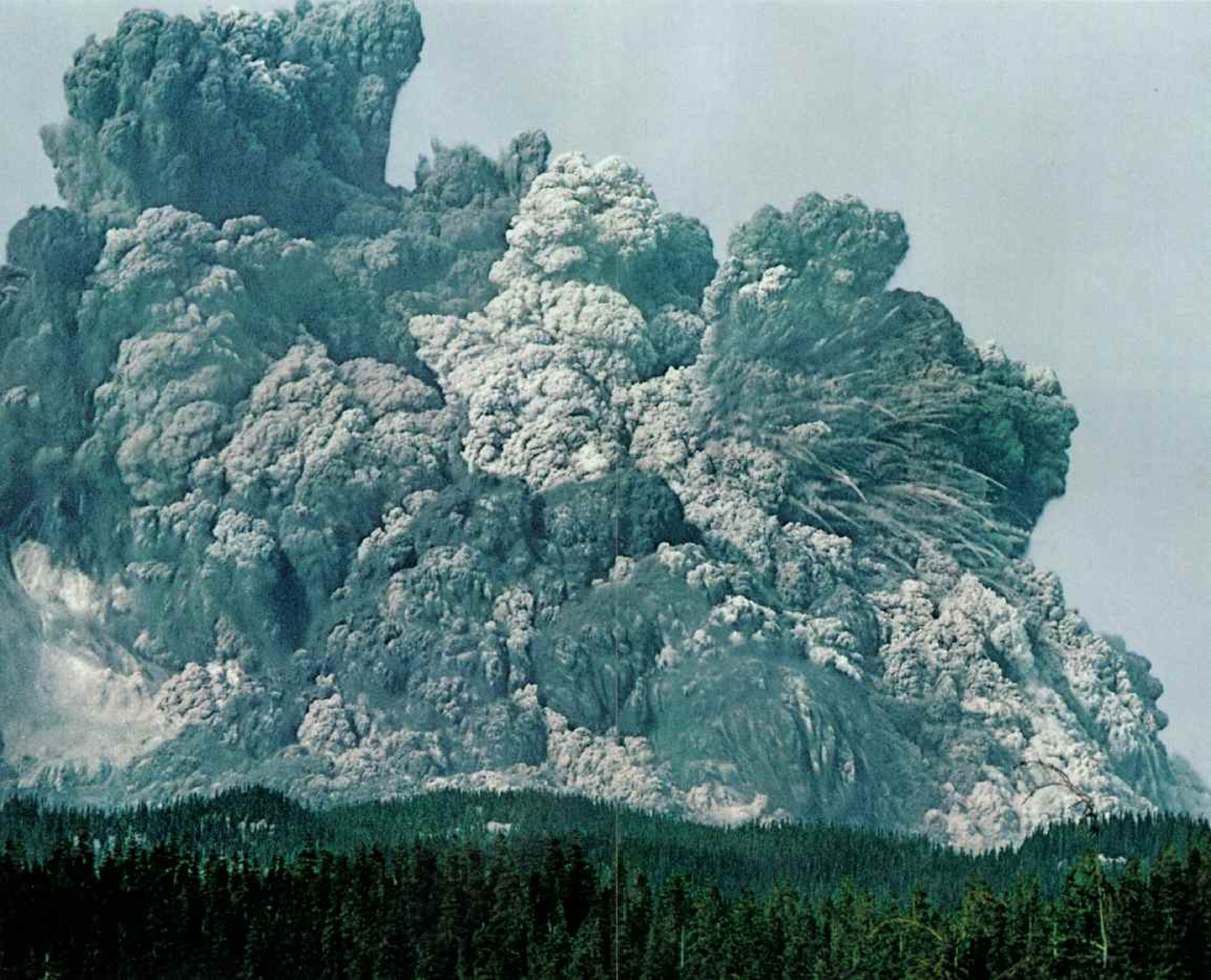
Miraculously, search parties later rescued 198 people from the ravaged area. But 61 others were left dead or missing in the choking ash and consuming debris.



PAINTING BY SUSAN SANFORD, NATIONAL GEOGRAPHIC ART DIVISION

VIEW LOOKING SOUTHWEST

GARY ROSENQUIST, EARTH IMAGES (PAGES 8-10)



Dream mountain turned nightmare, *St. Helens obliterated some of the Northwest's most popular forestland. Thousands of climbers, hunters, and backpackers each year took pleasure in the evergreen woods of Gifford Pinchot National Forest, where black-tailed deer, Roosevelt elk, black bear, cougar, and mountain goat roamed freely. The chill waters of Spirit Lake (***top***), stocked yearly with trout, show a dusting of ash from an earlier eruption in this panoramic photograph taken a month before the blast.*

*Four months later (***above***) the lake and ridges sprawl grimly lifeless beneath a crater 1.2 miles wide by 2.4 miles long. Some two million birds, fish, and animals perished in the May 18 explosion, and more than 150 miles of trout and salmon streams and 26 lakes were destroyed. The forests near the mountain were simply removed—uprooted, shredded, or blown away*

◀ THIS PAGE AND OPPOSITE PAGE FOLD OUT

by sandblasting winds of hurricane force.

Nearly 300 homes along the Toutle River were wrecked or badly damaged by floods and mudflows from melting glaciers, which also tossed about logging trucks and bulldozers as if they were toys. Gritty ash by the inches dropped on farming communities far to the east, blanketing fields and orchards, clogging traffic, and depressing spirits as the mountain spread its gray message of geologic upheaval.

BOTH BY MICHAEL LAWTON

A monstrous ash storm, supercharged with static electricity, hurls lightning

JACK JOYCE

over Glenoma, Washington, minutes after the eruption 20 miles to the south.

He refused to leave

LIFE and Mount St. Helens were one and the same for Harry Truman, 84. For more than half a century he had lived beneath the snow-crowned Cascade peak, where he built a guest lodge beside Spirit Lake. More pungently outspoken than the U.S. President who shared his name, Harry refused to flee last March when the volcano, only five miles away, awakened: "If I got out of here, I wouldn't live a _____ day, not a _____ day." He was also a mystic: "I talk to the mountain, the mountain talks to me. I am part of that mountain, the mountain is part of me." On May 18 St. Helens buried the lodge under hundreds of feet of ash and debris and the raised waters of Spirit Lake, and Harry's words became reality.

BOTH BY RALPH CRANE

FIRST I MUST TELL YOU that I count it no small wonder to be alive. Looking back on the fateful events preceding Mount St. Helens' terrible eruption last May 18, I recognize that I—and others—had been drawn into a strange kind of Russian roulette with that volcano in the Cascades.

For many weeks the mountain had masked its potential for tragedy with minor eruptions, then seemed to doze. In our efforts to get a close-range account of a significant geologic event, we moved in with the innocence of the uninitiated—until sudden holocaust shadowed us with peril and changed our lives forever.

The very beauty of the mountain helped deceive us. It was a mountain in praise of mountains, towering over lesser peaks, its near-perfect cone glistening white in all seasons. Thousands through the years had given it their hearts—climbers, artists, photographers, lovers of beauty's ultimate expression. Some were among the 61 people drawn into its deadly embrace on that shining Sunday morning last May.

For all its splendor, Mount St. Helens was a time bomb, ticking away toward a trigger labeled "self-destruct." Seven weeks before, the world received notice of the mountain's brooding when it first vented plumes of steam and ash. Its immediate domain in southwestern Washington, a favored land of deep forests, rushing streams, rich farmlands, and flourishing cities, waited anxiously as successive eruptions and earthquakes dirtied its crown and fractured its sides.

Then anxieties eased as days and weeks passed without disaster. Though the volcano seethed and trembled, and its bruised north flank bulged morbidly, there were even some who voiced impatience for bigger eruptions. To many, the mountain appeared to be calibrating down toward unreadable calm.

"VANCOUVER! VANCOUVER! This is it. . . ." With those words—tinged with excitement rather than panic, hearers said—David Johnston, geologist for the United States Geological Survey, announced the end of calm and the start of cataclysm. Thirty-year-old blond-bearded David was stationed at a USGS camp called Coldwater II, six miles from the mountaintop, to monitor eruptions (page 38).

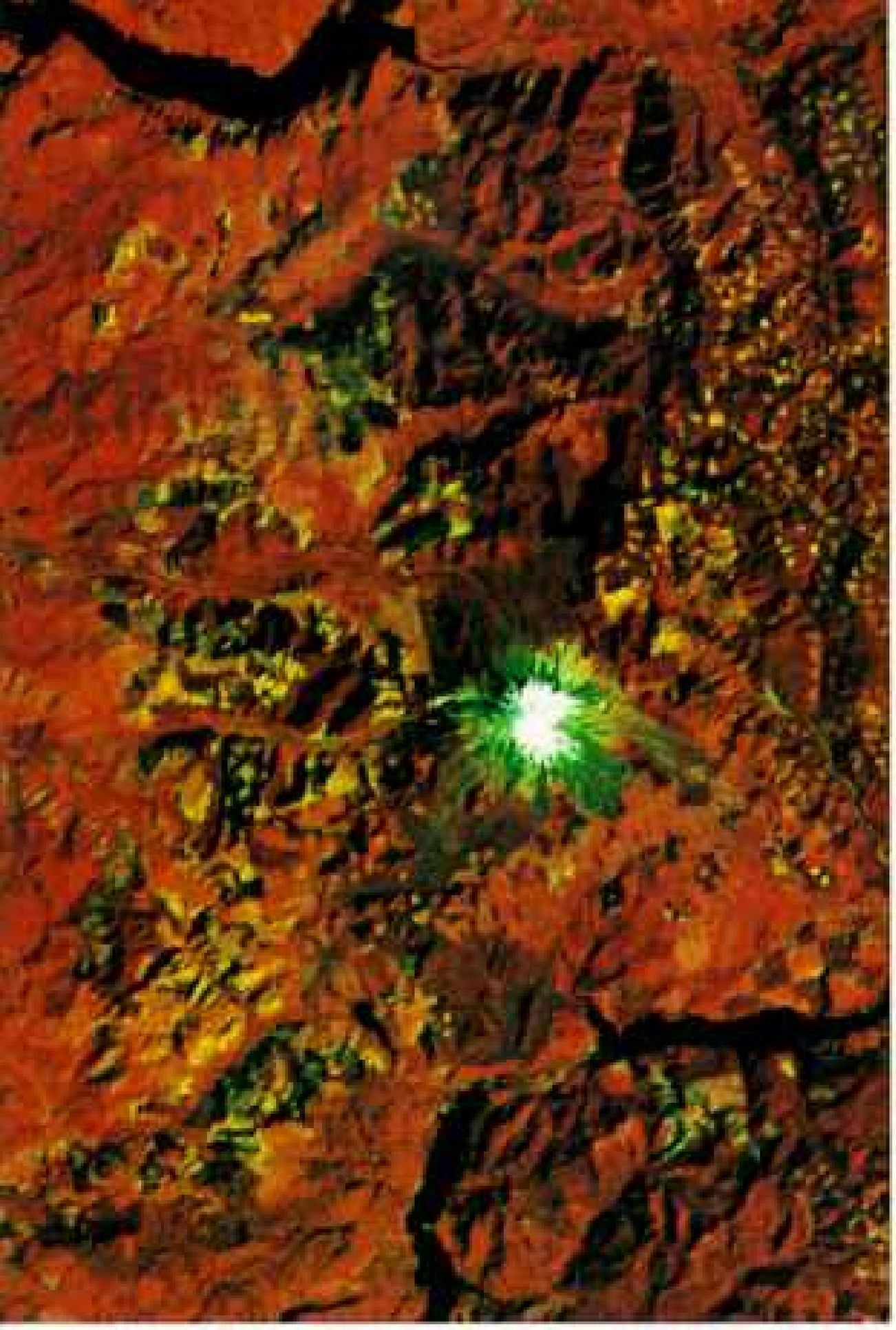
Those words were his last. The eruption he reported was powerful and unexpectedly lateral. Much of the initial blast was nozzled horizontally, fanning out northwest and northeast, its hurricane wave of scalding gases and fire-hot debris traveling at 200 miles an hour. Its force catapulted the geologist and the house trailer that sheltered him off a high ridge and into space above Coldwater Creek. His body has yet to be found.

The start of the eruption has been fixed at 8:32 a.m. Inevitably, the atomic bomb is cited for comparison of magnitude, and the energy computed is that of 500 Hiroshimas. In a quadrant extending roughly west to north, but including a shallower fan to the northeast, 150-foot Douglas firs were uprooted or broken like brittle straws for distances as far as 17 miles from the mountain.

An earthquake registering 5.0 on the Richter scale triggered the collapse of the fractured north side of the volcano, which was perhaps a factor in the devastating horizontal venting that followed. Tobogganing on a cushion of hot gases, the disintegrating north wall and cascades of rock swept down over the North Fork of the Toutle River, burying it under as much as 200 feet of new fill, which spread downstream in a 15-mile-long debris flow. The lateral blast hurled a thick blanket of ash over collapsing trees, tumbled bulldozers and logging trucks, crumpled pickups and station wagons, adding to the hopelessness of rescue efforts.

By
ROWE FINDLEY
ASSISTANT EDITOR

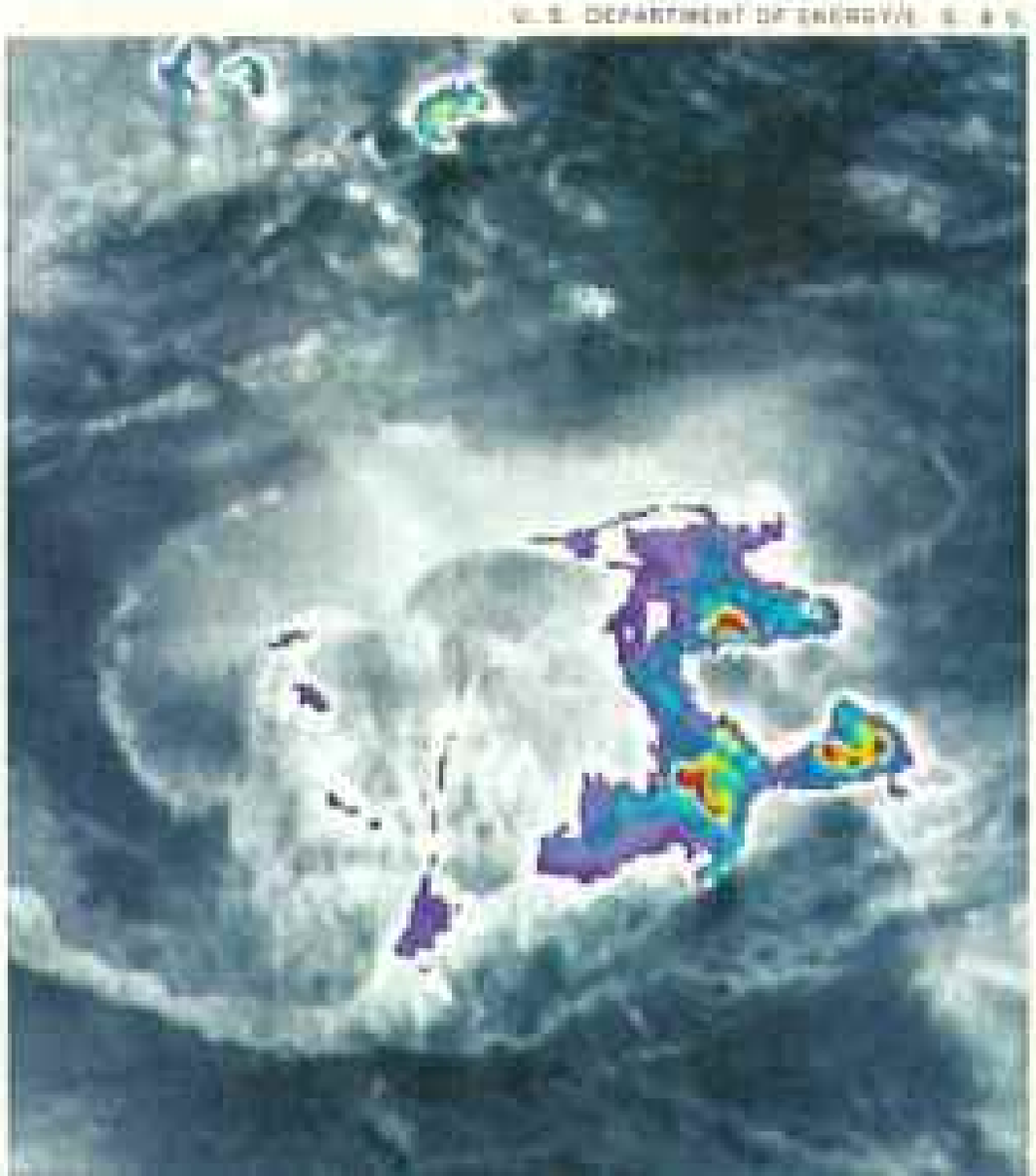
Soon the nozzling of the eruption turned entirely upward, and a roiling pillar of ash thrust some 12 miles into the Sunday morning sky, flanked by nervous jabs of orange lightning. The pillar plumed eastward into a widening dark cloud that would give Yakima, 85 miles distant, midnight blackness at 9:30 a.m. and would last the day (pages 52-3). Much of eastern Washington, northern Idaho, and western Montana would be brought to a halt by the ashfall. Within days the silt from the mountain would reach the Pacific, after causing destructive floods on



EROS DATA CENTER/GODDARD SPACE FLIGHT CENTER (ABOVE AND FACING PAGE)

From beauty mark to scar: *Satellite image* ***(above)*** *shows a normal, snow-clad St. Helens as a star burst; blue-black Spirit Lake lies just to the north. Forest appears red, checkered by logging. In the aftermath* ***(right)****, devastation flows from the crater, while debris smears the lake's new outline.*

Two days before the eruption, a color-coded thermograph ***(below)*** *pinpoints hot spots on the mountain.*



U. S. DEPARTMENT OF ENERGY/E. G. & G.

the Toutle and Cowlitz Rivers and closing the busy Columbia to deep-draft ships. By Wednesday the cloud would reach the Atlantic.

I refer to no notes in setting down these events, because they have cut a deep track in my mind. In fact, my memory unbidden replays sequences unendingly, perhaps because of their awesome magnitude and perhaps because they involve a deep sense of personal loss. I have only to close my eyes and ears to the present, and I see the faces and hear familiar names. . . .

REID BLACKBURN. I knew him only a week—the week before the May 18 eruption. At 27 he was a master of cameras and a student of words, a journalism graduate of Linfield College in Oregon and five-year photographer with the Vancouver *Columbian*, a radio technician, a backcountry trekker. He had just the right talents to keep vigil on the volcano and to fire two remote, radio-controlled cameras recording simultaneous images of significant events (page 38). For this meaningful project he was on loan from the *Columbian* to the USGS and the National Geographic Society. His post was a mountainside logging-road camp called Coldwater I, eight miles from the crest of Mount St. Helens, three miles farther west than Coldwater II.

Colleagues say that Reid had the incisive eye of the born portrait photographer, capturing a face precisely when the mask falls away to reveal an instant of truth. He was as gifted in filming animals, anticipating the wistful look of a puppy, the trust of a lamb.

Nine months before, Reid had married Fay Mall, a member of the *Columbian*'s office staff, who shared his life's goals and ambitions.

I first met Reid on Sunday, May 11, when I helicoptered to Coldwater I and spent the night there to watch the mountain. I returned the following Wednesday, Thursday, and Friday. The talk ranged from newspapering to backpacking. As we talked on Thursday afternoon, I felt the ground sway like a boat on water. "An earthquake," Reid said without expression. "It's about 4.5." Repeated jolts had calibrated him.

The eight miles that separated Reid from the crater seemed a reasonable margin of

safety before May 18. Afterward, with four feet of ash blanketing the camp, and in the knowledge that people twice that far from the mountain had died, I found it hard to think reasonably about margins of safety.

HARRY TRUMAN. He was a man who rejected margins of safety. For more than half a century he had lived at the foot of Mount St. Helens on the shores of Spirit Lake (page 16). When sheriff's deputies ordered all residents to leave for safety, Harry said no. Harry had raised the adjectival use of profanity to a new high, and in a position statement that demonstrated his art, he told me why he wouldn't leave:

"I'm going to stay right here because, I'll tell you why, my home and my _____ life's here. My wife and I, we both vowed years and years ago that we'd never leave Spirit Lake. We loved it. It's part of me, and I'm part of that _____ mountain. And if it took my place, and I got out of here, I wouldn't live a week anyway; I wouldn't live a day, not a _____ day. By God, my wife went down that _____ road _____ feet first, and that's the way I'm gonna go or I'm not gonna go."

Harry and his wife, Edna, had built a lodge and cabins by the lake, and their resort became a favored retreat for two generations of vacationers. Three years ago Edna died, and Harry closed the lodge, renting only a few cabins and boats each summer. When a steel gate was placed across the highway, barring outsiders but locking Harry in, he still did not change his mind: "I said block the _____ road, and don't let anyone through till Christmas ten years ago. I'm havin' a hell of a time livin' my life alone. I'm king of all I survey, I got _____ plenty whiskey, I got food enough for 15 years, and I'm settin' high on the _____ hog."

Harry said that he had provisioned an old mine shaft with ample drink and victuals,

Fearing the worst, *state officials barred entry to a 20-mile "red zone," its heart mapped at right, except for critical personnel such as geologists, who sought to sniff, feel, and listen to the mountain through sensitive devices. Without restrictions, thousands of sightseers would have died.*

AREA OF COMPLETE DEVASTATION

Green River
STREAM GAUGE
10 cm
Tradedollar Lake
Black Mt.
7,616 m
5,302 ft
Deadmans Lake
10 cm
SEARED ZONE
10 cm
Elk Lake
30 cm
Fawn Lake
Venus Lake
30 cm
5 cm
Coldwater Creek
Gary Rosenquist's campsite
Bear Meadow
30 cm
COLDWATER I
Photographer Reid Blackburn's post
CAMERA
19 cm
Coldwater Peak
1,746 m
5,727 ft
St. Helens Lake
50 cm
Mt. Margaret+
1,785 m
5,858 ft
40 cm
30 cm
Post-eruption shoreline
Pre-eruption shoreline
Clearwater Creek
87.5 cm
SEISMOMETER
COLDWATER II
CAMERA
GAS-SENSOR
Geologist David Johnston's station
GEODIMETER
Spirit Lake
TILTMETER
SEISMOMETER
STREAM GAUGE
Site of Harry Truman's lodge
DEBRIS FLOW
20 cm
50 cm
ASH FLOW
Bean Creek
20 cm
20 cm
50 cm
GEODIMETER
GEODIMETER
BLOWDOWN ZONE
DEBRIS FLOW
MUD AND AVALANCHE FLOW
TILTMETER
GEODIMETER
Smith Creek
Photographer Robert Landsburg's location
GEODIMETER
GEODIMETER
The eruption blew out a crater 2,100 feet deep and dropped the summit's elevation from 9,677 feet to 8,364 feet.
GEODIMETER
SEISMOMETER
TILTMETER
TILTMETER
GEODIMETER
2 cm
Mount St. Helens
20 cm
GEODIMETER (REPLACED)
MUDFLOW
SEISMOMETER
2 cm
GAS-SENSOR
Goat Mountain+
1,513 m
4,965 ft
SEISMOMETER
TILTMETER
TILTMETER
GEODIMETER
1 cm
2 cm
3 cm
STREAM GAUGE
Pine Creek
STREAM GAUGE
SEISMOMETER
STREAM GAUGE
Marble Mountain
1,258 m
4,128 ft
2 cm
TILTMETER
Merrill Lake
SEISMOMETER
1 cm
Lava Caves
TILTMETER
GIFFORD PINCHOT NAT. FOREST
POWER STATION
STREAM GAUGE (REPLACED)
Mudflows down Pine Creek and Muddy River caused excessive turbidity in Swift Reservoir, killing fish and vegetation.
POWER LINE
Lewis
DAM
Swift Reservoir
Cougar
Yale Lake
STREAM GAUGE
STREAM GAUGE

and many of his friends hope he might yet dig out of such a retreat. But the lack of warning preceding the May 18 eruption makes it all but certain that Harry was caught in or near his beloved lodge, which now lies crushed under thick debris and the raised level of Spirit Lake.

The mountain he elected never to leave rewarded him with an eternal embrace, a cataclysmic burial of a magnitude befitting deity more than man, an extravaganza befitting even Harry's gift for vocal brimstone.

DAVID JOHNSTON. You already know of his fate, but now you must know of his promise. Like Reid Blackburn's credentials for photography, David Johnston's training for geology was impeccable. The University of Illinois awarded him a degree in geology with honors, the University of Washington conferred master's and doctorate, and the National Science Foundation granted him a fellowship.

Better than most observers, David knew the awesome potential of Mount St. Helens. "This mountain is a powder keg, and the fuse is lit," he said, "but we don't know how long the fuse is." Yet he responded to the need for samples from the crater by volunteering to be the sampler.

"He was a marathon runner in excellent condition," explained Lon Stickney, USGS contract helicopter pilot, who had made more landings on the mountain than any other human. "David figured he could get down into the crater and back out again faster than any of his colleagues."

ST. HELENS became part of my life late last March. I had been working on a prospective NATIONAL GEOGRAPHIC article on the national forests, and the Fuji-like eminence of Mount St. Helens—named for an 18th-century British diplomat—dominated Gifford Pinchot National Forest. On March 21 my friend Gerry Gause of the Forest Service's regional office in Portland phoned me in Washington, D. C., and said that earthquakes were shaking the mountain. I checked flight schedules and began to read up on Mount St. Helens.

To my hand came an aptly titled USGS paper, "Potential Hazards From Future Eruptions of Mount St. Helens," by Drs. Dwight Crandell and Donal Mullineaux. They said that St. Helens had been the most active of the Cascade volcanoes (map, pages 54-5), and for a quarter century beginning in 1831 had concocted various combinations of steam, ash, mudflows, and lava eruptions. Before the 20th century ended, they predicted, another eruption was likely.

The quakes grew in number and force; the dormant volcano was stretching and stirring. By Wednesday, March 26, I was convinced, and scheduled an early flight Friday. The mountain yawned on Thursday afternoon, venting steam and ash. By the time I arrived Friday morning, intermittent plumes rose two miles above the peak and tinged its northeast slopes sooty gray.

This was the start of a geologic event—the first volcanic eruption in the contiguous 48 states since California's Lassen, another Cascade peak, shut down in 1917 after a three-year run. St. Helens became a siren to geologists, journalists, and the just plain curious who crowded into Portland, Oregon, and into Vancouver, Kelso, and Longview, Washington. Seers competed in foreseeing holocaust, T-shirt vendors had visions of hot sales, and sign makers exhausted plays on the word "ash." Sample: "St. Helens—keep your ash off my lawn." There were some people who irreverently christened the mountain Old Shake and Bake.

The name seemed deserved as late March became April and April slid past with the mountain still not fully awake. A second crater appeared beside the first, then the two merged into a single bowl 1,700 feet across and 850 feet deep. But the eruption level, geologists said, remained "low-energy mode."

Despite such restraint, there was growing suspense for the country roundabout. It was rugged country, still largely remote except by air, its high places inaccessible under snows most of the year. This was a country of lava caves some thought were home to Sasquatch, or Bigfoot, the giant apelike beast of legend and controversy. This was the wild country over which D. B. Cooper parachuted from a hijacked jet in 1971 with $200,000 in cash; he was never found, though a few thousand of his currency was.

Once this was a land of Indian legend, too, including one in which the favors of a beautiful maiden caused a battle between

two rival warriors. They hurled fiery rocks at each other and so angered the Great Spirit that he turned the three into Mount St. Helens, Mount Hood, and Mount Adams.

Spirit Lake, the mirror for the beauty of Mount St. Helens, owes its name to Indian stories of the disappearance of canoeists on its waters as strange moanings arose.

What would arise from modern-day St. Helens was of immediate concern last spring. The situation put great pressure on geologists for forecasts, but they lacked experience with volcanoes such as St. Helens, a composite of alternating layers of ash and lava. They worked long hours to place instruments on and around the mountain: seismometers to record quakes, gravity meters to gauge vertical swellings, tiltmeters and laser targets to detect outward bulging. A Dartmouth College team led by Dr. Richard Stoiber flew circles around the peak to sample its hot breath. Increased sulfur dioxide content would signal magma on the move. At the University of Washington, at Portland State, at other area universities, faculty geologists monitored their seismographs and analyzed ash samples from the mountain for any clues to its intentions.

BY SATURDAY, May 10, the pulse was heavier—some quakes approached 5.0 on the Richter scale. Infrared aerial photos showed several hot spots in the crater and on the flanks. Most alarming of all, the mountain's north face was swelling; it had already bulged laterally by some 300 feet and was still distending at a rate of five feet a day. The volcano would not remain on "hold" much longer.

Still, the third-of-a-mile-wide crater looked drowsy enough in the bright sunlight of late Sunday morning, May 11. With Dr. Marvin Beeson, geochemist at Portland State University, photographer David Cupp and I hopped out of a helicopter onto the crater's northeast lip.

Marvin sought ash samples for analysis. Most of the ash was old, ground-up mountain, but new, glassy ash could be collected and, if it proved high in silica, would indicate how explosive the eruption might be.

Our pilot, Kent Wooldridge, Army trained and Vietnam conditioned, made two precautionary passes before coming to a six-inch-high hover. My jump to the volcano's crest reminded me of watching Neil Armstrong's first step on the moon; would I sink into the mixed ash and snow to my knees or to my hips? Gratefully I found that its consistency was like coarse sand; I sank barely to my ankles, and walking was easy.

While Marvin gathered ash from the crater's lip and David documented the scene on film, I looked around at this uncertain new world. Hundreds of feet below, wispy steam breathed gently from the crater's throat. The south side, towering some 500 feet above us and capped by a disintegrating glacier, constantly whispered and rattled with cascading ice and rock.

The dirty snow was pocked with softball-size holes. With a start I realized that each hole held a rock or ice chunk lately hurled out of the crater. I wondered how good I would be at the volcano's version of dodge ball, I wondered when the next earth tremor was due, and I wondered why Marvin was so slow at spooning samples.

THE WEEK between May 11 and 18 now seems to me part of another life. There was the overnight of the 11th at Coldwater I with Reid. There was time that evening to drive down to Harry Truman's lodge.

Harry greeted me cheerily, iced bourbon in hand, a couple of his 16 house cats scampering underfoot. Yes, his birds had come back—the camp robbers and wrens and blackbirds he fed. Most of them had vanished after the March 27 eruption. The raccoons had never left. The three feet of snow that blanketed his grounds had now melted; long winter was over. He and the mountain were still on speaking terms, and it hadn't told him anything to change his mind about staying.

It was a time for looking back across his 84 years, to his boyhood in West Virginia, to his teenage years in Washington State, where his father had moved to work in the timber, to the Los Angeles of the 1920s, where, Harry said, he used a service station as a front to sell bootleg whiskey that he had brought in by boat from Canada. To years when the late Justice William O. Douglas visited his Spirit Lake lodge, and to his World War II meeting with the other Harry Truman when

BOTH BY JOHN V. CHRISTIANSEN, WOODFIN CAMP

the latter was the U. S. Vice President.

"By God, if we had Harry S. Truman in Washington now, he'd straighten out those _____ in a hurry!"

Harry R. Truman of Spirit Lake (he never told me what the "R." stood for) had found his life troubled since the mountain began to awaken. "I'm gettin' letters, hundreds of _____ letters from all over the _____ country. Some of 'em want to save me—somebody sent me a 'Bible for the hardheaded.' I get marriage proposals—now why would some 18-year-old chick want to marry an old _____ like me. I get dozens of letters from children who worry about me."

THE CHILDREN'S LETTERS moved Harry, especially a batch from an entire class at Clear Lake Elementary School, near Salem, Oregon. Harry said he planned ultimately to answer all his mail, but he wished he could visit the kids at Clear Lake. "I'd like to explain to them about me and the mountain."

Harry's wish met with enthusiasm at the school, and so a helicopter was arranged to take him there on Wednesday, May 14. I went along, on what proved to be Harry's last trip away from his beloved Spirit Lake.

No Santa Claus ever had a warmer greeting; the entire student body—104 strong—cheered and unfurled crayoned banners (Harry—We Love You) as the whirlybird eased down on the schoolyard turf. Principal Kate Mathews and teacher Scott Torgeson, whose class had written the letters to Harry, did welcoming honors. Harry, forgoing his usual adjectives, admirably explained how it is to have lived a long, full life, and to have found a piece of the world as dear as life itself. For each child who wrote him, he had a signed postcard showing Spirit Lake and the lodge.

But what would he do if he saw the lava coming for him? "I'd run," Harry said. The earthquakes worried him more than eruptions, he added, and he had endured a few thousand tremors since the volcano had

An eyewitness to the unimaginable, *Suzanne Christiansen drops awestruck on Mount Adams as the blast, 35 miles away, quickly spreads to a 20-mile halo of death.*

Robert Landsburg's brave final shots

ALL FROM THE ESTATE OF ROBERT LANDSBURG

IT WAS THE EVENT of a lifetime, this eruption of Mount St. Helens that had begun on March 27. That's what Robert Landsburg decided, and the 48-year-old photographer from Portland, Oregon, undertook to document it with his camera.

During April and early May he made a dozen trips to the vicinity of the mountain, hiking and climbing to various vantage points. The morning of May 18 found him once more near the volcano, seeking "just one more" eruption sequence to round out his coverage.

*When the mountain exploded, he already had his camera on a tripod, aimed and cocked. As the all-engulfing cloud of ash climbed the sky toward him, four miles from the summit, he desperately cranked frames across his lens (**left** and **above**), then rewound the film into its cassette inside the camera, wrenched the camera from its tripod, and stowed it in a pack. His wallet was in the pack too—perhaps to assure future identification.*

Seventeen days later his body was found in the ash, together with the film that he bought with his life. It contained not only telling images of the killing edge of the blast but also the scratches, bubbles, warpings, and light leaks caused by heat and ash, the very thumbprint of holocaust.

started to stir. How did he keep from being tossed out of bed at night? "I wear spurs to bed," Harry said.

More cheers and waves. The helicopter eases up and out across sun-dappled fields. The jumping-bean cluster of young well-wishers shrinks and swings out of sight. A panorama of lush meadows and woodlands, prosperous towns, and ample rivers slides beneath Harry's attentive gaze. "What a beautiful country we got, boys—what a beautiful _____ country," Harry said.

Good-bye, Harry, and good luck.

THURSDAY, May 15. That famous Northwest weather trick—now you see it but mostly you don't—plagues efforts to learn what the volcano is doing. A brief glimpse early in the day shows hardly a steam plume; then the clouds drop a curtain. We sit by the chopper at Coldwater I through overtures of alternating cloud and sun, raindrops and rainbows. The curtain over the mountain never lifts.

Friday, May 16. The mountain is playing games with us. An early morning radio message from Coldwater I reports St. Helens in full view. By the time we get aloft, the curtain is closing. By the time we reach the mountain, the mountain can no longer be seen.

Saturday, May 17. All sunshine and no clouds. The mountain drowses on. The north-face bulge continues—swelling five feet a day; other signs say that nothing is about to happen. No need to keep flying around the sleepy mountain.

Instead, I drive to Cougar, a little timber-industry settlement some 12 miles southwest of the mountain, to see my friends Mort and Sandy Mortensen, who run the Wildwood Inn, a café and bar catering to loggers, fishermen, and whoever else turns up. Lately, business had been hit-and-miss, depending on what the volcano was doing. The town had been evacuated more than once, and there was no business.

I took the time to reassure myself that the Wildwood Inn's new deep fryer was still turning out delectable fried chicken.

And that was the last day of my final week from another life.

SUNDAY, May 18. First sun finds the mountain still drowsing. Because it is drowsing, I decide not to watch it today, a decision that soon will seem like the quintessence of wisdom. Because it is drowsing, others—campers, hikers, photographers, a few timber cutters—will be drawn in, or at least feel no need to hurry out. Their regrets will soon be compressed into a few terrible seconds before oblivion.

Ten megatons of TNT. More than 5,000 times the amount dropped in the great raid on Dresden, Germany, in 1945. Made up mostly of carbon dioxide and water vapor, innocuous except when under the terrible pressure and heat of a volcano's insides and then suddenly released.

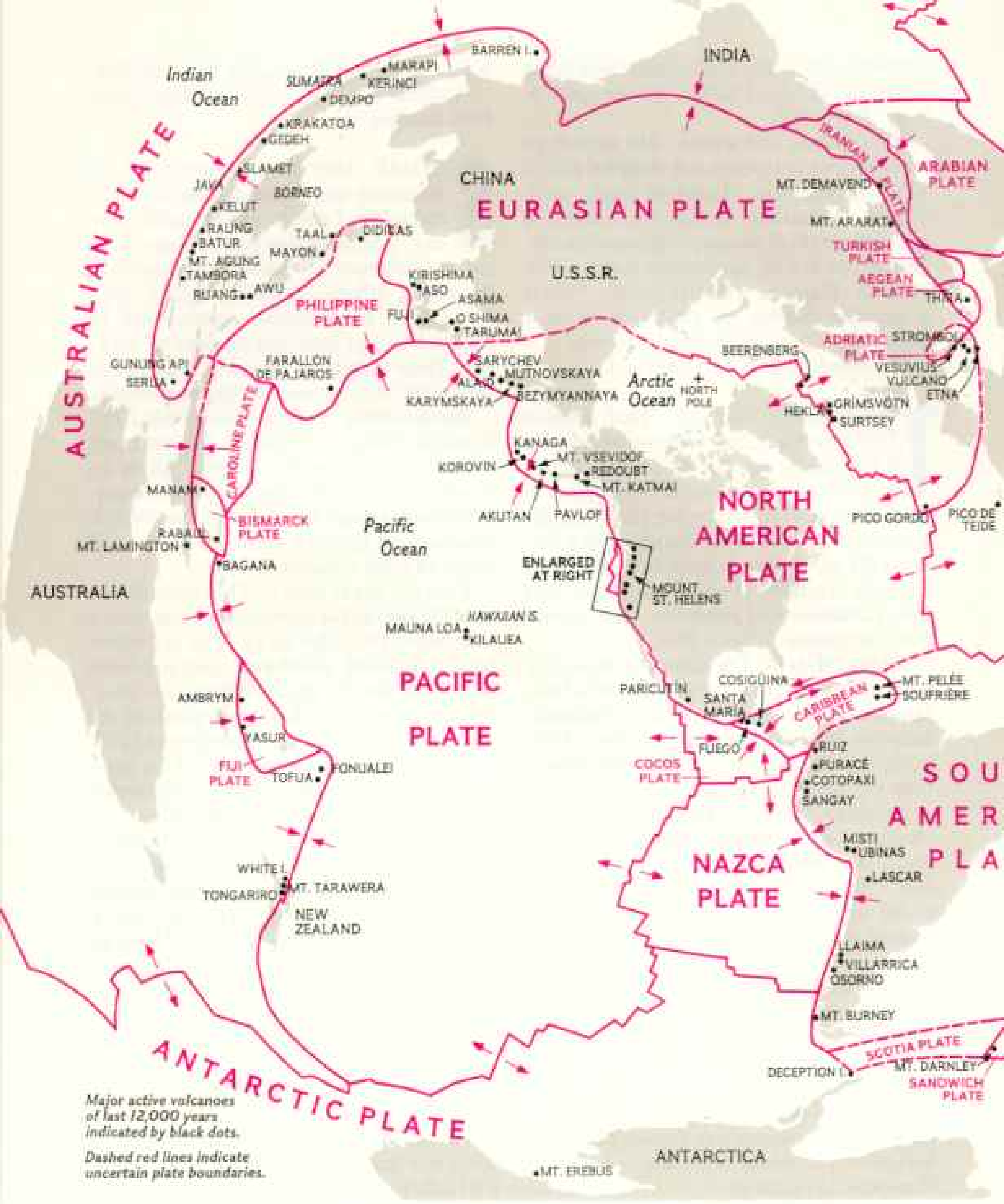
That 5.0 quake does it. The entire mountainside falls as the gases explode out with a roar heard 200 miles away. The incredible blast rolls north, northwest, and northeast at aircraft speeds. In one continuous thunderous sweep, it scythes down giants of the forest, clear-cutting 200 square miles in all (pages 36-7). Within three miles of the summit, the trees simply vanish—transported through the air for unknown distances.

Then comes the ash—fiery, hot, blanketing, suffocating—and a hail of boulders and ice. The multichrome, three-dimensional world of trees, hills, and sky becomes a monotone of powdery gray ash, heating downed logs and automobile tires till they smolder and blaze, blotting out horizons and perceptions of depth. Roiling in the wake, the abrasive, searing dust in mere minutes clouds over the same 200 square miles and beyond, falling on the earth by inches and then by feet.

The failed north wall of the mountain has become a massive sled of earth, crashing irresistibly downslope until it banks up against the steep far wall of the North Toutle Valley. This is the moment of burial for

Transformed to a lunar landscape, *the formerly green North Toutle River Valley was buried by some 200 feet of landslide, washed by waves of foamy dry ash at 1200°F, and pocked by steam explosions in the debris. President Carter toured the area May 22, saying "the moon looks like a golf course compared to what's up there."*

JOHN MARSHALL



Major active volcanoes of last 12,000 years indicated by black dots.

Dashed red lines indicate uncertain plate boundaries.

SHIFTING PLATES GIVE BIRTH

RAFTS SLIPPING AND SLIDING on a hot, viscous sea, the immense plates of earth's fragmented crust pull apart from, grind past, or slide beneath one another at rates of up to eight inches a year. Most land volcanoes erupt along plate edges where ocean floors plunge deep under continents

AZIMUTHAL EQUIDISTANT PROJECTION CENTERED ON THE UNITED STATES

MAPS DRAWN BY SIROONIAN STEPANOFF
COMPILED BY ROSS M. EMERSON
NATIONAL GEOGRAPHIC ART DIVISION

Volcanoes pepper the Pacific Northwest

Mount St. Helens and the other towering young volcanoes of the Cascade Range have been built up by the submergence of the Juan de Fuca plate beneath North America. Creeping under the coast at more than an inch a year, the small oceanic plate melts rock into pockets of magma that work their way up some 60 miles to the surface.

PAINTING BY SUSAN SANFORD, NATIONAL GEOGRAPHIC ART DIVISION

TO ERUPTIONS

and melting rock rises to the surface as magma. Some 300 active volcanoes ring the Pacific from Chile to Alaska, to Japan, and New Zealand.

In a grim reconnaissance, searchers in a National Guard helicopter found

Harry Truman and his lodge, as well as for some twenty summer homes at a site called the Village, a mile down the valley.

The eruption's main force now nozzles upward, and the light-eating pillar of ash quickly carries to 30,000 feet, to 40,000, to 50,000, to 60,000 . . . The top curls over and anvils out and flares and streams broadly eastward on the winds.

The shining Sunday morning turns forebodingly gray and to a blackness in which a hand cannot be seen in front of an eye.

In the eerie gray and black, relieved only by jabs of lightning, filled with thunder and abrading winds, a thousand desperate acts of search and salvation are under way.

PSYCHOLOGICAL SHOCK WAVES of unbelief quickly roll across the Pacific Northwest. In Vancouver and Portland, in Kelso and Longview, and in a hundred other cities and towns, the

RALPH PERRY, BLACK STAR

two victims asphyxiated in this truck, ten miles from the mountaintop.

towering dark cloud is ominously visible.

A phone call from my friend Ralph Perry of the Vancouver *Columbian* sends me outside to gaze at the spectacle. As soon as I can, I get airborne for a better look, and recoil from accepting what I see.

The whole top of the mountain is gone.

Lofty, near-symmetrical Mount St. Helens is no more. Where it had towered, there now squats an ugly, flat-topped, truncated abomination. From its center rises a broad unremitting explosion of ash, turning blue-gray in the overspreading shadow of its ever widening cloud. In the far deepening gloom, orange lightning flashes like the flicking of serpents' tongues. From the foot of the awesome mountain there spreads a ground-veiling pall.

Somewhere down there lies Coldwater I, above the rushing waters of Coldwater Creek and the valley I had left in verdant beauty only 40 hours before. * * *

MOUNT ST. HELENS: II

IN THE PATH OF DESTRUCTION

Smokelike ash slowly cleared, revealing a ghastly wasteland of slain forest, twisted and tumbled vehicles, buried homes—and human tragedy

IN THE FIRST SECONDS of the eruption, the collapsing north face of St. Helens sends juggernauts of ice tumbling down into the hot ash. Quickly the ice melts, and an estimated 46 billion gallons of water create the combination of mudflow and flood that geologists had feared. For 15 miles down the North Toutle River, the debris obliterates the recently pristine valley, already despoiled by ash and a slain forest (pages 46-7).

Like a science-fiction monster, the debris eats the river, the roads, the downed trees, the logging trucks, a few cars and campers. Beyond sweeps the flood, all but engulfing a Weyerhaeuser logging yard, tumbling or miring Cats and Kenworths, sending a million logs churning on the flood crest.

I do not give up hope for Reid Blackburn, who is activating the remote cameras from the camp at Coldwater I. After all, he is eight miles from the mountain, and he has a face mask and protective clothing. He is on high ground, above the floods and avalanches. I am more concerned about Fred Stocker and Jim McWhirter, who have been staying at Coldwater I with Reid.

Last evening Fred and Jim went to Olympia for a hot bath and a lobster dinner. They had planned to return to camp early today, early enough to be in the most perilous part of the Toutle Valley right now.

A midmorning radio report says: "NATIONAL GEOGRAPHIC team wiped out by mudflow in the Toutle Valley."

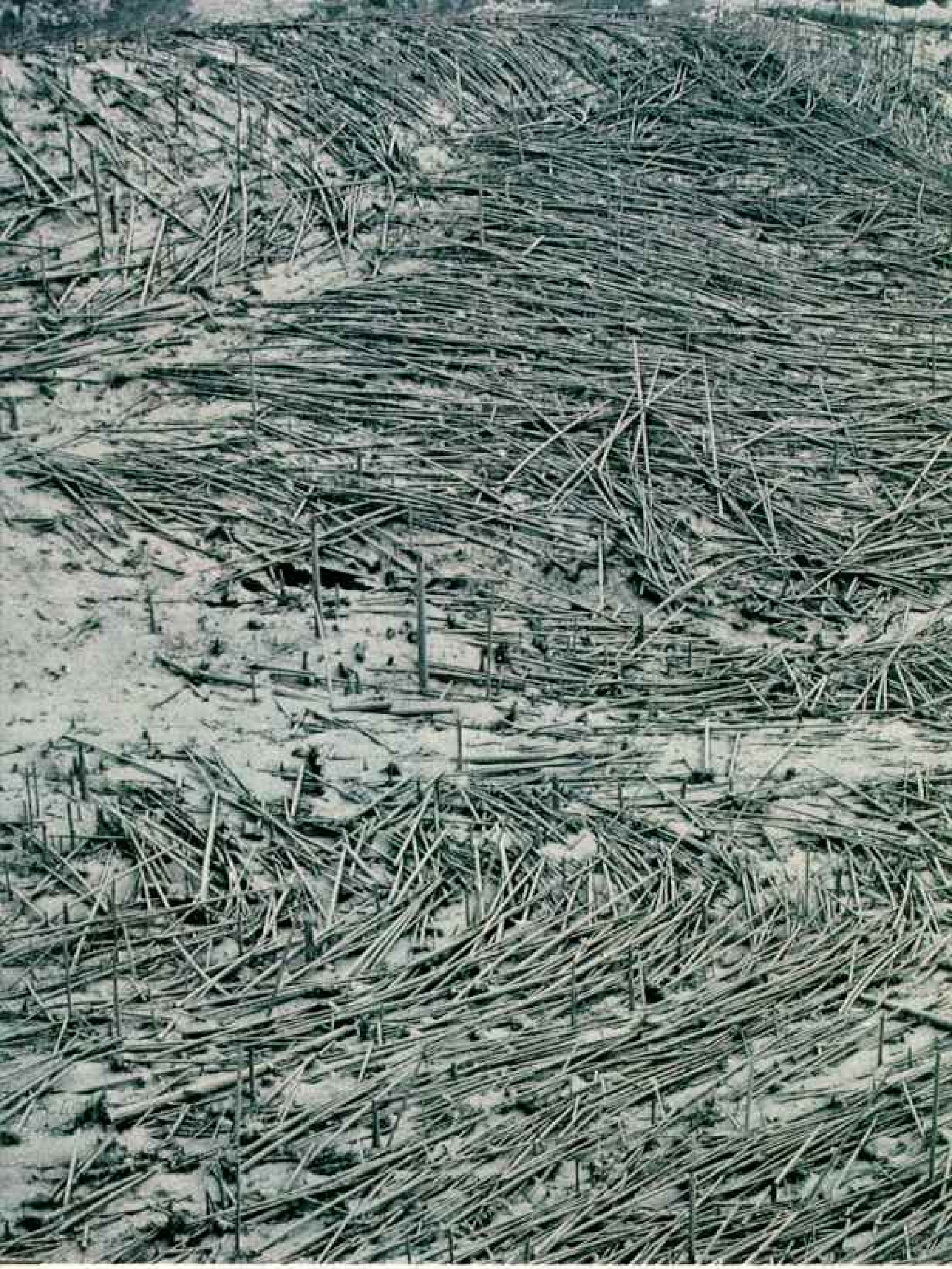
Dwight Reber flew as soon as he could to the Toutle Valley and the Coldwater I area. From the first week of the eruption, Dwight has been our helicopter pilot and he has made more than a dozen flights to the camp. Now he rides alone, because his Hughes 500 seats three besides himself, and Fred, Jim, and Reid all might need transport.

I hear Dwight's voice on the radio of the airplane I am in: "Three-Three Foxtrot leaving restricted area." I ask my pilot, Greg Hawes, to hurry back to Pearson field at Vancouver to await the helicopter.

As I wait, I get a call telling me Fred and Jim are safe. They had not reached the disaster part of the Toutle Valley when the flood came down; they were able to turn back.

The gold and purple of Three-Three Foxtrot looks dusty as it settles to the grass by the runway. I run forward and try to read Dwight's face for news of Reid. He flicks the shutdown switches and sags slightly. I see that his eyes are red and moist. He shakes his head hopelessly.

Chain-reaction disaster: *The eruption's heat melted tons of ice and snow, sending a witches' brew of mud, ash, and debris down the South Toutle River Valley, mangling trucks and scattering timber at a logging camp* ***(left)****. All told, the mountain's rampage last May cost an estimated billion dollars.* RALPH PERRY, BLACK STAR



Scattered like straw, *mature trees that towered 150 feet were flattened by the initial hot, debris-laden blast. Though much of the wood may be salvageable,*

National Geographic, January 1981

JAMES A. SUGAR

3.2 billion board feet of timber was blown down or destroyed in a 200-square-mile area—a fatal swath for some who had ventured too near.

"There's no way, there's just no way anyone could be alive up there," he says. "There's four feet of ash over the camp. The only sign of the camp is the top of Reid's car. It's full of ash. The windows are blown in."

Dwight coughs, wipes at grit in his eye, slides from the helicopter. My throat aches as I urge him to return to his base, get a medical checkup, get a thorough inspection of his aircraft. Then we'd take another look.

I balk at accepting Dwight's fateful words. Maybe Reid got over the ridges to the northwest. He was a walker.

WHILE I WAIT, I make another flight, this time to see the flood devastation on the Toutle and Cowlitz Rivers—dozens of houses inundated or swept away, Weyerhaeuser rail lines wiped out and railcars swept away, lumber-company employee buses called "crummies" mired or overturned, once green fields awash or silted over. Through Kelso-Longview the silt-heavy Cowlitz carries a miles-long jumble of logs. They drum hard against bridge abutments and hold tiny knots of spectators in spells of unbelief. Just 35 miles to the east, the volcano still vents its ash into a darkening sky. Though it is slackening, it will not pause for another day and a half.

Next morning I flew with Dwight to Coldwater I, and my last hopes faded. Beyond Coldwater, for ten miles beyond that, I saw the same gray blanket, the awesome blowdown of giant trees.

Surely, it seemed to me, we had somehow slipped through a warp in time and space to land on a different planet in a different geologic age. We masked ourselves against breathing the cloud of ash through which we flew without a horizon. Spirit Lake at first appeared gone; then I discerned it to be displaced somewhat, its surface darkly opaque with the floating trunks of blown-down trees and coatings of ash. The altimeter hinted that the whole valley floor was greatly raised, the lake dammed to a much higher level. Somewhere deep beneath lay the crushed remnants of Harry Truman's lodge.

We flew down valley, over a craterlike caldron of hissing, geysering steam. "That's where the Village was!" Dwight said. There was no sign of the vacation homes, no sign of a tree, a road, anything familiar.

STEVE SMALL, THE COLUMBIAN

They gave their lives

*TO MONITOR the mountain, photographer Reid Blackburn of the Vancouver "Columbian" (**above**) set up radio-triggered cameras for the U. S. Geological Survey and NATIONAL GEOGRAPHIC. Seeing the May 18 blast from eight miles away, he fired four frames, then fled to his car (**right**), where he was later found.*

*Geologist David Johnston of the Survey (**below**) kept vigil from six miles away and vanished in the blast. The fathers of both young men agreed that their sons had died doing what they most wanted to do.*

BRIAN DRAKE (BELOW) AND RALPH PERRY

The whole world was a spectrum of grays, powder light when dry, almost black when water soaked, with many shades between. In the vast debris flow that floored the valley lay chunks of ice from the glaciers, a few as big as boxcars. They were melting and creating wet circles like grief-darkened eyes. Others, already melted, had left moon-like craters. The drying mud lay arrested in a million heavings and writhings of its recent fury.

The mountains above the valley had also been bombarded by ice missiles. Wherever frozen chunks had landed, dark vertical streaks of melt now stained the ash slopes like the bleeding of wounds.

ALL-ENGULFING MUD had also buried miles of the South Toutle River Valley, and floods had raged through another Weyerhaeuser logging yard, tossing ordered acres of huge logs into chaos, wrecking a train. High ridges south of that valley divided the quick and the dead; in a fan extending southward around the volcano to a bearing of northeast, people at the foot of the mountain itself survived, even though they looked up and saw the ash cloud directly overhead.

Death lay on the opposite side. As we flew above the mountain, through turbulent air swimming with ash, I marveled at Dwight's rescue attempt the day before. Even his Army helicopter experience in Vietnam had hardly prepared him for this. Only the hope of saving a life drove him on.

At Coldwater I, he now hovered over Reid's car and tried to blow away ash with the rotors. But it boiled up menacingly. The ash was still very hot.

We saw 110-foot-tall logging booms toppled and twisted, bulldozers overturned, trucks mired or wrecked, here and there an isolated car or pickup, windows shattered. Were there victims inside? Here a body lay by a station wagon's open door, there in the bed of a truck.

I had seen enough. But at Kelso airport, where we went to refuel, the Washington Army National Guard was mounting rescue missions with big olive drab Huey helicopters, flying in pairs. Could photographer Jim Sugar and I go along? Climb aboard.

With Capts. Frank Shipton and Darald

Erasing centuries *of forest growth, the blast also wiped out summer camps, public campgrounds, vacation lodges, and private cabins around Spirit Lake, which still simmers six days after the eruption* (**above**). *An avalanche swept thousands of spruce, fir, hemlock, and other debris into the lake, which, along with melting glacier runoff, raised its water level by about 200 feet. Three-day-old pyroclastic flows near the lake's North Toutle River outlet* (**right**) *smolder at 330°C (626°F) just ten feet below the surface.*

NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT W. MADDEN (ABOVE); LON STICKNEY, THE COLUMBIAN (BELOW)

Stebner at the controls, we lift off and fly back into the realm of total gray. Staff Sgt. Bob M. Williams, crew chief, points out other vehicles, other bodies, and charts them for later recovery. Our concern now is for the living.

This crew is part of 116th Air Cavalry, diverted from its two-week summer training exercise. A second rescue mission late in the day, with pilots Grant Green and Harold Ward and crew chief Bob Mares, combs the ridges north and west of Coldwater I. We see more glass-shattered derelict vehicles, one of them a small pickup atop a little knob some ten miles from the volcano. Inside, they say, are two bodies. I look but fail to see them. I don't look very hard.

NEXT MORNING with Dwight we fly again. The Washington State Patrol had received one of those recurring reports of incredible survival—a camping couple, John and Christy Killian, had somehow lived through the holocaust. They were supposed to be hiking toward Route 504 near Coldwater Creek. This area lay in the worst devastation not far from Spirit Lake.

Bob Cory of the state patrol navigates, search map in hand. As on the previous day's mission, we look for footprints. In the light-gray ash, as in new-fallen snow, footprints would leap to the eye. My heart pounds when I see tracks on a mountainside logging road. Then, sadly, I realize that they are too small, too close together—the hoppings of a rabbit that wound a few dozen yards before vanishing under a log.

Otherwise, we detect no evidence of life. We comb the same melancholy valleys and ridges we had flown the previous day, see the same wrecked and lonely vehicles, feel the same tight fear in the chest.

More than fear for personal safety, I felt a growing apprehension for all of us living on a planetary crust so fragilely afloat atop such terrible heats and pressures. Never again, it came to me then and remains with me to this day, would I regain my former complacency about this world we live on.

That loss of complacency proved a shared element in the many stories of survival that I now began to hear. Keith and Dorothy Stoffel of Spokane, for instance. Both geologists, they were flying in a light plane directly over the crater at 8:32 a.m. on May 18.

"We arrived at 7:50 in the restricted zone, and made two passes directly over the crater and several around the mountain," Dorothy said. "The thing that impressed us was that it didn't look like an active volcano—more like one going to sleep."

Then an incredible sight froze thought and feeling: "We were making a final pass over the crater at about a thousand feet, when Keith started to see debris-slides coming off the glaciers. Suddenly, the whole north half of the mountain began sliding away, directly beneath our feet! I went into shock. Keith snapped pictures of the slide, which showed steam starting to come out from under the leading edge, and the vertical blast beginning.

"Then he ran out of film. That's what saved our lives. Because then Keith glanced over his left shoulder, saw the lateral blast starting and recognized the peril of our situation. He told the pilot, Bruce Judson, that we had to get out of there.

"So Bruce opened up full throttle, but it still looked like the ash cloud was going to catch up with us. We were headed east, and so was the cloud. Keith was afraid lightning would strike the plane. The pilot turned south and dived to gain airspeed."

Though the doomsday cloud umbrellaed overhead, they finally escaped its shadow and swung toward Portland. The pilot radioed Seattle's FAA control center that the mountain had exploded, to get everyone away from there, because the blast was big, Big, BIG!

"It took me a month to learn to relax," Dorothy said. Her mind plays and replays the thought that but for the difference of a few seconds, that little Cessna 182 would have flipped and fallen like a seared grasshopper, and the fatality list would be three names longer.

FOR THOSE ON THE GROUND, terror abruptly became a traveling companion as they fled the volcano's lethal reach, or died trying. Among the lucky ones were the 25 members of a tree-planting crew at work on the foot of the mountain itself, only three miles from the summit on the south side.

Kran Kilpatrick, a young U. S. Forest Service silviculturist, remembers the instant of stunned disbelief when the eruption began: "There was no sound to it, not a sound—it was like a silent movie, and we were all in it. First the ash cloud shot out to the east, then to the west, then some lighter stuff started shooting straight up. At the same time the ash curtain started coming right down the south slope toward us. I could see boulders—they must have been huge—being hurled out of the leading edge, and then being swept up again in the advancing cloud."

In frantic haste that seemed in slow motion, the crew scurried into six trucks and dashed toward safety over mountain roads. As Kran's crew was soon to learn, they were truly the lucky ones. Only the day before, they had been working on the northeast side of the mountain, now a dead gray hell.

Northwest of the peak, some 14 miles away, a four-man tree-thinning crew was caught by the blast. They tried to walk out, their scorched clothing sticking to burned skin. One man climbed a tree to escape the fiery blanket of ash, and his body was found there weeks later. After eight hours a helicopter rescued the other three, two of whom died in a Portland hospital.

Far above and safely west of the disintegrating mountain, a Seattle-to-Portland jetliner took special account of the awesome sight. Inviting passengers to witness geologic history in the making, the pilot circled for what seemed an eternity to one woman aboard. Finally she sent a message to the pilot: Please hurry on and land. "My son, Lon Stickney, flies a helicopter for the Geological Survey, and he's been flying around that mountain for weeks. I've got to find out if he's safe."

Lon indeed was safe, but he was also more anxious now than he had been in six weeks of volcano flying. He was piloting a Bell Jet Ranger on a rescue flight into the gray swirling maelstrom that had been Mount St. Helens, and wondering about the survival chances of anybody at Coldwater II.

On Lon's last visit to the area, the previous afternoon, he had flown Dave Johnston over the volcano, then left him for his first overnight at Coldwater II. At dawn this day, Sunday, Dave had reported all serene; then at 8:32 had come his unfinished "This is it" message. After those words—silence.

Now Lon felt anxiety deepen to despair as he searched the high ridge that had been Coldwater II. There he saw that everything—trailer, instruments, a jeep—had been swept away. After the initial shock came growing awareness of the dimensions of the disaster, of the high toll of life it must have taken. "When I finally landed," Lon said, "I was in tears."

ANNIE GRIFFITHS

Fear for her father's life *clouds the face of 13-year-old Michele Hoy of Toutle. On May 19 a 200-foot-high wall of water was reported crashing down the Toutle Valley, where Dale Hoy had been allowed to return to check out the family farm. The flood story proved to be a rumor, and Hoy was soon reported safe.*

At Cougar, 12 miles southwest of St. Helens, Mort and Sandy Mortensen stood outside their Wildwood Inn and stared at the ash cloud devouring the sky. "It just kept spilling over and turning darker," Sandy said, "until all the daylight you could see was a long way off and looked like it was coming through a curtain." Winds aloft swept most ash eastward, and Cougar got only a dusting.

OVER by the South Toutle River, cameraman David Crockett of Seattle's KOMO-TV was following logging roads upstream for a closer look at the mountain. The eruption caused him quickly to turn his station wagon around, but debris flows washed out his escape route and the black cloud overtook him.

As darkness came down on him, he started his camera and recorded a narration of his attempt to walk out, an attempt in which he had little hope of success. But he made it, living to share his "last words" with television viewers, to the accompaniment of six minutes of videotape that registered only blackness.

Hours of darkling nightmare, howling with searing winds and crackling with lightning and thunder, at last ended in a helicopter rescue for campers Bruce Nelson and Sue Ruff of Kelso. Their ordeal began when the volcano's lateral blast leveled giant firs over their campsite, 12 miles north of the peak. Their fellow campers were not so fortunate. Two suffered severe injuries, and two others lay dead with the fallen forest.

Mere seconds spelled the difference for Ty and Marianna Kearney of Vancouver. Both ham radio operators, they were completing their first week of volunteer duty as volcano-watchers from their radio-equipped van, eight miles west of the summit. They logged an earthquake at 8:32 a.m. that focused their attention on the peak.

Pulverized concrete explodes *from the near end of a bridge seconds after it was snapped by a huge logjam on the mud-gorged Toutle River. About 2,000 people were hurriedly evacuated from the path of the torrent—some by helicopter, at the last minute.* ROGER WERTH, WOODFIN CAMP

JERRY COUGHLIAN, THE COLUMBIAN (BELOW)

RALPH PERRY

ROGER WERTH; WOOLF IN CAMP (ABOVE AND LOWER RIGHT)

Gooey, smelly, unstoppable, *a special kind of flood—mudflows—surprised residents downriver from Mount St. Helens. Racing at about 30 miles an hour, the onslaught bloated the sleepy Toutle from a width of about 200 feet to more than a third of a mile. Near the town of Toutle, a homeowner's dream house lies encased in mud as thick as wet cement* ***(above)****. During the messy cleanup, Gary Roggenback salvages tools from his rented house* ***(lower right)****. Weeks later Joe Halleck III* ***(upper right)*** *and friend Tom Harper find the depth of the hard-packed flow has left an easy dunk shot. Joe's reaction to the inside of his family's home: "Yuck! Three feet of mud all over the place."*

Westward into the Cowlitz River, the Toutle dumped enough sediment to cover a square mile nearly 40 feet deep. Near Castle Rock, ranchers labor to free one of several heifers mired in the muck ***(left)****. A tow truck saved the cattle by gently winching them on their sides over the slick flats. Other animals were less fortunate. By the thousands, trout, salmon, deer, elk, and other wildlife died from the eruption and its destruction of their habitats.*

Pulses of light *from a laser device on the tripod at right help keep geologists in touch with surface swelling caused by rising magma beneath the crater. They say another big blast is unlikely, although smaller explosions may continue for decades. On a time scale of millennia, such volcanoes destroy themselves and then build themselves up again—a geologic form of reincarnation.*

"And I heard Gerry report it," Ty told me, "and add, 'The camper and the car just over to the south of me [Coldwater I] are covered. It's going to get me too.' "

Gerry Martin was another radio-watcher, situated some eight miles north-northwest of the volcano's crest, near Coldwater Peak.

"I got out of my van," Ty said, "and saw what I thought was Goat Rocks—at least part of it—sliding down. I ran in and got my camera and began taking pictures. The lateral cloud was racing toward Coldwater Peak, and soon rolled beyond. The vertical cloud disappeared in the overcast."

The first mile of their escape route lay east, right into the face of the lateral wave of ash. Then the logging road turned south toward lower, sheltered ground: "I threw the tripod in, slammed the van's top down, and drove right toward the cloud."

Ty fought back the urge to floorboard the accelerator, which might have wrecked or disabled the van on the rough road. The swelling edge of the cloud seemed to leap toward them as they at last reached the corner and swung south toward protective ravines. Seconds later the tree-toppling winds reached the same turn, at about the southernmost limit of its destructive swath.

Though cauliflowering ash overspread the sky, the Kearneys got only dustings as they drove homeward in stunned incredulity. They worried about others around the mountain, including Gerry—and with good reason. Gerry didn't make it.

THE DRUMSTICK TATTOO of giant logs churning in a wall of floodwater sent two Tacoma fishermen scurrying from their camp beside the South Fork of the Toutle. Behind the wall of water Roald Reitan, 20, beheld an even more horrifying sight heading his way—a section of railroad trestle, scything the trees like a mowing machine. He and Venus Ann Dergan got to their car just as the flood started to carry it away. They jumped out, and Venus was swept under a log.

"It just sucked her under, and her head was caught by two logs. All I could see was her nose." Roald struggled toward her, managed to grasp her hair. Using all his strength, he freed her from the logs, and both clambered to the jumble of logs and to high ground. Later a Weyerhaeuser helicopter picked them up and got them to a hospital, where both were treated for bruises and Venus for a broken wrist.

The chance to earn extra pay as weekend timber cutters had drawn Tom Gadwa and Wally Bowers toward the mountain the

RALPH PERRY

morning of the big eruption. In a red pickup, Tom, 35, of Montesano, and Wally, 41, of Winlock, wound up the logging roads to a camp near Elk Lake, in a stand of fir, hemlock, and yellow cedar. Shortly after 8:32 a.m., the volcano cut all the timber that they had come to cut. The blast of wind scooped the water from a small lake and slammed it onto their camp, crumpling a steel high-lead tower, toppling massive log loaders, burying huge Cats to the top of their treads.

By the following Thursday, logging contractors Keith and Dan Ross of Toutle, unable to get an air-rescue mission to the area, decided to walk in, an eight-mile round trip.

"The ash was still so hot," Keith told me, "that when we broke through, we had to walk fast to keep from burning our legs. When we got to the camp, all we could find of the truck was one piece of chrome."

There has been no sign of Tom and Wally. And searchers looked for eight weeks before recovering the bodies of Jerome and Shirley Moore of Kelso. On the Saturday before the eruption, they had driven their motor home to the lofty, forested serenity of Tradedollar Lake, 11 miles north of the peak. The blast blew the vehicle 600 feet.

At first searchers found only the wrecked pickup of campers John and Christy Killian of Vader. Then a portable food cooler and other clues led them to where Christy had died. With fall coming on, they still searched for John.

As greenest fern sprouted from the gray ash, there were still 27 people to be accounted for. The probable—almost certain—toll of human lives stood at 61. • • •

MOUNT ST. HELENS: III

THE DAY THE SKY FELL

A menacing plume boiled 12 miles high as life downwind came to a halt and darkness reigned at noon

A TOLL OF HUNDREDS—even thousands—seemed likely that Sunday, May 18, as the mountain turned itself inside out. The ashen pall swept darkly over the beautiful Yakima Valley, across fields of wheat and alfalfa around Moses Lake and Ritzville, and settled on Spokane, the Idaho Panhandle, Montana. . . .

Cars, trucks, buses, trains, planes stopped. Churches let out, and people prayed their way home. Service stations, restaurants, drugstores closed. Some electric grids failed as ash caused transformers to arc and short out. Thousands of travelers sought shelter in motels, schools, homes. In Yakima, midnight gloom arrived at 9:30 in the morning and streetlamps burned all

Gray, choking blizzard *envelops pedestrians in Yakima, Washington, as the volcano spews a rain of ash hundreds of miles eastward.*

DAVID A. CUPP

Night fell at midmorning *on Yakima (**above**), in stark contrast to the view on a clear day (**below**). May 18 dawned a bright Sunday morning—until about 9:30 a.m., when an ugly black cloud swept in from the west. Unalerted to the eruption 85 miles away, residents braced for a thunderstorm. What fell instead resembled soft sand. More than half an inch blanketed the city, precipitating anxiety and bewilderment: Was it dangerous to humans? Crops? How to get rid of it? At first, no one knew.*

BOTH BY DAN WHITE

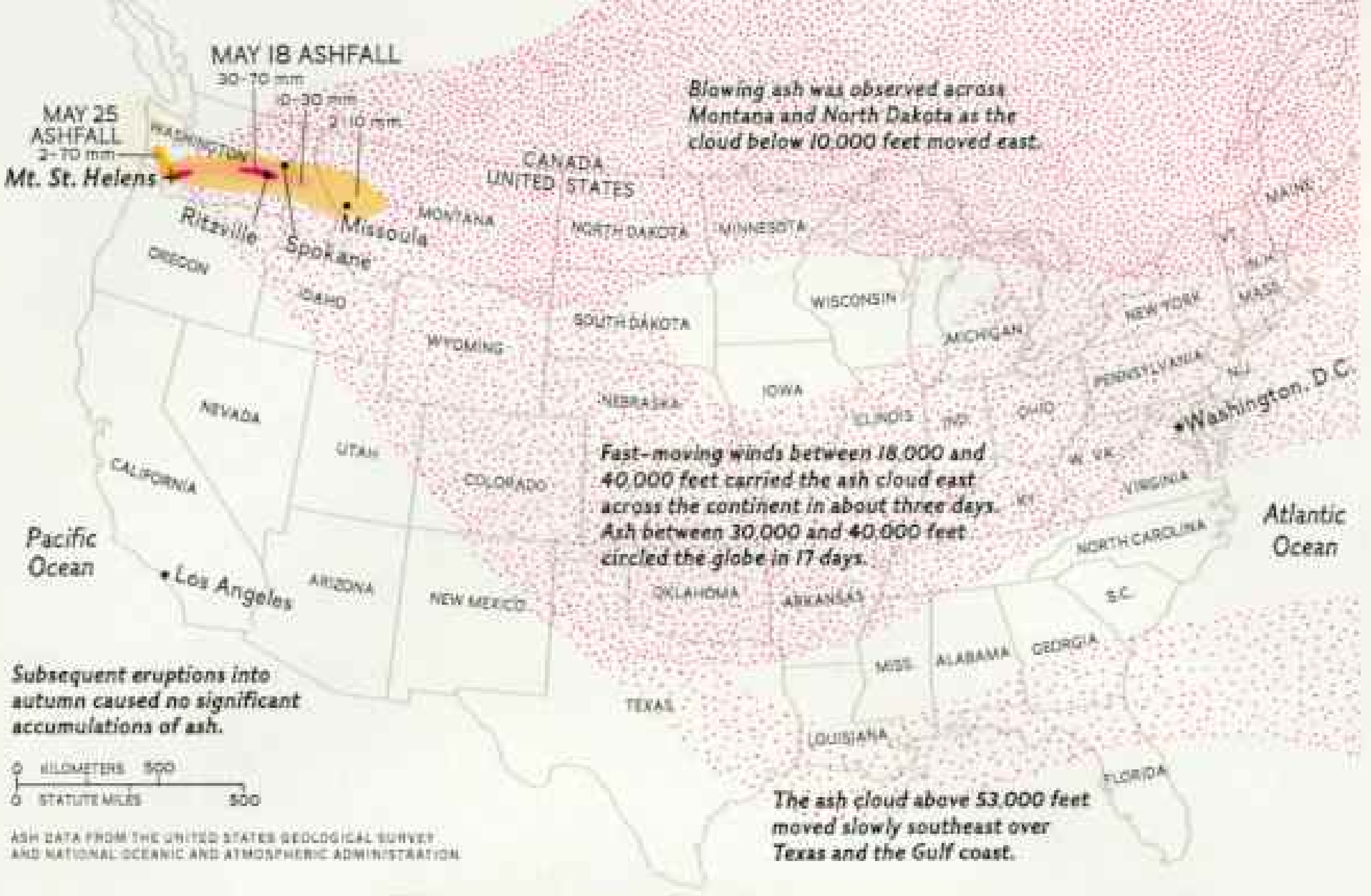
day. In memory it has become Black Sunday (above).

It was more than blackness—it was blackness that hid the unknown. No headlights could cut it, to reveal the stalled car ahead. Largely composed of fine volcanic glass particles, the cloud was itself a mass of cutting edges. For insects, the edges quickly abraded wax coatings and allowed vital body fluids to escape—dehydration and death. Some small creatures quickly choked, some birds lost bearings and vision and fell. Larger creatures avoided suffocation but seemed disoriented; cattle huddled in fields, elk and deer wandered crazily.

Beavers on a pond near Packwood, 35 miles from St. Helens, impressed an observer; about 30 seconds before the blast, they slapped the water with their tails, as if on common signal, and dived for their lodge.

Like the beaver, humankind tried to get home. To mask mouth, nose, and eyes, people used any fabric available, including panty hose. When air filters on vehicles clogged and carburetors gagged, they rigged Rube Goldberg protuberances of fine-mesh screens and shop-vacuum hose and masking tape to try to scoop and strain enough usable air to keep engines running.

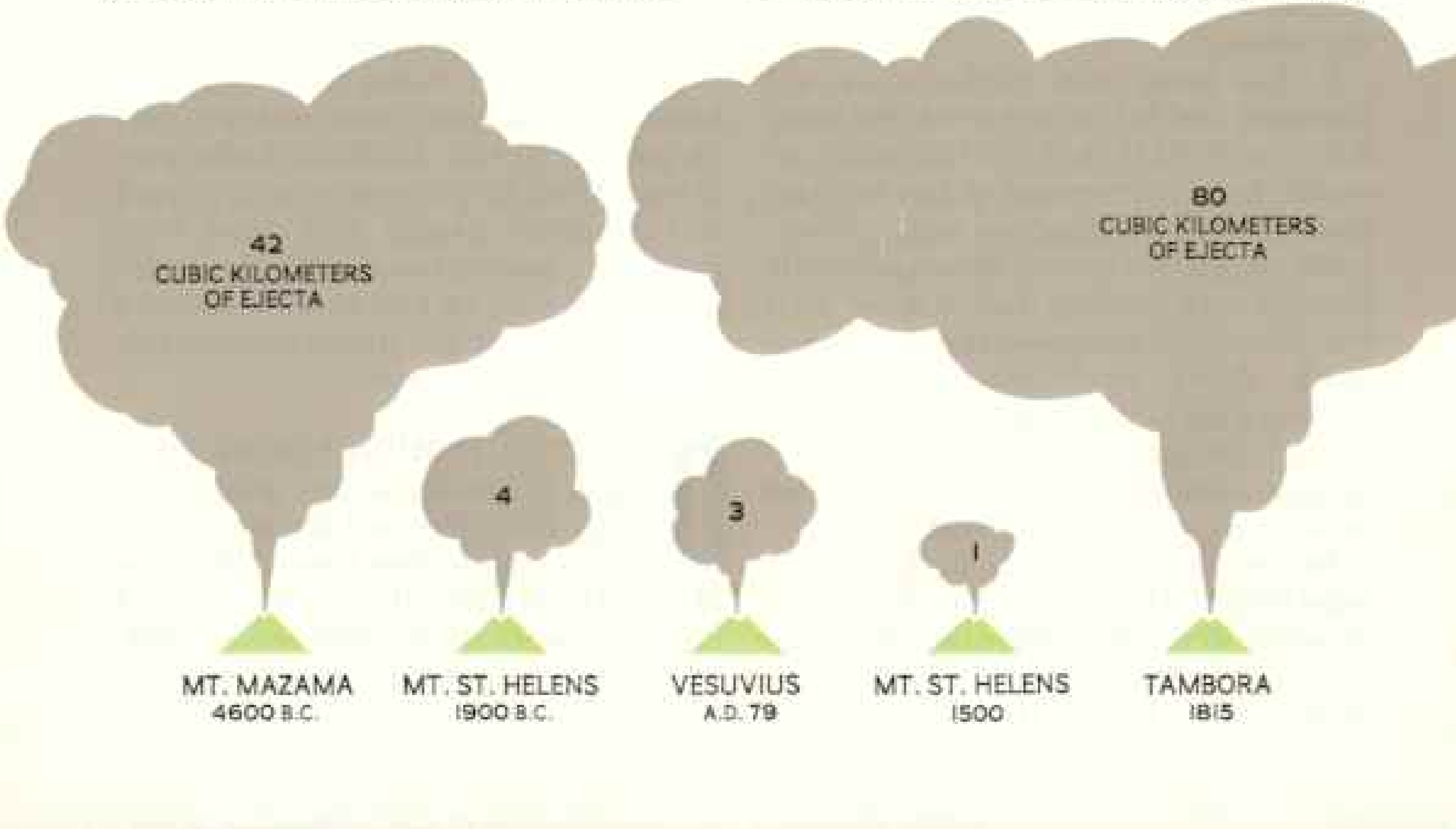
DISPERSED FAMILIES suffered torments of anxiety as they tried to reunite. Gil Miller and his son, Chris, were 40 miles from home, fishing on McDaniel Lake with three other men and their sons, when the daylight began to fail.

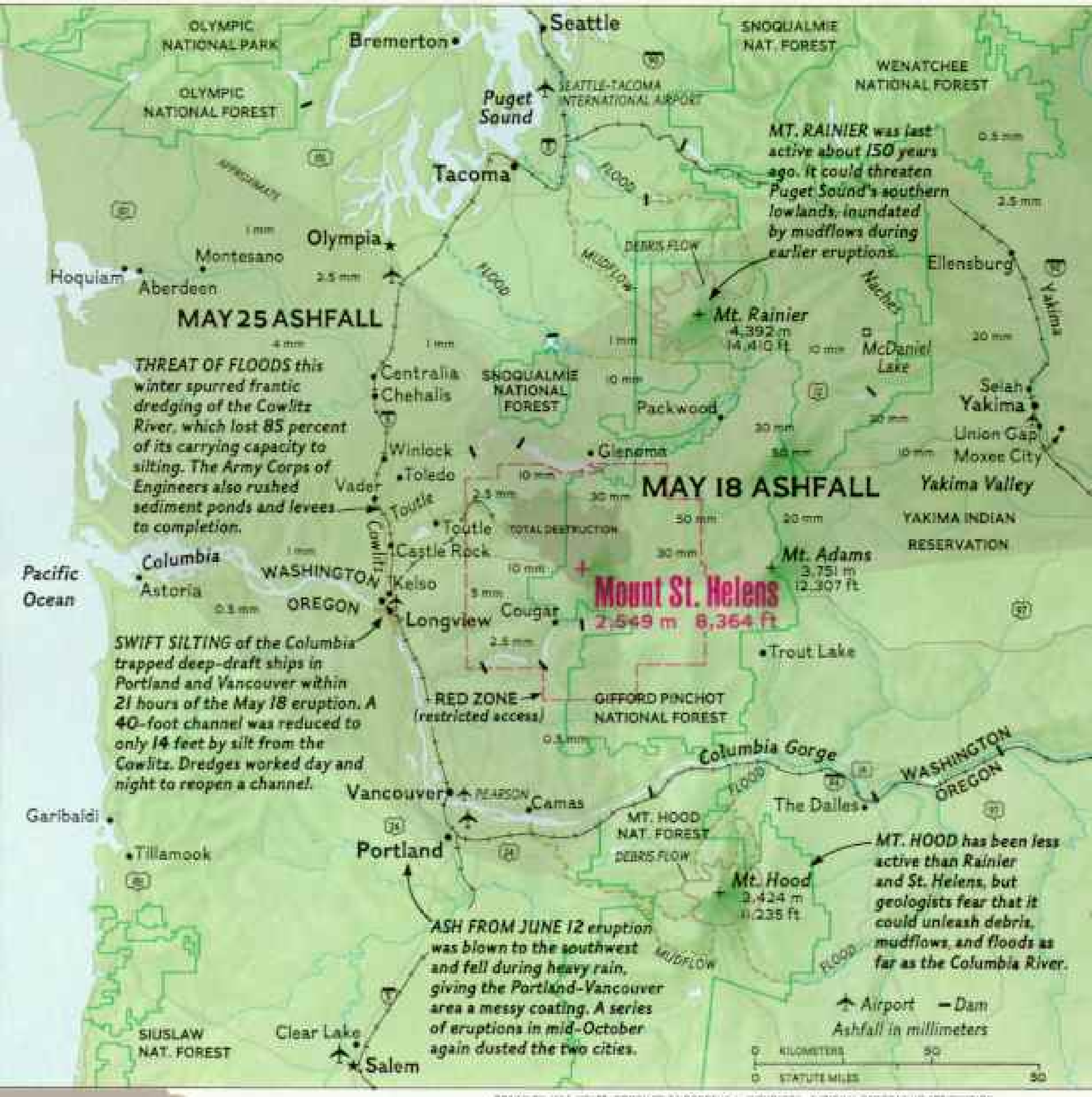


The mountain that roared

*ST. HELENS quickly became a national event (**above**). Where ash from the May 18 upheaval stayed airborne, people far to the east gazed at dusky skies and made the awesome connection. Within the fallout zone some towns were smothered by nearly three inches, and residents donned face masks. Other communities that got a dusting considered it only a nuisance. During smaller subsequent eruptions, winds blew the ash west and south. But all breathed a glad sigh when it proved essentially nontoxic.*

*Where ash fell, scientists pointed to long-term benefits. Soils in the Northwest owe much of their fertility to repeated deposits from numerous eruptions in the Cascade Range. But the immediate future remained unsettled for those in the shadow of a giant no longer asleep (**right**). Mount St. Helens last came to life in 1831 and sputtered intermittently for 25 years. Its rebirth has focused attention on other historically active Cascade peaks such as Mount Hood, which was rattled by more than 50 small quakes last July.*

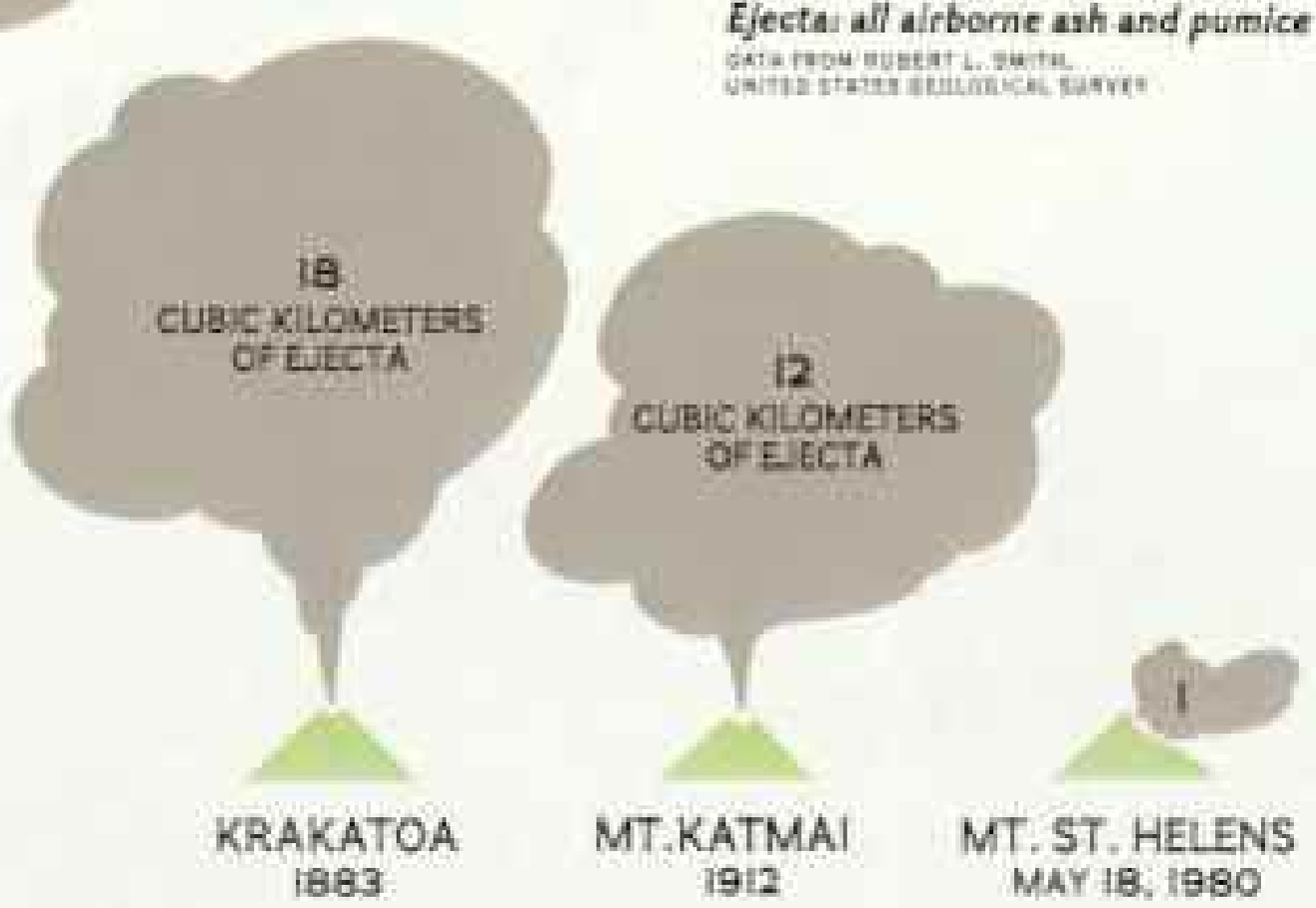




DRAWN BY JANE WOLFE. COMPILED BY DOROTHY A. NICHOLSON, NATIONAL GEOGRAPHIC ART DIVISION

Ejecta: all airborne ash and pumice

DATA FROM ROBERT L. SMITH, UNITED STATES GEOLOGICAL SURVEY



*Mere firecracker judged against blasts of the past (**left**)—measured by the volume of airborne debris—St. Helens nonetheless has been the Cascades' most active volcano for 4,500 years. Indonesia's Tambora killed 12,000 people, and its airborne ash cooled the earth enough to cause the "year without a summer" of 1816. Meteorological effects from St. Helens, in contrast, were predicted to be negligible.*

"This black, black cloud, of a blackness I had never seen, came over, and of course we thought it was going to be a tremendous rainstorm," Gil told me. "Then we could see the sprinkles on the lake, and we looked at our coats and saw we weren't getting wet. Then it all hit us about the same time that it had to be an eruption of Mount St. Helens.

"So we dashed for camp, but by the time we started packing we had to use flashlights. The only way we could see to drive was to look for the edge of the road, somebody looking out the passenger side and me looking for the other edge—all the time hoping no one was stalled in front of us.

"We were very concerned for the rest of our families back in Yakima. Every once in a while, in the middle of all the static, we'd get a blurp of news on the radio, and that just made us worry more. We wondered if the ash would stop the engine, and we wondered what breathing it was doing to us."

After three agonizing hours they reached Yakima and found all their loved ones safe: "I'll never forget that ride."

About 3,000 motorists across central and eastern Washington did not get home that day, nor for a few days to come. Police and emergency vehicles helped herd them off the hazardous highways into makeshift refugee centers, a duty that exacted a high price.

"By the next day more than half the state patrol cars and local police and emergency vehicles were out of commission," Governor Dixy Lee Ray told me. "Planes were grounded, and trains and trucks stopped, except in a narrow western fringe of the state of Washington. Food distribution and other basic services were breaking down. It was an unprecedented emergency."

Governor Ray directed National Guardsmen and state emergency agencies into action. Though St. Helens closed down to sporadic ventings by Wednesday, May 21, a return to normal conditions seemed hopelessly in the future.

Meanwhile, there was the question of whether damage to crops was on a disaster scale. Most of central Washington is near-desert, dependent on irrigation, and every sigh of wind picked up a puff of talcum-fine ash. A brisk breeze meant a whiteout. The situation could last for months.

SURVEYING Mount St. Helens' legacy, I first drove toward the eastern side of the Cascades, trying as I went to buy a spare air filter. None were to be had, and so I relied on the stop-and-slam method of cleaning filters, pulling to the shoulder periodically to remove the filter and slam it against the pavement to jar out the caking dust.

The dust was causing only a light haze as I crossed the Yakima Indian Reservation. The dusting on pines was minimal. But as the road wound down toward the broad Yakima Valley, I saw the airborne ash gradually thicken and at last devour the visible world. The few yards of visible highway vanished temporarily in the dust clouds of passing cars, and driving became a chancy business.

Over the Memorial Day weekend, Yakima police closed the downtown business section for emergency ash removal. During the next month, an estimated 600,000 tons were trucked away by a fleet that included National Guard vehicles and others on loan from as far away as Seattle and Portland.

On Sunday morning I walked a block inside the barricaded zone to the First Christian Church of Yakima. Doors were locked, the church empty. Posted by the entrance was the title of the previous Sunday's sermon, "What's It All About?"

Across this city of 51,000, residents swept and shoveled ash from roofs, walks, and driveways, and block by block front-end loaders and dump trucks scooped it up and convoyed it to huge dumps, where fire department pumpers played water over growing mountains of concrete gray. A curbside sign advertised: Mount St. Helens Ash, 50 Cents a Gallon. Accept No Substitutes.

Face masks were a must, and robbers

Life goes on *for the "Swede," a Yakima drifter who patiently tidies his corner of town. For others it was harder. The abrasive ash filtered indoors, scratching furniture. When cars kicked up the grit over newly cleaned yards, homeowners retaliated with "speed bumps"—rows of ash piled across the streets and wet down.*

DAVID F. CURP

JAMES MASON, BLACK STAR

Like snow that wouldn't melt, *the ashfall left a 600,000-ton headache for Yakima. Days after the ash settled, a stiff breeze was enough to stir it up* ***(above right)****. "Ash bombs" dumped from rooftops during the cleanup thickened the pall* ***(above)****. Much of the ash was used for landfill, but enough poured into sewers to clog the city's wastewater treatment plant.*

Of more concern was the impact on the fertile Yakima Valley. The sheer weight of the ash flattened hayfields; fruit growers used helicopters, sprayers, and hand-held sticks to knock it from trees. Agricultural losses in the Pacific Northwest totaled tens of millions of dollars.

After a smaller blast on May 25, winds blew the ash curse to those west of the mountain, including a bus driver in Kelso, Washington ***(right)****.*

NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT W. MADDEN (ABOVE) AND ANNIE GRIFFITHS

kept theirs on while holding up a drugstore. Thereupon a bank posted this sign: For Security Purposes—Please Remove Your Mask Upon Entering This Bank.

At Yakima's Public Works Center, I waylaid assistant city manager Larry Wittenberg for a few minutes between phone calls and emergency planning sessions. "Getting our airport open again has been a major goal," he said, "so that we will have the use of it for emergency supplies and equipment. It's now open only to helicopters."

The price tag on cleanup worried Larry, who found the problem unique in ten years of city-government posts. "It's been costing us $100,000 a day," he said, "and we have a long way to go. Yakima doesn't have the resources. How can we pay? The state and federal governments must help."

Promises of help had already come from Governor Ray and President Carter. "Starting with the basics of food distribution, water supply, medical and police services, we must put our state back together again," the governor had said.

A BIGGER QUESTION, one that would take longer to assess, was crop damage. Central and eastern Washington's big business is agriculture. First estimates of the ashfall's toll wavered between serious and disastrous—perhaps 12 percent crop loss, at a dollar value as high as 300 million. But what did such figures mean in terms of farm families trying to weather the crisis? And what of the crops of those Red Delicious apples for which Yakima Valley is famed, for instance?

I took my concerns to young Bill Zirkle of Zirkle Fruit Company of Selah, head of a family firm that had thrived on the slogan "Grown in Volcanic Ash." A Zirkle three generations back had found that the ash-rich soil grew apples big and red, and so began the enterprise.

More than ash and apples occupied my mind as I journeyed ten dust-clouded miles from Yakima toward the Zirkle orchards. The killer mountain, which also had reformed earthscapes on a scale worthy of Genesis, was now sending me through a melancholy gray land to a community with a mystic, untranslatable name—Selah.

Selah is an ancient Hebrew word that punctuates some of the Old Testament psalms. It likely means "Amen," or "Forever." It seemed especially portentous now as I remembered the 46th Psalm: "God is our refuge and strength, a very present help in trouble. Therefore will not we fear, though the earth be removed, and though the mountains be carried into the midst of the sea; Though the waters thereof roar and be troubled, though the mountains shake with the swelling thereof. Selah. . . . the earth melted. . . . Selah."

In the past several days I had seen the earth removed, the mountain shaking and swelling and melting, and the flood carrying much of it into the midst of the sea. And here I was suddenly on my way through a mordant pall to . . . Selah.

JUST WHEN some bearded Isaiah might have loomed in the eddying dust to pronounce meaning on it all, the sky brightened and I drove through Selah to the Zirkle farm, with its big storage barn, sheds, spacious ranch-style house amid rolling orchards. Though ash dulled all surfaces, the trees looked surprisingly green. Bill Zirkle was hopping off a tractor.

"We got an inch here—half sand and the rest dust," Bill began. "We knew we had to get it off the trees. If the sun came out, absorption of rays would burn the leaves fast. If it rained, the stuff would soak up several times its weight and break the trees. First we called in helicopters to try to blow it off."

They were only partly effective, so the big mobile blowers—normally used to spray the trees with liquid nutrients and pesticides—were turned on, and 11 smaller antifrost wind machines were left running.

"We got more of the dust off, but at a price to the equipment," Bill said. He pointed to the fiberglass propeller of one of the sprayers. The dust had abraded it to a sliver.

With most of the ash removed, Bill dared to try the overhead water sprayers that make artificial rain for the orchards. Results were good, and that accounted for the cheery green that I saw on nearby trees.

"If the ash had come when the trees were in bloom, that would have been it—no crop," Bill said. "If it had come when the trees were already heavy with fruit, it would have broken them off, a disaster. As it is, we

stand a good chance for making a crop, although quality remains a big question."

The Zirkles produce those famous elongated, five-knobbed Red Delicious apples, 200,000 bushels in an average year.

Like their neighbors, the Zirkles have grim memories of Black Sunday. "The darkness came so fast there was no time to think about trying to run, even if we'd wanted to," Bill said. His wife, Pat, and three children fled indoors, expecting the most horrendous thunderstorm of their lives. They were right, but it heralded ash instead of rain.

"And it was close," Bill said, "so close that you saw lightning and heard thunder almost at the same time. One bolt hit between me and a neighbor—jarred the ground."

THE ASH STORM did not compel everyone's attention, fearful though it was. I asked farmer Larry Lenseigne of Moxee City what he did when it got so dark in morning.

"I did what I always do," he told me. "I did what the chickens do. I went to bed."

Larry, with sons Dean and LeRoy, grows hops. The vines climb cord webs strung from 18-foot poles across the fields, giving a feeling of giant vineyards. But now the vineyards stood limply gray in morning calm.

"I don't think they're hurt much—provided we don't get more dust," Larry said. We watched as LeRoy, wearing a mask and listening to the latest news about St. Helens on his tractor radio, disked the gray ash under, lapping the field in his own dust storm. "The quicker we plow this stuff under, the less dust problem we'll have," Larry said.

Local fertilizer dealer Gil Miller, the same man who had groped his way through 40 highway miles of darkness from McDaniel Lake, gave me another example of how heavily the volcanic fallout had descended on the Yakima Valley.

"We have a platform scale 10 by 70 feet, for weighing truckloads of fertilizer," Gil said. "When we closed on Friday, the scale read 0. When we returned Monday, it read 1,140 pounds. That's 35 tons to the acre."

Elwood Sires of nearby Union Gap reassured me that the ash had not wiped out the honeybees, as reported. "The toll is insignificant compared to one application of pesticide," the former head of the area beekeepers association said. "Even if all the bees in the fields had died, there are always enough in the hives to regenerate numbers."

Farther east, around Ritzville and Moses Lake, where bees are vital to the pollination of alfalfa, worry ran deeper. Except near the mountain itself, ash fell deepest there—three inches in its first fluffy state.

"Alfalfa hay was near the stage where it needed to be cut," extension agent Roland Hintze told me, "and the ash didn't sift off it as it did other crops. The overall loss, on about 11,000 acres, looks like 12 percent."

Wheat fared better, he said. "I think it will run better than an average year."

Roland estimated an agricultural loss from the ashfall of 3.5 to 4 million dollars—about 5 percent—to Adams County. The estimate could be too low because of some unknowns: plant disease and the abrasive grit's long-range toll on farm machinery.

Even so, the outlook for Washington's farmers had improved greatly by midsummer over the early guesstimates triggered by the May 18 eruption. Overall farming losses were projected at 175 million dollars, or 7 percent, a figure that promised to decline further as final harvest totals came in.

OF ALL the volcano's feared calling cards, from flood to fiery avalanche, the ubiquitous ash most disrupts earth's life forms.

Ash in the lungs and bronchial tubes—that was the coroner's finding on most of the fatalities. Most air-breathing creatures killed by the eruption probably suffocated, even though consciousness may have first yielded to heat.

Ash and avalanche buried all aquatic life in the upper reaches of the Toutle River, then heated much of the lower river to 80 and 90°F, fatal to all trout and virtually all other fish.

Suzy Graves, a fish biologist, told me of other effects of the ash, how it can blanket the bottom gravel and smother eggs, how it can cake gills and, being very abrasive, cause gill diseases. Some is gunpowder-fine and can remain suspended in the water almost indefinitely, stirred up by currents.

Washington State tentatively put a loss tag on sportfishing of trout and other fish at 22 million dollars for 1980 alone.

Silt clogged the shipping channel of the Columbia River. The Norwegian motor vessel *Hoegh Mascot* informed the world shortly after 5 a.m. on Monday, May 19, that she was aground in what had been a 40-foot channel. The Coast Guard promptly closed the river, trapping 24 oceangoing ships upstream, and found that the channel was now only 14 feet deep. Within three days the Army Corps of Engineers had three dredges rescooping a channel to forestall economic disaster at blocked ports.

The ashfall even visited a special form of schizophrenia on civic leaders, in the view of Scott Reed of the Idaho Water Resources Board. "It's absolutely mandatory," he explained, "to talk out of both sides of the mouth. First you have to make sure your region is declared a disaster area, so it will become eligible for all that aid. But on the other hand it's bad to call your part of the country a disaster area, particularly at the start of the tourist season, when tourism is its major business."

But an initial decline in tourism had reversed by midsummer, and the area appeared headed for a prosperous year helped by thousands who came to get a distant view of the volcano.

Through summer and into fall, blanketed ash slowed salvage efforts of Weyerhaeuser, the largest single corporate loser. Of the approximately 200 square miles mowed down by the May 18 eruption, about half belonged to "the tree-growing company." How much timber did Weyerhaeuser lose?

"We put it at 36,500 acres of commercially harvestable timber, plus 26,000 acres of young trees," Byron Rickert of the firm's Longview office told me. Company roads, railroads, logging yards, and incidental lands ashed over added 5,500 acres. "That's a seventh of our St. Helens Tree Farm," Byron said, "but only around one percent of Weyerhaeuser's total ownership."

The biggest salvage project has amounted to an enormous game of pick-up-sticks along rivers: "About ten million board feet of cut logs got swept down the Toutle and Cowlitz, and we've now recovered 65 percent," Byron said. Among items that will never be recovered, being lost, twisted, or demolished, are 30 huge logging trucks, 22 yellow crew buses, 39 railroad cars, 4 fire engines. . . .

But Weyerhaeuser people are grateful that the mountain blew on a Sunday. On a Monday there would have been 330 workers in those woods.

The ash-thick floods that swept the Toutle and Cowlitz took out the water system for the town of Toutle and clogged intakes for Castle Rock and Longview. Longview kept supplies in the lines by odd-even-day restrictions on use and by borrowing from Weyerhaeuser's pulp-plant water system.

My Weyerhaeuser inquiries produced perhaps the world's most dedicated golfer. Where were you when the mountain blew? I asked Murray Mason, a Weyerhaeuser executive. "Playing golf," he replied.

Could he see the eruption?

"Yes, and it was very hard to concentrate on my game, but I finished the round, and finished in the money."

THE TENTATIVE GREEN of new growth touched the gray wasteland by early autumn. Beachheads of fern, fireweed, and asters clung to steep slopes of Coldwater Peak, in the heart of the devastated area. An optimistic ground squirrel foraged for his lunch.

In a one-and-a-half-million-dollar effort to aid nature's healing, the U. S. Soil Conservation Service sowed seed and fertilizer over much of the devastated area. The service hoped that grasses would spring up to retard erosion during the seasonally heavy rains and snows of winter and spring.

Scores of scientists also were tramping, plotting, and sampling the area. "The devastation zone will be a unique natural laboratory for years to come," Dr. William Moir, plant ecologist with the Forest Service's

Bringing green back to the red zone, *a helicopter sprays fertilizer on fast-growing grass seed, an attempt to prevent erosion of ravaged hillsides by winter rains. Elsewhere, life returns at a more natural pace as carpenter ants dig their way out of buried logs, flies come back to the lakes, and elk probe scorched woodland for tender shoots. Complete rebuilding of the food chain may take 40 years or more.* RALPH HERT

Forestry Sciences Lab in Corvallis, Oregon, told me. "We can gain knowledge about effects on soil, streams, lakes, and atmosphere that will be of great value."

Science's tasks seemed simple and clear-cut compared to the lesson assigned to the people of the Pacific Northwest: How do you learn to live with an active volcano in your backyard? On May 25, only a week after St. Helens' deadly paroxysm, the mountain served notice of continuing hazard—it vented an eight-mile-high plume of ash that dusted Portland and Vancouver and fell as mud in rainy Kelso and Longview.

More eruptions punctuated summer and fall. In mid-October a series of explosions showered more grit on Portland and Vancouver. A lava dome in the crater quickly grew to 880 feet across and 160 feet high.

The USGS by then had installed Dr. Donald Peterson in Vancouver as scientist in charge of long-range monitoring of the mountain. "This new eruption shows we can't afford to let our guard down," he said. "Our studies of Mount St. Helens are just beginning. I hope we can also increase our monitoring of other Cascade volcanoes."

They will also monitor area streams. A USGS report warned that winter and spring runoff could swell the Cowlitz River with many times the silt carried in the floods of last May. Thousands might be forced to flee.

ON A BRILLIANT autumn morning I flew in a helicopter over the mountain and into the crater. Light blue smoke vented through fissures caked yellow with sulfur, and a strong sulfur smell raked my nostrils. Along webs of cracks, hundreds of steam vents gushed white vapor plumes.

As our helicopter hung over a newly forming dome, I wondered: How long must the Northwest keep vigil on this volcano? For a generation, as in the last century?

No one could say for sure. And Harry Truman, the man who professed to talk with the mountain, was gone. □

Searching for a pulse *of life in the mutilated forest, biologists have discovered such plants as fireweed, lupine, and thimbleberry rising from the ash—promising early recovery for life in the shadow of Mount St. Helens.* JOHN MARSHALL

By MICHAEL R. VOORHIES

Photographs by ANNIE GRIFFITHS

DWARFING THE ST. HELENS ERUPTION

Ancient Ashfall Creates a

PAINTING BY JAY MATTERNES

Silently an ominous cloud of ash rolls across Nebraska from a massive volcano far to the west. It will engulf this water hole and entomb its animals, including these rhinoceroses and horses. The time: ten million years ago.

Pompeii of Prehistoric Animals

AN IMMENSE CLOUD of glassy powder, spewed from a volcano somewhere in the western United States some ten million years ago, drifted downwind over the Great Plains and finally settled to earth in what is now northeastern Nebraska. The prodigious ashfall blanketed hundreds of square miles. Herds of rhinoceroses, three-toed horses, camels, and tiny saber-toothed deer, confused and choking, perished in the blizzard of abrasive dust.

On a far vaster scale the disaster was a prehistoric prototype of recent ashfalls from the eruptions of Mount St. Helens in the Cascade Range of Washington (pages 3-65).

Along a streambed in northern Antelope County, Nebraska, I have discovered dramatic evidence of the ancient catastrophe. Excavating the ashy filling of a prehistoric water hole, my crew and I from the University of Nebraska State Museum have dug up the skeletons of several hundred victims of the dusty cataclysm. The skeletons, some intertwined and piled on top of one another, have lain buried, mostly in undisturbed death poses, for millions of years since the animals were overwhelmed.

Our work has provided a detailed glimpse of the subtropical savanna habitat—so different from the look of modern Nebraska—that flourished during the Miocene epoch in the Great Plains.

By coincidence, the site of our finds lies only eight miles from the town of Orchard (population 460), the place where I was born and raised. As a child, I collected petrified

bones and teeth in nearby streams and dry washes. Of course, I never dreamed of the treasure of fossil skeletons that lay hidden almost beneath my feet.

Three decades later, near sundown on a long day of fossil prospecting, I was walking along the valley rim above a tributary of Verdigre Creek. In cuts and slopes, erosion had laid bare a bed of silvery gray volcanic ash—the fossil-bearing formation—sandwiched between layers of sandstone.

Before turning back toward camp, I dropped down to the streambed to explore one more gullied escarpment. Suddenly, high above my head, I saw the skull, gleaming white against the weathered ash of the ravine wall. Finding the bank too steep to climb, I backtracked to the rim and dropped to a narrow ledge for a closer look. It was a baby rhinoceros skull about a foot long, perfectly preserved, its big teeth glossily marbled with the dark chemicals of fossilization.

Hands trembling with excitement, I gently picked and brushed the soft ash away from the skull. To my joy I found it joined to a string of neck vertebrae running back under the hill! In the dark I stumbled back to camp with, for once, a good excuse for being late to supper. "I've never seen anything like it," I told my wife, Jane. "The whole animal could be there."

The next day's digging uncovered a bonanza: Not only was the baby rhinoceros intact, but the articulated skeletons of three more rhinos, including a full-grown adult, also extended back into the hill. Here was a bone hunter's dream come true. In river-deposited layers, such as the sandstone above and below the ash, whole skulls are a rarity and full skeletons almost unheard of.

Further testing of the ash bed yielded 12 more skeletons from an area no larger than an average living room. The farmers who held the land, Melvin Colson, who died in 1979, and Carolyn and Glen Osborn, Jr., the present owners, generously let us extend our dig, right to the edge of a cornfield. In June 1978, with support from the National Geographic Society, we brought in a bulldozer and cleared off the surface ash. We staked out with string a pattern of squares three meters on a side to map precisely the position of the fossils we hoped to find.

A crew of museum preparators and students worked with me for two field seasons. Like farmers at harvest, we labored from sunup to sundown. Skeletons crowded so close together that we had to crouch uncomfortably to excavate them.

Removing them was a challenge. Imagine attempting to lift a sack of thin, cracked wineglasses out of a brier patch without shattering them; that suggests the difficulty of moving brittle, delicate, fossilized bones.

To avoid breakage, we first impregnated skulls and bones with a plastic preservative, then "dressed" them in plaster casts. Clustered in piles, the skeletons looked like participants in a gang tackle in football.

A Detailed Record of Prehistoric Life

Although our fossil mammals (rhinos, horses, camels, and others) all apparently belong to previously named species, the new skeletons are by far the most complete remains of these creatures ever unearthed. Rarely found parts such as tongue bones, cartilages, tendons, and tiny bones in the middle ear all survive in exquisite detail and in their correct positions.

Such small and fragile parts, like the tendons of a turkey leg, were only partly calcified in life, and survived primarily because no action of water, wind, or earth movement ever shifted them after burial. Fragments of fossil birds are rare in rocks of this age, so it is likely that totally new forms are represented by skeletons from the ash bed.

Volcanic dust again veils the sun *on a windy day as a remarkable fossil menagerie is uncovered near the town of Orchard, Nebraska. Excavator Mary Ann Jones, well protected against glassy grit, brushes the powdery shroud from the ribs of a rhinoceros. She will encase them in plaster for the trip to the University of Nebraska State Museum in Lincoln. Two seasons of excavations, supported in part by a National Geographic Society grant, have revealed an unprecedented range of fossils, from complete skeletons of rhinos—the dominant herbivores of this prehistoric subtropical savanna—to turtles and tiny diatoms.*

GREGORY BROWN

Fallen in their tracks, *victims reappear when a crew (**facing page**) disentangles bones of rhinos, horses, and camels. The head of a rhino calf (**above**) rests between a female's pelvis and kneecap, close to the nursing position. Here the author, a paleontologist at the Nebraska museum, kneels in the bone bed he discovered in a stream-cut ravine near Orchard (**map**). Analysis of the ash may pinpoint its source. The closest large volcanic field active ten million years ago lay 650 miles away in New Mexico.*

A cardinal joy of paleontology is the thrill of discovery—being the first to see a new fossil. In the ash quarry each of us savored such special moments: preparator Gregory Brown finding fossil feather impressions—the first of many; student Susan Stover discovering the porous bones of an unborn calf inside an adult rhino skeleton; preparator Mary Ann Jones extracting fossil grass seeds from a rhino's throat cavity; volunteer King Richey unearthing the giant tusk of an elephantlike *Gomphotherium;* student Eileen McBride finding a bird skeleton complete with small polished pebbles in its gizzard.

Our fossil quarry was abominably dusty. Whenever a slight breeze lifted the powdery volcanic ash, we had to put on dust masks. Ash permeated everything. It was prickly and irritating to the skin, and it ruined cameras and surveying instruments.

"I know just what those rhinos must have suffered," said crew member Ken Terrell, coughing during a dust storm. We could leave the quarry; for the animals in an ash-blanketed landscape, there was no escape.

Most of the rhino skeletons were either crouched with legs tucked under their bodies, or were lying on their sides. A few had the ribs scattered where the gases of decomposition had caused bloating and explosion. Yet the overall impression was of a large herd of animals peacefully at rest.

Suckling Calves With Mothers

Day by day, month by month, as the skeletons emerged, it was difficult not to think of the rhinos as individuals. Jinx was the nickname we gave a young rhino calf found with its skull nosing beneath the rib cage of an adult female. We uncovered more than a dozen similar pairs of adult females and young calves, and I am convinced that they were mothers with close-clinging offspring. The young may have been trying to nurse right up until death overtook them.

It appears that these Nebraska rhinos—a short-limbed genus called *Teleoceras* (accent the *oc*)—were much more social animals than modern rhinos. The present-day three Asiatic and two African species are mostly solitary animals that congregate only during brief breeding episodes.

Classifying the fossil rhinos by age and sex leads me to conclude that *Teleoceras* formed

Death comes with agony *in a rain of volcanic dust, causing the animals to suffocate. The ash was so extensive—several hundred square miles and in places more than ten feet deep—that the eruption must have been at least a hundred times greater than that of Mount St. Helens. The ash preserved fine details. Grass seeds remained in the throats of rhinos. The stomachs of wading birds contained their last meal of mouse and lizard. Dr. Voorhies has re-covered the site to safeguard it.*

stable herds of adult females and their calves accompanied by single adult bulls. (We identified small-tusked rhinos as females from fetuses inside the pelvic cavities.)

The presence of lots of calves and young adults suggests a healthy, vigorous herd struck down in its prime. A study of tooth wear revealed well-defined age groups among the calves (almost one year, two years, three years, and so on). The ages showed that all were born at the same time each year, suggesting a tighter breeding schedule than that of modern rhinos, which

PAINTING BY JAY MATTERNES

may mate and give birth at any season.

Of about a hundred skeletons collected, seven are adult males. Adult females, mostly far younger than the bulls, outnumber males by more than six to one. This age-sex ratio closely parallels that of some modern savanna antelope and zebra herds.

We theorized about the cause of death and burial. The animals were overcome in a curved, shallow depression on an otherwise flat floodplain. We don't know the extent of the ash at our site, but its overall shape, three meters thick in the middle, a third of a meter at the edges, resembles a boomerang. The skeletons are concentrated along the midline of the deposit.

We found most smaller skeletons (birds, horses, camels) at the bottom of the ash bed; nearly all the rhinos, in contrast, are lying above them. Smaller creatures frequently show partial crushing, as if trampled by the rhinos before the latter finally succumbed.

Signs that scavengers tore at and dismembered some of the carcasses strengthen the case that the animals were not killed and covered instantaneously. I believe that most

of the ash fell within a few days, that wind kept it stirred up like drifting snow, and that as much as a month may have gone by before the last rhino died at the water hole.

Water hole? Yes, it is clear from the presence of numerous aquatic turtles and microscopic diatoms that water stood in the depression when the rhinos died. The water was probably very shallow and stagnant.

What, actually, was the cause of death? Since the bones are entombed in volcanic ash, the circumstantial evidence is strong that the ash was responsible. But how?

Unlike the inhabitants of the Roman city of Pompeii, who met death instantly from hot cinders and pumice raining down from Mount Vesuvius, the Nebraska rhinos were killed and eventually buried by ash from an eruption many hundreds of, perhaps more than a thousand, miles away. It was an explosion dwarfing the recent eruptions of Mount St. Helens. (The Cascade volcanoes did not exist then.) Unlike the deposit on Pompeii, this ash fell far from its source and was surely cool, with no lethal gases. But like Pompeii, it halted life in mid-course, revealing details of a locale and its inhabitants that otherwise might have been lost to time.

I suspect, but cannot yet prove, that the animals died slowly of suffocation as their lungs filled with the highly abrasive volcanic dust. Under magnification, the individual fragments of ash show sharp, jagged edges. Such material undoubtedly would severely damage delicate lung tissues.

Home of Prehistoric Thousands

Nebraska ten million years ago was warmer than now. The rhinos probably never saw snow. Near our ash bed, in the same geologic level, I dug up big land tortoises—hot-country dwellers—and alligators, which could not survive extended chill.

I tried to imagine the late Miocene landscape in Antelope County, which today has a rolling, rumpled surface cut by draws and creek beds. Certainly the dominant impression would be of flatness—a horizon so level that a saber-toothed cat could watch the sun rise between the legs of a distant camel. An ocean of grass would reach as far as the eye could see, interrupted by shallow stream valleys and clumps of forest.

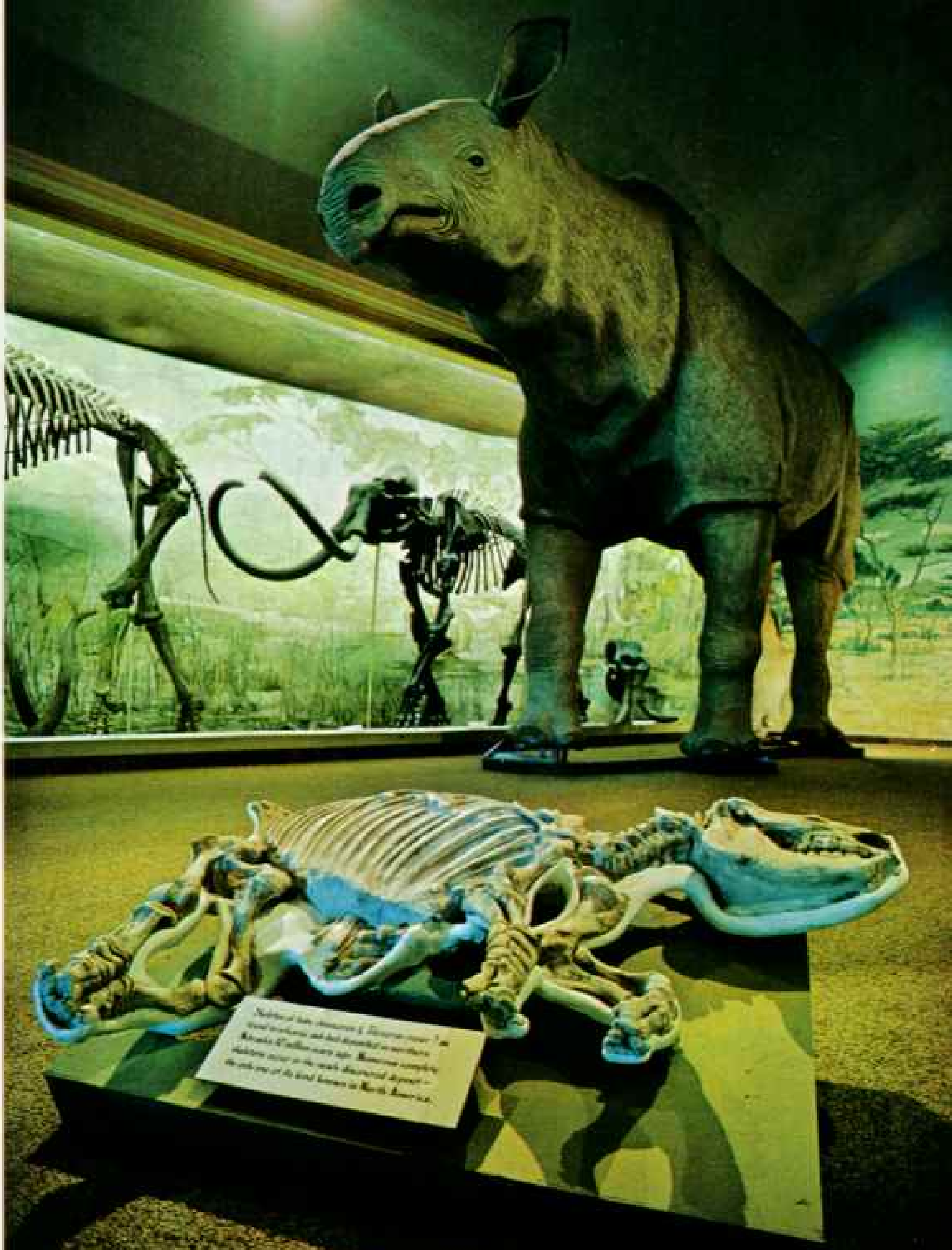
Animal life would be present in stunning numbers and diversity. Dozens of hoofed species, comparable in variety to those on the African savannas today, lived on the American plains. Numerous grazers—rhinos, horses, camels, prongbucks—cropped the grass, while those with other feeding strategies—huge gomphotheres, tapirs, three-horned deer, browsing horses—frequented the wooded areas. Meat-eaters ranging in size from weasels to great lumbering bear dogs ranged over the landscape.

By the late fall of 1979, when bulldozers filled in the excavation, we had extracted more than 200 skeletons. We hauled off about 40 tons (2,000 casts) of jacketed fossils to the museum laboratory, where they are now being opened and the bones cleaned for exhibition and study.

Our ash-bed fossils give us much new information about the anatomy and behavior of many members of the ancient grassland animal community. Now what is needed is an equally well-preserved sample of what woodland life was like on the Great Plains ten million years ago.

Maybe next summer, I (or someone) will find it. . . . □

An evolutionary moment *is frozen in time. Complete skeletons of the horse Pliohippus verify the transition of a primitive three-toed variety* ***(above)*** *to the one-toed type* ***(top)*** *ten million years ago.*



New portal to Great Plains prehistory *was opened by the excavation. At the University of Nebraska State Museum a rhino calf, 20 inches (50 centimeters) at the shoulder, lies near a reconstructed hornless rhino, 17 feet (5 meters) tall, that roamed Asia 25 million years ago—the world's largest land mammal. Mammoths, beyond, stalked Nebraska during the Ice Age.*

THEY'RE REDESIGNING THE AIRPLANE

Bold concepts take wing, and the old familiar airplane may never look the same. Computer-smart electronic systems are changing the way airplanes are designed, built, and flown. A wing that pivots 60 degrees (right) promises a fuel-efficient, speed-of-sound jetliner, whose sonic boom would dissipate before reaching the ground. How fast or efficiently man flies depends only on the soaring of his imagination.

NEARLY EIGHTY YEARS after the Wright brothers flew, the airplane is finally catching up with the hummingbird. This summer, in a series of test flights, a specially modified United States Air Force F-16 fighter will exhibit hummingbird-like maneuvering qualities, summed up by Lt. Gen. Thomas P. Stafford as the ability to go *Zang!*

From normal straight-ahead flight and without changing wing or nose position, the fighter will suddenly dart sideways *(Zang!)*, straight up *(Zang!)*, or straight down. The airplane's nose can also rotate a bit, explained General Stafford, to afford a shot at an adversary. All this can be combined with turns, loops, rolls, and other standard maneuvers.

By MICHAEL E. LONG
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by
JAMES A. SUGAR

The *Zangs* will be accomplished through movement of airfoils hanging like shark fins from the underside of the fighter, coordinated by a computer with other control surfaces. "In the past you could get agility like this only from a spacecraft," said former astronaut Stafford, now retired as head of Air Force research and development. "In the future," he continued, "every pilot should be able to shoot 100 percent with this kind of airplane. And when somebody tries to chase him, he just goes—*Zang*—sideways."

The ability to go *Zang* is just one of a number of recent advances in aviation technology that are producing significant, even revolutionary, changes in the way aircraft are designed, built, and flown. Consider:

- A U. S. military Stealth airplane is virtually invisible to enemy radar.
- A new generation of longer winged, fuel-efficient jetliners promises advances in creature comforts for both passengers and pilots.
- A young Californian designs airplanes that don't stall, which is like making tires that don't go flat. Stall-spin accidents total 20 percent of general aviation fatalities.*
- A British military jet carries more payload by taking off from a curved ramp that looks like a ski jump.
- A unique X-wing craft will perform like a hybrid. With rotors whirling, it will take off and land vertically, like a helicopter; rotors locked in the form of an X, it will fly and maneuver like a fixed-wing airplane at high subsonic speeds.
- Coming up as a substitute for the rivet—high-technology glue.
- In the all-electronic cockpit, multiprogram cathode-ray tubes replace conventional flight and navigation instruments.

Many of these advances, now being proved under National Aeronautics and Space Administration and military auspices, can be employed in civil aircraft. For example, the X wing, under development for U. S. Navy duty, could later come ashore as a corporate or commuter aircraft that requires no runway. The radical craft gets its fixed-wing capability from high-velocity air pumped from slots in the trailing edges of its rotors. This increases the airflow over them to create lift, enabling the locked rotors to function as conventional wings.

Learning about these marvelous things, I felt like Rip Van Winkle—I was a Marine Corps jet pilot and flight instructor, but my tour of duty ended in 1959. Nor did Ben R. Rich, vice president of Lockheed's super-secret Advanced Development Projects, the famed "Skunk Works," make me feel any better when he told me: "We did things ten years ago that you haven't even heard of."

Indeed. Lockheed's high-flying U-2, built in 1955, cruised in secrecy until the Russians shot one down in 1960. Lockheed's SR-71 Blackbird flies faster than Mach 3—three times the speed of sound. But nobody will tell you how much faster, or how high it flies, even though it first flew in 1964.

Nobody's going to tell you much about the new Stealth airplane that foils enemy radar. The U. S. Department of Defense

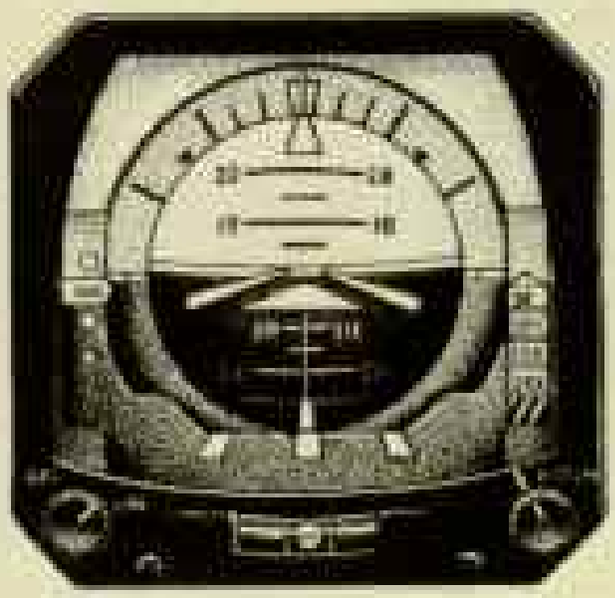
*The author's in-depth appraisal of "The Air-Safety Challenge" appeared in the August 1977 issue.

Instant cloud *bursts into being as a Grumman F-14 Navy fighter approaches the sound barrier. The resulting shock wave caused sudden temperature and pressure changes to condense water vapor. Since shock waves impair an aircraft's efficiency, to minimize them is a goal in the design of wings for new jetliners.* © PAUL A. LOWE

Instruments

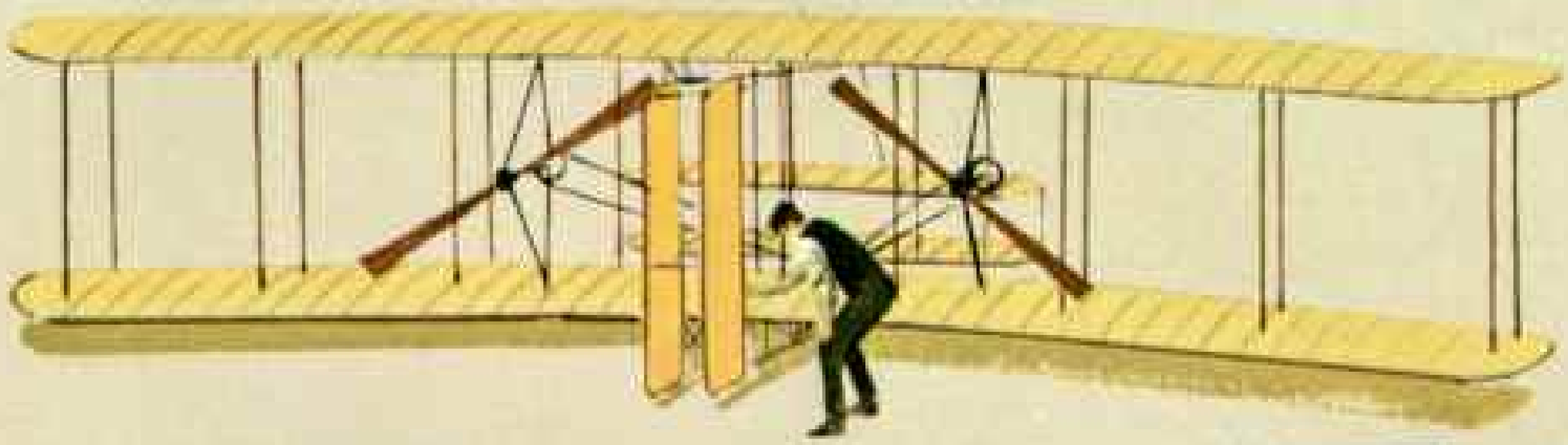
One step beyond a carpenter's level, a skid/slip indicator of the 1920s showed balanced flight when ball was centered.

Gyroscopic artificial horizon, new in 1929, permitted true blind flight. This one from the 1940s shows a left turn.



Flight directors on today's jetliners help a pilot maintain flight phases such as cruising, as well as showing him his current attitude.

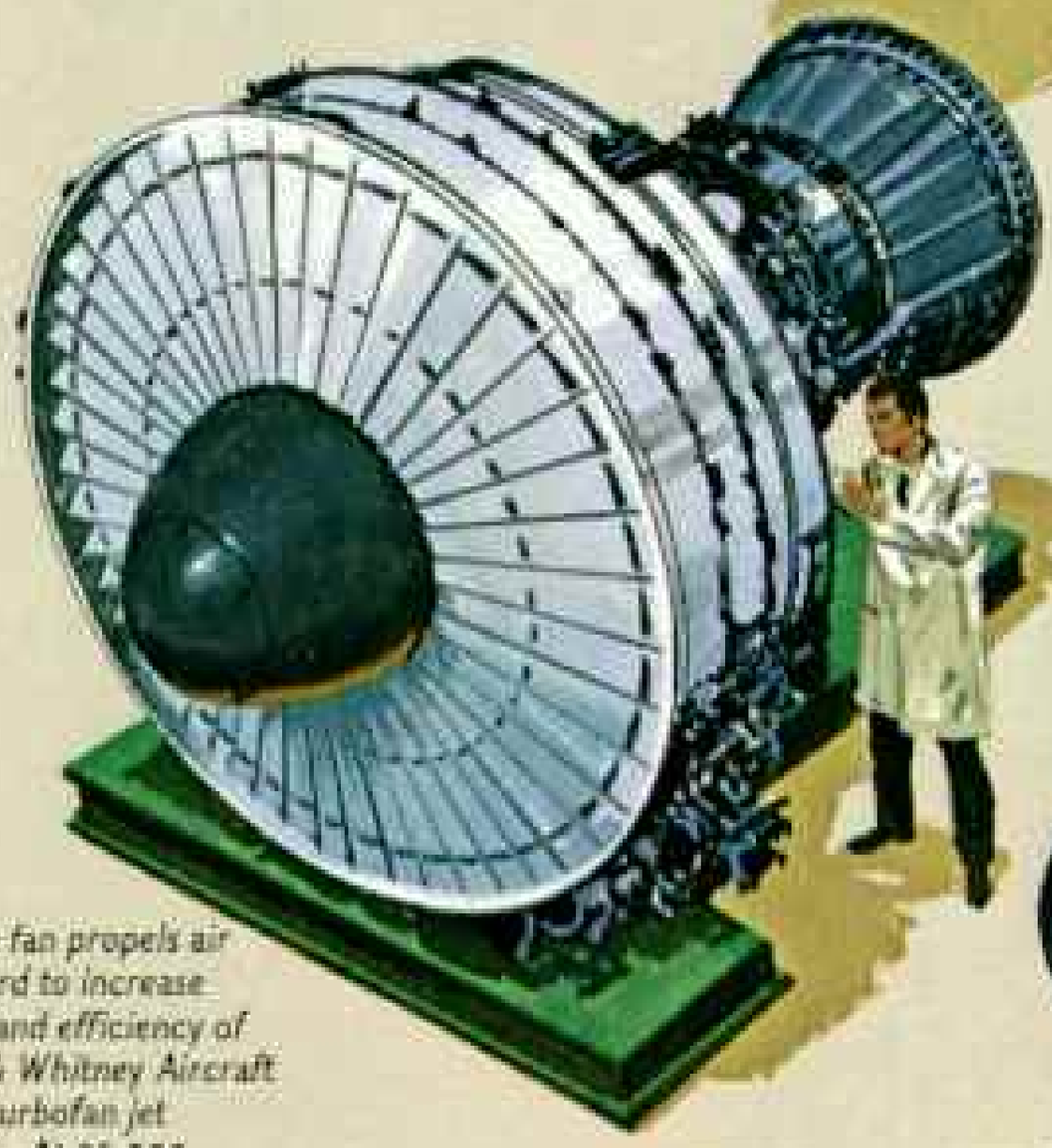
Future electronic attitude and command displays can instantly give the pilot more flight data, yet the ball level, at bottom, will still have its place.



Wright Flyer I of wood, wire, and fabric used twin wings, rudders, and propellers, as well as a canard—a forward elevator—for pitch control.

Louis Blériot's Type XI used a single wing, box-girder fuselage, control column, and rudder bar. In 1909 Blériot was first to fly the English Channel, a preview of the practical uses of the airplane.

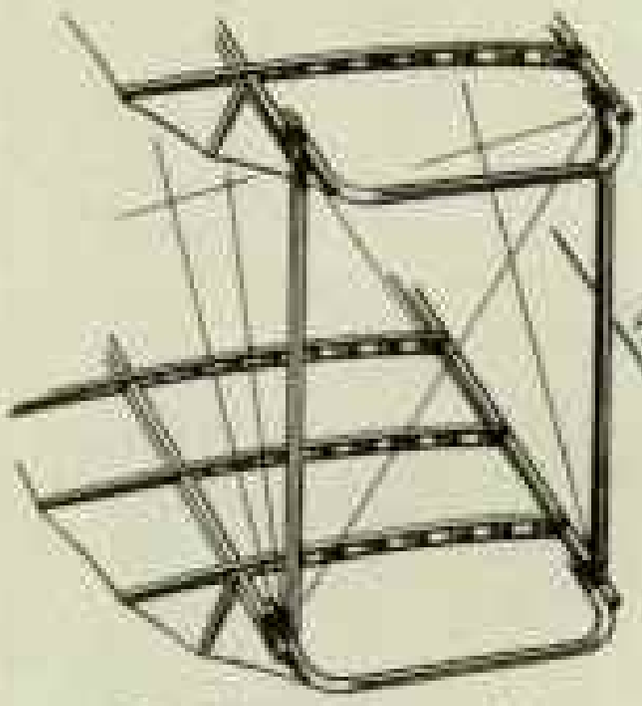
Power



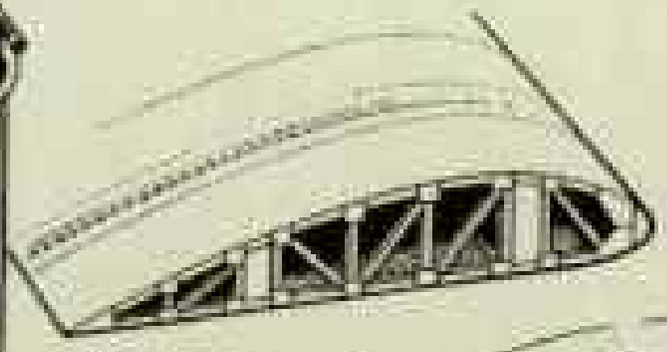
A huge fan propels air rearward to increase thrust and efficiency of Pratt & Whitney Aircraft JT9D turbofan jet engines. At 50,000 pounds of thrust each, four are needed to power the Boeing 747 jumbo jet.

First of the high-performance axial-flow engines, the Pratt & Whitney Aircraft J57 turbojet generated 19,000 pounds of thrust with an afterburner and powered airplanes of the 1950s.

The Evolution of the



Flexible wood frame of the Wright Flyer's wings could be warped, changing their geometry to turn the craft.



Thick airfoils (in cross section) for good lifting performance and stout structural framing characterized the wings of typical aircraft of the 1920s and '30s.

For efficient flight just below the speed of sound, a wing developed by NASA has a nearly flat top with a reverse curve on the trailing edge of the bottom.

The wing of the future may, through internal control mechanisms, change its shape to perform efficiently at all speeds, from takeoff and landing to supersonic cruise.

Wing structure

Construction

In the 1930s, the Northrop Gamma, with its all-metal, stressed-skin fuselage and internally braced wing, pioneered concepts later used in such craft as the DC-3.

Plywood fuselage of the 1912 Deperdussin was formed in two halves, then joined to make a strong structural unit.

At 12 horsepower, the Wrights' aluminum four-cylinder, water-cooled engine was the first to lift a craft into the air age.

Aircraft propulsion in the 1920s and '30s was generated by complex but reliable piston engines such as this Wright Cyclone 7 radial engine — so-called because its cylinders resemble spokes in a wheel.

The four airplanes pictured here represent significant early stages in construction techniques to advance the goals of high-strength-to-weight ratio, increased payload, speed, safety, and efficiency.

PAINTING BY FRED WOLFF, IN COOPERATION WITH AVIATION CONSULTANTS RICHARD HALLION AND TOM CROUCH

Airplane

announcement last August provides barely enough grist for speculation. In order to present less of a radar target, the airplane is relatively small. Its design tends toward the smooth and the curved, instead of the conventional boxy and angular shapes that reflect radar best (page 102).

A special material coating the airplane absorbs and diffuses incoming radar impulses. A sophisticated countermeasures system electronically interferes with the radar waves. While none of these technologies is entirely new, the Stealth airplane appears to have combined them in a most successful fashion.

Though there's more going on in U. S. aviation than meets the reporter's eye, it's no secret that the two dominant factors in the immediate future will be the soaring cost of fuel and the amazing feats of computer-smart avionics (a contraction of aviation electronics).

Jet fuel, just 13 cents a gallon before the Arab oil embargo of 1973, had increased to 90 cents by mid-1980. The airlines are feeling the pinch and so are you. Last year coach fares increased an average of one-third. To help manufacturers produce more fuel-efficient engines, better aerodynamics, and lighter structures, NASA embarked on a half-billion-dollar program in 1975 that is bearing fruit in the construction of new aircraft and the retrofit of older ones.

NASA's winglets, which look like wing tips bent upward, sprout from the wings of executive jets to combat drag, a force that retards an aircraft's movement through the air. The Air Force is considering a retrofit of most of its jet-tanker fleet with winglets for

KERBY SMITH (LEFT, ABOVE) AND BELOW)

LUNA SCHWARZ (ABOVE AND BELOW)

***An eyeball on the enemy**—day, night, or bad weather—is the final connection in the target-finding system mounted on the nose of the U. S. Army's Advanced Attack Helicopter. In simulated combat, test pilot Bill Norton **(left)** sees in his electronic monocle an image of an enemy tank **(right,** at top). As he turns his head to follow the target, sensors in the cockpit monitor the movement of his helmet and aim the weaponry automatically. At his command, a laser-guided missile fires, runs to its target, and destroys the tank (sequence at right).*

Every field's a Kitty Hawk *for pilots of the Eagle (**facing page**), a twin-engine, single-prop flying machine designed by trans-Atlantic balloonist Larry Newman. Inspired by such diverse craft as the Wright Flyer, Rutan VariEze, "Gossamer Albatross," and XB-70, it is constructed of sailcloth over an aluminum frame. The front-mounted canard is also an elevator; twin rudders are mounted under the wing tips. With four hours' training, a novice is ready to fly over his own rainbow (**below**).*

NATIONAL GEOGRAPHIC PHOTOGRAPHER JOTE IMBODEN (ABOVE AND OPPOSITE)

estimated fuel savings of one billion dollars by the year 2000.

NASA researchers also pursue the Holy Grail of aerodynamic efficiency, laminar flow control. If achieved, airflow over a wing would be rendered glass smooth instead of slightly turbulent, reducing fuel consumption by an astounding 30 percent. One proposed method would accomplish this by means of suction slots along a wing's surface. Another NASA program raises the possibility of a comeback for that casualty of the jet age, the propeller. In wind-tunnel tests, multiblade curving propellers have shown the potential for exceeding the fuel efficiency of jets at airliner speeds and altitudes.

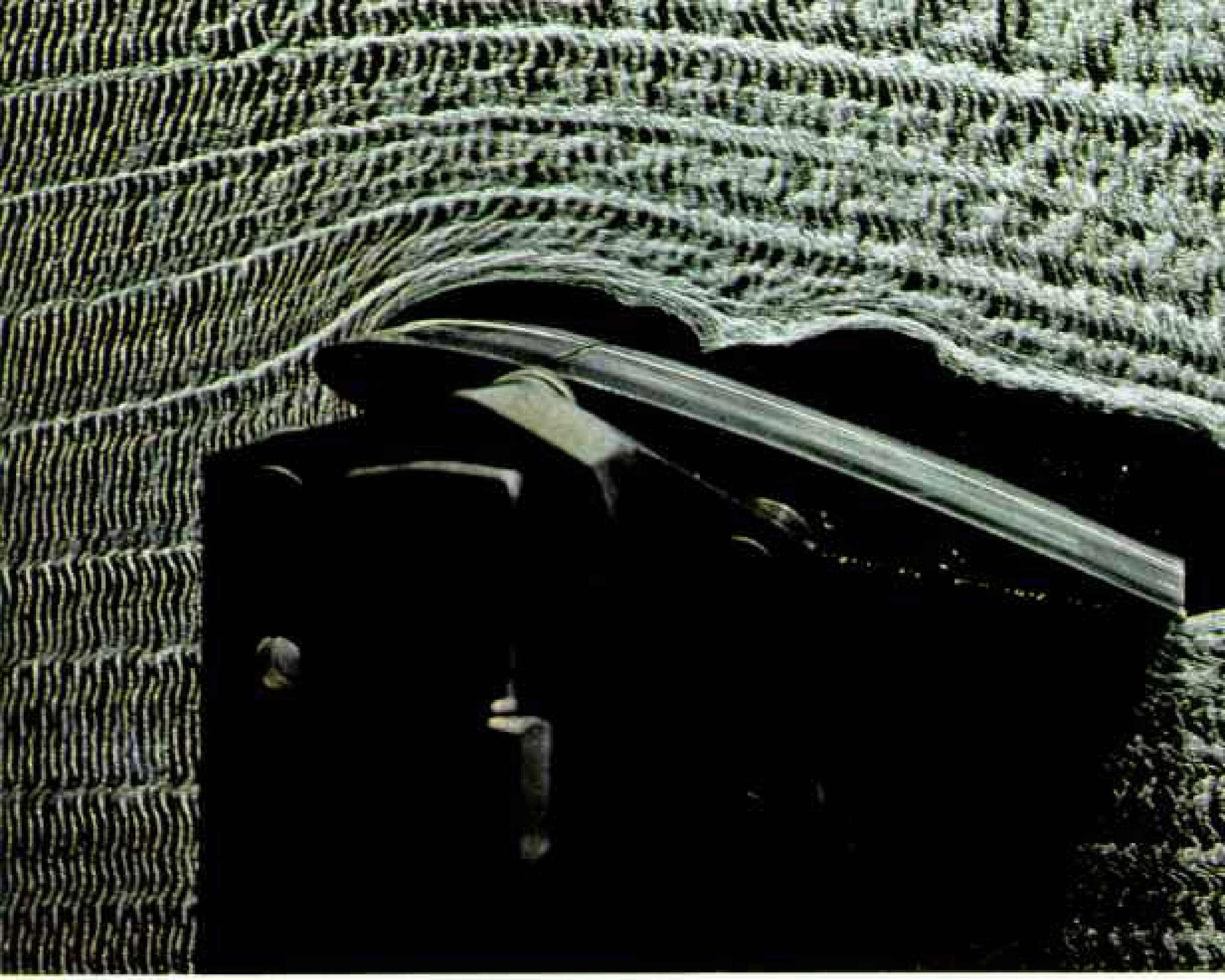
Computers Revolutionize Aviation

Meanwhile the computer is shrinking to minuscule size. At Wright-Patterson Air Force Base, a research center near Dayton, Ohio, avionics laboratory chief scientist Dr. Jesse Ryles told me: "By the year 2000 we could have the technology to put the entire avionics computing system of a 1980 aircraft"—all the black boxes that now weigh hundreds of pounds—"on a silicon chip about 12 centimeters square." That's about the size of a pair of aces held side by side.

In this microelectronic world of the future, the incredible could become commonplace: A computer monitoring a pilot's brain waves spots the telltale pattern shown in tests to be emitted just before a tired pilot makes a mistake—in time to alert him and to prevent the mistake. A pilot activates switches and armaments by voice command, for example, "Bang!" Or even by just thinking the command—" ."

Computers, black boxes, microelectronics. To better appreciate the complexities of aviation's future, I accepted an invitation to experience the simplicity of its past in a classic biplane, a 1933 de Havilland Tiger Moth. My friend Tom Foxworth, a West Berlin-based Pan American pilot, suggested a flight that would retrace the first airline route from London to Paris. There was no better craft for the trip, Tom said, than the Tiger, a cousin of the de Havillands that flew the route in 1919.

A dozen patches scarred the silver fabric wings and the maroon fuselage of this oldest



Test and test again

SUBTLE DIFFERENCES in design can have major effects—for good or ill—on aircraft performance. Stall characteristics of helicopter rotor blades are evaluated (**above**) *at NASA's Ames Research Center in California. Hydrogen bubbles are generated in a water tunnel to simulate airflow and make it visible.*

For a like purpose, a thin film of oil under ultraviolet light (**right**) *shows airflow on a model of the new Boeing 767 jetliner in wind-tunnel testing.*

A Honeywell technician adjusts a glowing ring laser gyro (**left**). *Three of them used in conjunction will give ultraprecise data on pitch, roll, and yaw of new passenger and military aircraft.*

National Geographic, January 1981

JAMES A. SUGAR WITH DAVE HUTCHINSON, THE BOEING COMPANY (BELOW)

airworthy Tiger, a fond possession of the Tiger Club at Redhill Aerodrome in Surrey, south of London. Aircraft engineer Adrian Deverell explained to me that the 24-foot-long airplane was a veteran of 15,000 flight hours and several crashes, and had served as a tutor to dozens of English fighter pilots in World War II.

"She's a bit long in the tooth," advised Deverell, "but she has no vices. The wood in her wings is solid spruce, and the glue's still sound. Her fuselage structure is steel tube, so she bends instead of shattering in a crash. Why, I saw a bloke spin a Tiger right into the ground once. He stepped out of the plane, staggered, and said, 'Gad, it was exciting while it lasted.'"

Deverell made it clear that he thought the pinnacle of aviation technology had already been achieved: "You can't beat the old biplanes—they're natural. Show me a tin aeroplane with a lid on it and I'll turn me nose up. Ah, you might as well sit in a car."

On a windy September afternoon Tom and I sat in the Tiger's open cockpits, donned leather helmets and goggles, and then Tom took off into a leaden sky. "We'll cross the Channel and turn right at the French coast," he had explained. "Then we'll fly down to the Somme River estuary and follow the river inland until we pick up the highway to Paris." So much for the navigation part.

Under Tom's expert hands the Tiger performed without fault. No matter that our airspeed was only 70 miles an hour, that it was bone-chilling cold, that we hollered ourselves hoarse trying to talk to each other. This is the way it was when flying was new.

You get the feel of flight in an airplane like this. Even though the instrument panel has an airspeed indicator, the hum of the wind in the wing-strut wires tells you the same thing. The stick in your hand is directly linked by cables and pulleys to the control surfaces—rudder, elevators, and ailerons.

It was a memorable flight—over the gray chop of the Channel, past coastal bunkers from World War II, over neat farm fields where fresh-cut hay was wrapped in rolls like tape. Then a landing at Paris's Charles de Gaulle Airport under the very nose of a Boeing 747 waiting to take the runway.

As Tom turned off the runway, a yellow car sped up, and an official excitedly emerged. "Monsieur, you must hurry. The jet plane wants to take off!"

Yes, that 747 . . . the blast from its engines could damage the fragile Tiger . . . yes, we must hurry . . . Tom asks me to jump out and run beside the wing tip; the airplane has no brakes and could ground-loop . . . finally we are parked in front of an Air France Concorde (page 94).

New Glue Dooms Rivets

In a way Adrian Deverell is right, and I share his fondness for this airplane that is one with the air, as a sailboat is one with the sea. But with jet engines and swept wings the world doesn't travel at 70 miles an hour any more. Let's see how some other things have changed in the way airplanes are built and flown today.

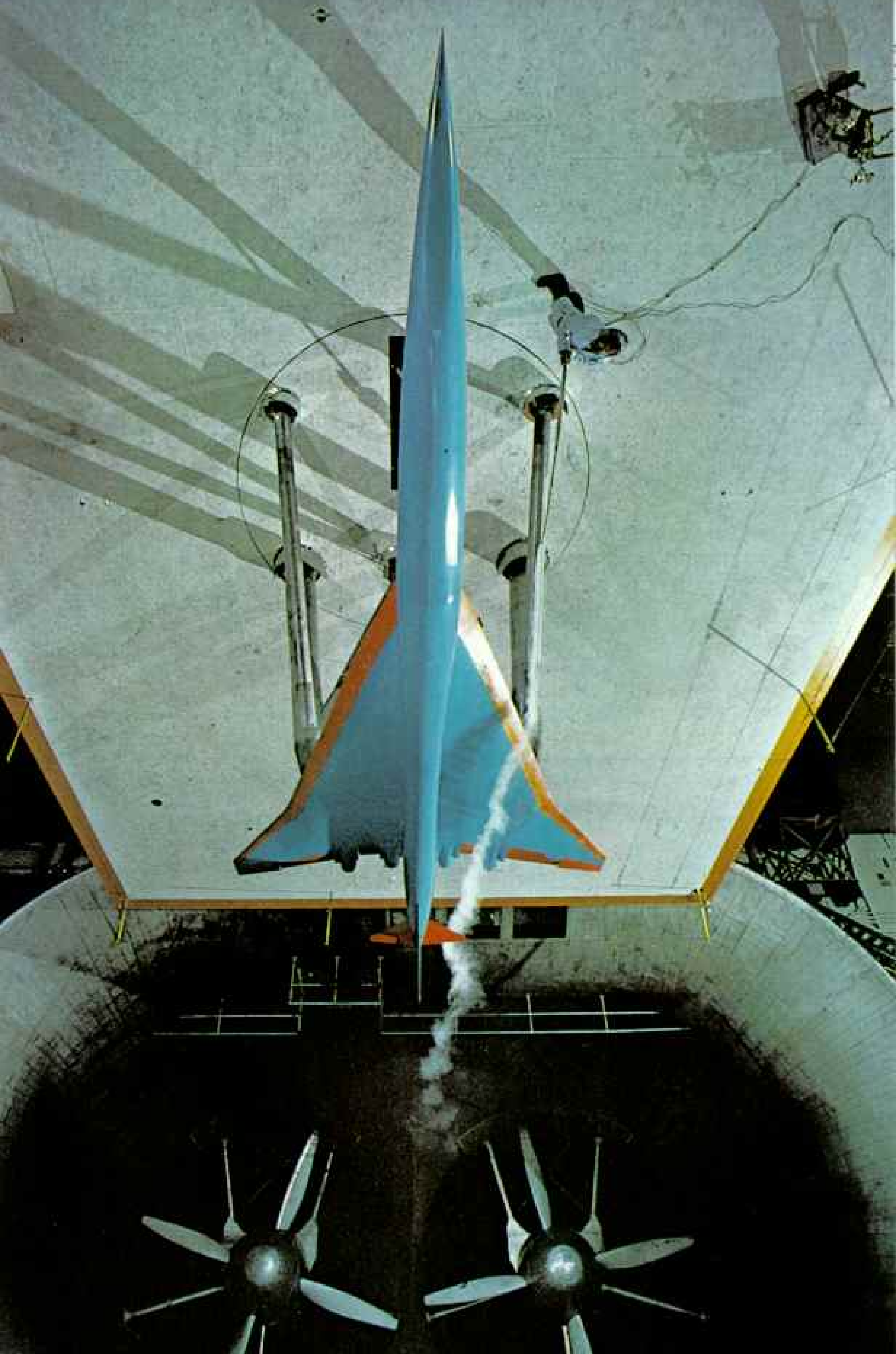
• Structures: Not one rivet marks the surfaces of fuselage panels that have completed four normal aircraft lifetimes in an Air Force-sponsored fatigue test at the Douglas Aircraft Company in Long Beach, California. Deverell, as well as model-airplane builders galore, should applaud the substance that bonds the fuselage members together—epoxy glue. Its use promises to save weight as well as increase structural durability. No rivets, no holes.

Another weight saver for fuel-conscious designers is graphite epoxy, a composite of graphite fibers in an epoxy matrix that is much lighter than aluminum but as much as four times as strong. By using the composite material in portions of its new 767 jetliner, set for delivery in 1982, Boeing plans to save 1,100 pounds. "That means five more passengers in the payload," says Ken Holtby, vice president for new programs.

While others are easing cautiously into the

Corkscrew landing *is one in a big bag of tricks available to the advanced Harrier attack jet. With swiveling nozzles that change the direction of engine thrust, the airplane can take off vertically or from a short ski-jump ramp. At battle speeds it can make quick, unorthodox dogfight maneuvers.*

JAMES A. SUGAR WITH NELSON H. BROWN AND LARRY D. KINNEY



use of composites, William P. Lear, inventor of the Learjet, has gone all the way. Before he died in 1978, Lear designed a turboprop corporate airplane structured almost entirely of graphite epoxy. Now his company, LearAvia of Reno, Nevada, is evaluating a prototype, the Lear Fan. On paper Lear's venturesome airplane flies farther, more quietly, and with greater fuel efficiency than its corporate cousins. If it proves out in the air, competitors may take off for their drawing boards.

Loaded Harrier Gets an Assist

• Aerodynamics: While the Tiger and most other airplanes make rolling takeoffs and landings, the maverick British Aerospace Harrier can take off and land vertically. Through movable nozzles, the engine's exhaust is directed downward for vertical flight and aft for horizontal flight.

But there's a catch. The Harrier's engine, generating 21,500 pounds of thrust, cannot lift the airplane vertically when it is fully loaded with weapons and fuel at 25,000 pounds. So a short takeoff roll is necessary. For aircraft-carrier operations, the resourceful British have taken this an incredible step further—a full-payload takeoff from a ski-jump ramp 130 feet long and just 40 feet wide. "Coming off the ramp, you're not yet flying," explained Harrier expert John Fozard, "but like a ski jumper, your momentum is upward. Meanwhile you are rotating the engine nozzles aft, and the aircraft is accelerating to flying speed.

"So you've bought yourself a runway in the sky," Fozard continued. "And from a pilot's point of view, there's all that lovely, dry air between you and the horrid, wet sea."

When Harrier test pilot Mike Snelling briefed me before a demonstration ride off the ski jump at the 1978 Farnborough Air Show, he stated that it would be "uneventful." However, he advised, in the remote chance of engine failure as we came off the ramp, "there will be no time for a conference. You will see me eject, and you may take that as your cue that all is no longer well."

All went well, however, and the Harrier's ski-jump takeoff is something of an aeronautical event. The U. S. Marine Corps plans portable ski jumps for battlefield use that can be set up in just six hours. The Navy figures that there may be a place in its future for small ski-jump carriers to augment its big-deck force.

• Controls: The Air Force's new fighter, the General Dynamics F-16, is the first production airplane in which the cable-and-pulley control system of the Tiger has been entirely replaced with electronics. Signals speed from the control stick along wires to a computer, and thence roundabout to the control surfaces of the 48-foot-long fighter. This fly-by-wire control system opens a whole

JAMES A. SUGAR WITH NELSON H. BROWN (OPPOSITE)

Son of SST? *McDonnell Douglas's model of an advanced supersonic transport (**facing page**) is readied for wind-tunnel testing at a NASA facility. The wing design promises as much as 40 percent better fuel economy than the Concorde's.*

*Lockheed chief engineers Bard Allison (**above,** at right) and Russell Hopps hold models of a subsonic transport with canards and a second-generation SST.*

Rutan VariEze

North American P-51 Mustang

Douglas C-47

Northrop Gamma

Ryan "Spirit of St. Louis"

Deperdussin Racer

Wright Flyer

Innovation Speed Complexity

IN FEWER THAN 80 YEARS, airplanes have developed from frail curiosities to machines essential in communication, transportation, and defense. Aviation and technology have spun cycles of innovation, advancing the state of the art in many industries. Certain aircraft, such as those shown here, were breakthroughs. Some seem never to quit. Hundreds of DC-3s, paragons of utility and reliability, are still flying.

Wright Flyer *(1903) gave man his first sustained and controlled powered flight.*

Deperdussin Racer *(1912) was first to use a monocoque fuselage and exceed 100 mph.*

Ryan "Spirit of St. Louis" *(1927) carried Charles Lindbergh solo across the Atlantic and ignited world interest in aviation.*

Northrop Gamma *(1933) pioneered all-metal construction for transport aircraft.*

Douglas C-47 *(DC-3, 1935), shown in 1942 war paint, revolutionized air transport.*

North American P-51 Mustang *(1940) scored as the finest all-around fighter of World War II for its strength, arms, and range.*

Rutan VariEze *(1975), designed for building at home, may presage the future for small, safe, and efficient propeller craft.*

Boeing 707 *(1957) employed a shapely swept wing and podded engines to bring the jet-transport age to maturity.*

Lockheed YF-12C (SR-71) *(1964) can fly in excess of Mach 3—three times the speed of sound—because of breakthroughs in aerodynamics, materials, and engines.*

Anglo-French Concorde *(1969) proved that supersonic transports could fly the Atlantic safely, if not economically, at Mach 2.*

General Dynamics F-16XL SCAMP *(1980s), a proposed variant of the F-16 fighter, would use a highly efficient wing to permit sustained supersonic speed. High fuel consumption keeps current fighters subsonic except for short bursts.*

PAINTING BY FRED WOLFF, IN COOPERATION WITH RICHARD HALLION

***Two celebrities** in the history of aviation rendezvous in Paris. In three and a half hours the Tiger Moth could fly to London, the Concorde to New York.*

bag of computer-smart aerodynamic tricks.

For example, when an F-16 pilot lowers his landing gear, the computer reduces the sensitivity of the fighter-quick flight controls so the pilot won't overcontrol the airplane during the landing. During flight, even hard-maneuvering flight, the computer constantly repositions the forward edge of the wing to achieve the best angle with the airflow for maximum lift.

The computer can also keep the pilot out of trouble. "With the fly-by-wire system, we can train the airplane as well as the pilot," says Lt. Col. David Peterson, director of the F-16 test force at Edwards Air Force Base in California. "We've had some airplanes with horrendous, even dangerous flying qualities," he added, "just too expensive to fix aerodynamically. Now we just reprogram the computer."

• Instrumentation: From the Tiger Moth to today's jets, flight instruments look pretty much the same—round steel gauges with clocklike hands that record such things as airspeed and altitude. In the all-electronic cockpit of the new fighter attack aircraft proposed for the Navy and Marine Corps, the McDonnell Douglas F/A-18, the old gauges are gone. TV-like cathode-ray tubes display not just flight and navigation instruments but hundreds of other programs that the pilot can change with the press of a button: takeoff and other checklists, weaponry displays, maps of the terrain below, notification that failure has occurred in, say, the hydraulic system and what to do about it.

Such is the rapid pace of change in avionics that the long, bulky tubes may be replaced in a decade by so-called flat-panel displays less than three inches thick. In one display, multitudes of light-emitting diodes wink on and off like a miniature billboard to generate letters and symbols and even conventional instrument displays.

I asked Jack Krings, director of flight operations at McDonnell, if young pilots could adapt to the new instruments. "They already have," he replied. "They've been watching TV and playing video games since they were kids."

F-15—King of the Skies

Despite advances in long-range missilery —a radar-guided missile from a Grumman F-14 Navy fighter has destroyed a target drone 109 miles away—fighter pilots still hone their skills for close-in, maneuvering combat. "We're not into *Star Wars* yet," said Lt. Col. Jim Cash at Langley Air Force Base in Virginia. "Though speeds are greater now, the basic fighter maneuvers for visual combat haven't changed since World War I. The most important thing is still the ability to turn, to get behind your adversary."

Colonel Cash flies one of the most efficient turning machines ever invented, the McDonnell Douglas F-15 fighter, designed for one purpose—to gain superiority over the

enemy in the air. The F-15 even looks superior on the ground, with its pointed nose, gracefully curving fuselage, and two engines so big they make twin bulges between its 18-foot-high vertical tail fins. This airplane wants to fly, I thought, and when Cash invited me to come along, so did I.

In the late 1950s, when I flew the Grumman F-9, one of the Navy's first jet fighters, I became accustomed to long, leisurely takeoff rolls and slow, lengthy climbs. The engine's 5,000 pounds of thrust had to work hard to propel 15,000 pounds of airplane. With the F-15, swiftest of tactical fighters, it's the other way around: Thrust (48,000 pounds) exceeds weight (43,000 pounds), and when the throttles go forward, things happen *now*.

After a takeoff roll remarkable for its brevity, the airplane seems to stand on its tail and fairly bound into the air. Colonel Cash maintains a 60-degree climb, and we pass through 9,500 feet *before* reaching the end of the runway. "No other airplane in the world can match this vertical acceleration," he says. Leveling off at 23,000 feet, he prepares for mock combat with an opponent 10,000 feet below us.

"Here he comes," says Cash, rudely whipping in 90 degrees of bank. I look down and see a speck becoming bigger, bigger, bigger—an F-15 climbing toward us like a bullet with wings. As it zooms past in a vertical climb, Cash maneuvers to keep it in sight. "I lost him, you got him?" he asks.

What I am getting is a reacquaintance with an old and tiresome adversary called g's, multiples of the force of gravity encountered when an airplane maneuvers violently, as ours is doing now.

Regaining contact, Cash turns hard to get on the tail of our opponent, who turns harder, while Cash turns harder still. The accelerometer on my instrument panel bounces between 6 and 6.5 g's, and I weigh—literally—more than 1,000 pounds. The force plasters my feet to the floor, binds my arms to my thighs, and tugs at my cheeks as if they are taffy.

After ten seconds: I'm in an invisible vise. Inflatable rubber sacs in my flight suit have automatically expanded—drum tight—against my legs and abdomen to prevent blackout. After twenty seconds: It is getting difficult to breathe and I feel tired, incredibly tired. Thirty seconds: Enough of this infernal massage. "I've had it, Cash. Let's knock it off and do something else."

Later, during a flight in the F-16 with Lt. Col. Robert Ettinger, I experienced a turn that climaxed for several seconds at 8.8 g's, more than enough to put my mortal frame into the dreamworld of blackout. However, this rarely happens in the F-16, because the seat slants 30 degrees to the rear, putting a pilot in a semireclining position that increases g tolerance. So I remained conscious, though mighty uncomfortable. Future fighter pilots may enjoy—if that is the word—greater g tolerance by flying on their backs in seats that automatically recline with the onset of g's. In tests of such a seat at the Naval Air Development Center, Warminster, Pennsylvania, pilot subjects tolerated up to 14 g's.

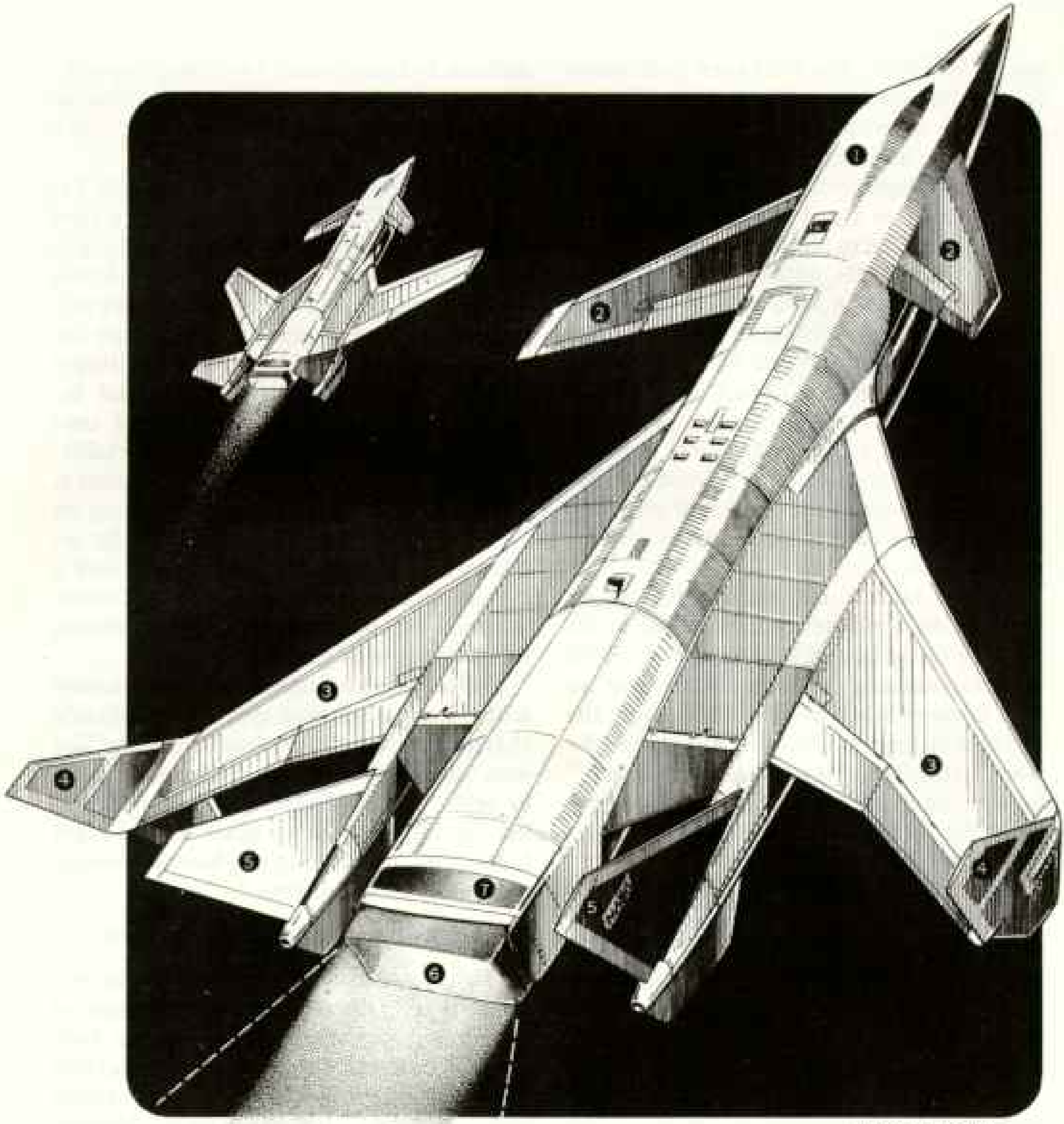
Colonel Cash explained that a new missile with sensitive infrared eyes could radically change the tactics of visual combat. "You won't have to get on somebody's tail then," he said. "Just pull hard, point your nose at him, and fire. It will be a quick, hard-fought battle," he added, "and this business is really going to get hazardous."

Pilot Flies Airplane From Ground

High above the Mojave Desert a futuristic airplane tests the maneuvering concepts of tomorrow, including the ability to turn twice as efficiently as the front-line fighters of today. Name just about any advanced technology and HiMAT—Highly Maneuverable Aircraft Technology—has it. The NASA-Air Force research craft built by Rockwell International is a flying computer on the inside—even the engine is electronically controlled. Outside, winglets and canards protrude from a skin that is almost entirely graphite-epoxy composite.

"It's the most complex project we've ever attempted," said Ike Gillam, director of NASA's Dryden Flight Research Center, where former projects have included the space-shuttle landing trials and the rocket-powered X-15 flights of the 1960s.

Everything seems to be on board HiMAT except the pilot. He stays on the ground and flies the aircraft by remote control after it has been dropped at 45,000 feet by a B-52



PAINTING BY FRED WOLFF

HiMAT's plug-in advances

*TINKERTOY APPROACH will permit new components such as wings, canards, and engine nozzles (**above**) to be fitted to the basic core of existing HiMATs, standing for Highly Maneuverable Aircraft Technology. This system's modularity will achieve testing flexibility while holding down costs.*

Advanced versions would share these features with current HiMATs: (1) electronics pallet with micro-processors and forward-looking television; (2) canards to improve airflow over the wings (3) and allow extremely tight turns; (4) winglets to increase stability, minimize drag, and enhance lift; (5) twin vertical tails to give directional stability and control.

Future versions would also incorporate: (6) engine nozzle swiveling up or down 20 degrees for abrupt and unusual maneuvers; (7) clamshell thrust diverter to open in flight for instant deceleration in combat.

Forward-swept wing on another version (left) may improve performance during low-speed flight. In construction, both current and possible advanced HiMATs employ graphite epoxy, a composite material twice as strong as aluminum at half the weight.

Ultimate model airplane, *the HiMAT research aircraft, a NASA-Air Force jet, is scaled down and piloted remotely both to save money and to avoid the possibility of pilot loss.*

*After technicians check out the nearly omniscient on-board computers and button up the airplane (**bottom**), the craft is slung under a B-52's wing (**below**). Released at 45,000 feet, it is controlled from a ground station or chase plane. Tests promise to confirm the design's potential as a fighter of the future that can outmaneuver anything now flying.*

bomber. This technique, pioneered at Dryden, permits a smaller vehicle to be tested. A down-size version of a 17,000-pound airplane capable of carrying a man, HiMAT weighs just 3,400 pounds.

Two of the small unmanned HiMATs were built for 17 million dollars. Just one man-rated craft would have cost more than 80 million dollars. This is welcome news for taxpayers, because another dimension in which aviation technology is advancing is cost, especially with fighters. One F-14, together with spare parts and support activities, costs 23 million dollars. One F-15, 18 million dollars.

Costs Soar to Incredible Heights

"From the days of the Wright brothers through the F-18," says Norman R. Augustine, vice president for technical operations at Martin Marietta Aerospace, "aircraft costs have been increasing by a factor of four every ten years." Viewing this "inexorable trend" in relation to defense-budget increases, the former undersecretary of the Army makes a prediction: "In the year 2054 the entire defense budget will purchase just one tactical aircraft. This aircraft will have to be shared between the Air Force and Navy three and a half days each per week."

As a former marine, I protested the omission of the corps from this scenario. Augustine responded that perhaps the Marines could use the airplane on weekends, but that anyway, this would be up to the Navy.

Levity aside, Augustine is not kidding about costs. "I present this in tongue-in-cheek fashion," he told me, "but the data are real. The trend is real. In the future we're going to have to exercise discipline."

Noting that "scientific and engineering knowledge is increasing with almost bewildering speed," David Lewis, chief executive officer and chairman of the board of General Dynamics, states that "essentially any level of performance can now be designed into an airplane weapons system, if someone is willing to pay the cost."

Paradoxically, technology may come to its own rescue. "Take an 80,000-pound tactical aircraft of the 1960s," says Michael Pelehach, president of Grumman International, "and redesign it with the technology of the 1980s. With advanced composite

materials you could get the weight down to 53,000 pounds; with better aerodynamics, to 44,000; with new engine technology, to 37,000 pounds.

"Like steak, airplanes are bought by the pound," Pelehach told me. "The trend in the future will be to smaller, lighter, less expensive airplanes."

Dr. Hans Mark, Secretary of the Air Force, pointed out another trend—the increasing production rate of Soviet combat aircraft. "They are building four times as many warplanes as we are," he said. At this rate, Dr. Mark explained, the U. S. Air Force could completely replace its inventory of tactical airplanes every three years.

The Soviet design philosophy used to emphasize rough-and-ready serviceability. Kelly Johnson, who created the U-2, SR-71, and many other significant aircraft during a distinguished career at Lockheed, recalled a remark that the Soviet designer Andrei Tupolev made to him in 1962:

"You Americans build airplanes like fine lady's watches. Drop watch—watch break. We Russians build airplanes like Mickey Mouse clocks. Drop clock—clock stop. Pick up clock and shake—then clock work."

But in the past 15 years or so, experts note, the Russians have made the transition from Mickey Mouse to the micro-processor. "Quality has increased dramatically," Grumman's Pelehach said. "They can design as well as we can."

Vice Adm. Wesley L. McDonald, deputy chief of naval operations for air warfare, told me: "When you see the sophistication of the Backfire bomber, it is naive to think we can come up with a cheap substitute to meet its threat."

Competition Grows for American Firms

Looking at U. S. civil aviation, Dr. Mark, former director of NASA's Ames Research Center near San Francisco, expressed both pride and concern. "American airplanes comprise 85 percent of the free world's commercial jet aircraft," he said. "In 1979 our aeronautical exports amounted to nearly 12 billion dollars, second only to foodstuffs." The Boeing Commercial Airplane Company contributed a hefty 3.5 billion dollars of that total.

"This is no accident," he continued. "The investment the federal government made in wind tunnels and flight-research facilities beginning in the 1950s has led to the generation of jet transports we build today. But we are not maintaining the pace of this investment, and I think we are failing to see it as the seed from which prosperity grows."

Dr. Mark noted that Airbus Industrie—a European government-supported consortium—in 1979 moved into second place, after Boeing, in orders for commercial jet transports. "The other guys are catching up," he said.

In the race for more than 100 billion dollars in orders for civil transports by the 1990s, manufacturers emphasize fuel economy, attained by better aerodynamics, more efficient engines, electronic flight management, and weight-saving materials. The new jetliners—Boeing's 757 and 767, Airbus Industrie's A310, and McDonnell Douglas's DC-XX, still in design—won't look much different from existing airplanes, but passengers and pilots alike will experience some advances in aviation comfort.

For instance, pilots' seats in Boeing's new

Largely self-taught, *Robert T. Jones of NASA's Ames Research Center became one of the world's leading aeronautical designers. Among his contributions are the principles of the swept wing and pivoting wing. His curiosity even led him to design an electronic violin.*

airplanes will be covered with lamb's wool. Taking a cue from some midwestern farmers who use lamb's wool as a seat on their tractors, Boeing engineers strapped pilots in various seats for long periods during a scientific squirm test. The results revealed that lamb's wool seats induce significantly fewer squirms, twitches, jiggles, and scratches than conventional seats. Wool from New Zealand lambs proved best.

Boeing has also modulated the flight-deck cacophony of as many as 18 warning bells, horns, buzzers, clackers, and musical tones of former aircraft to four: a bell for a fire, whoops for inadvertent proximity to the ground, a police siren for excessive airspeed and other conditions, and electronic owl-like hoots for equipment malfunctions.

New Planes Give Passengers a Break

Except for the relatively narrow-bodied Boeing 757, the new jetliners will have two aisles, and no passenger will be more than one seat away from an aisle. The 757, scheduled for delivery in 1983, will offer two sets of three-abreast seats separated by a single aisle, plus architectural niceties to convey a feeling of spaciousness. Cool pastels highlight the cabin interior. Storage bins large enough to handle a guitar, a backpack, or a set of golf clubs blend with the ceiling instead of hanging, an engineer says, "like cabinets in a kitchen."

Aboard the Airbus A310, mothers with infants will find a foldout platform in rest rooms for diaper changes; passengers in the center row of seats will have their own storage bins. In McDonnell Douglas's jetliner, passenger seats will average one and a half inches wider than those in the old DC-8. Reason: people are getting bigger. Collating anthropometric data, Douglas engineers discerned that, from a 1955 baseline, American men will be one and a half inches taller, on an average, by 1990. Women will be three-quarters of an inch wider in the hips.

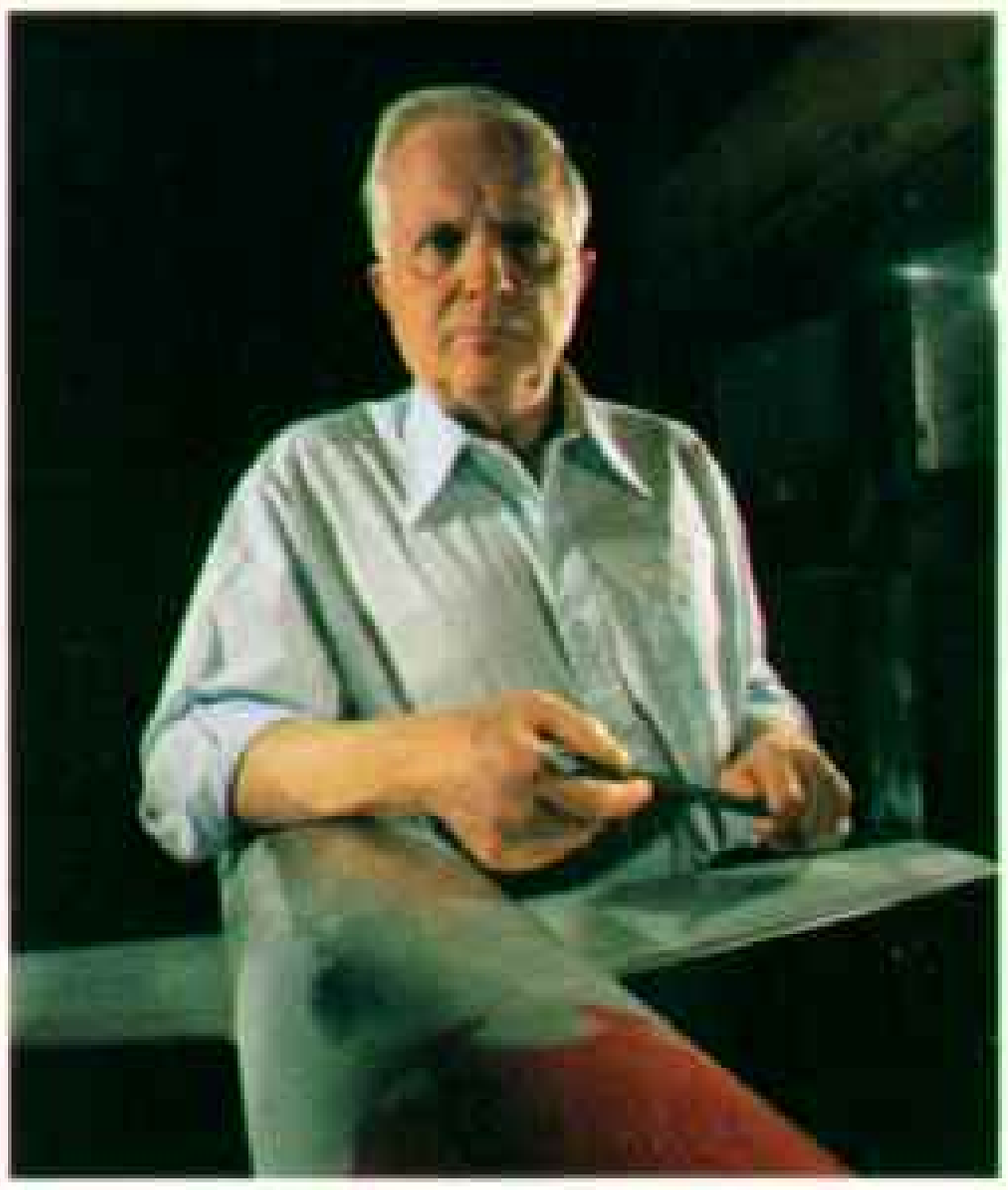
Thus comfortably ensconced, passengers may not notice the major aerodynamic improvement common to the new transports —longer wings. As soaring birds and sailplanes teach us, longer wings are more energy efficient.

"The airlines first wanted an airplane that could go faster—just below the speed of sound, in fact," said Dr. Richard T. Whitcomb (below), now retired after a distinguished career with NASA. The problem was, he explained, at this speed the wing experienced high-drag shock waves.

To delay the formation of these waves, Whitcomb reshaped the wing, making it flatter on top, with a cusp on the bottom near the trailing edge. The new wing worked in flight tests.

"Then the Arabs lowered the boom on fuel," he recalled, "and suddenly people weren't the least bit interested in flying faster." So Whitcomb switched to plan B: Make the wing thicker and longer, and fly it at the former speed, .8 Mach. "By doing this, we bought a 10 to 15 percent gain in aerodynamic efficiency," he said.

With computer-smart controls, wings can be made longer without compromising structural strength. When a gust of bumpy air strikes the longer wings of the new Lockheed TriStars being purchased by Pan American and other airlines, computers will move the wings' outer control surfaces—the ailerons—upward, thus relieving the load



First applying theory, *NASA's Richard Whitcomb later refines his designs in practice with a metal file. His discoveries include the "Coke bottle" fuselage for practical supersonic flight, the supercritical wing for low drag at high subsonic speeds, and winglets.*

on the wings as well as smoothing out the ride for the passengers.

"We would have thought twice about buying the airplanes without this improvement," says Pan American vice president and chief engineer Lewis H. Allen. The airline expects to save at least three million dollars a year on fuel costs with its TriStar fleet.

With the emphasis on fuel-efficient aircraft, prospects for an advanced supersonic transport fly into the winds of controversy generated by the Anglo-French Concorde: too expensive, too noisy, too fuel consuming. Yet a NASA research program, authorized by Congress in 1971 after the cancellation of the U. S. SST project, has produced breakthroughs in areas that plague Concorde: noise reduction, less costly fabrication of titanium, an engine that can "shift gears" to function efficiently at either subsonic or supersonic speed, and, especially, improved aerodynamics.

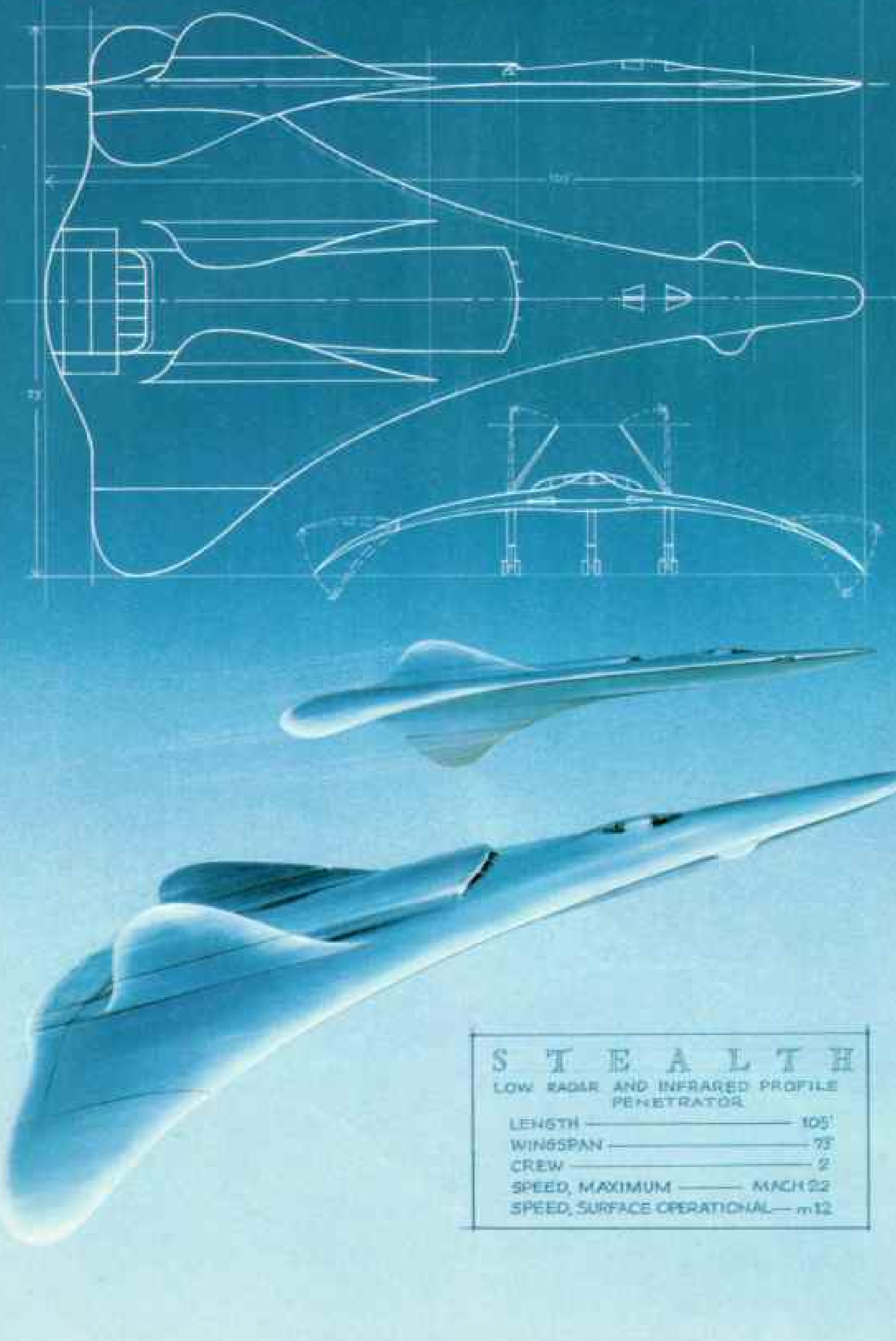
Richard D. FitzSimmons, director of advanced engineering at Douglas, says that his company's wing represents a "40 percent increase in aerodynamic efficiency over Concorde, translating into a 40 percent decrease in fuel burned." If air could bleed, this wing

With bonelike canards *in their snouts, the backward-looking craft of independent designer Burt Rutan do not stall—a major aerodynamic innovation.*

*Available as kits, Rutan's airplanes are home built (***above***) by laying up fiberglass over a foam core.*

NZTMS

S T E A L T H



S T E A L T H

LOW RADAR AND INFRARED PROFILE PENETRATOR

LENGTH	105'
WINGSPAN	73'
CREW	2
SPEED, MAXIMUM	MACH 22
SPEED, SURFACE OPERATIONAL	m12

would cut. Highly swept, with razor-sharp leading edges, it resembles an arrowhead. Applying the new wing and engine technology to smaller airplanes, an exciting possibility arises—a fighter capable of sustained supersonic speed.

New Craft Recall an Old Friend

Burt Rutan, a tall Californian with muttonchop sideburns, seems to advance aviation technology all by himself. Burt is president of the Rutan Aircraft Factory, occupying a small building at the Mojave airport. He employs three people.

Burt designs airplanes mostly for home builders—you buy the plans and you build the airplane. More than 300 of his VariEze designs are flying. Burt calls the airplane that because it is "very easy" to build.

His airplanes seem a little odd because the horizontal "tail" is in the front, while the propeller is usually in the rear, leading some to wonder which way they fly. They fly well.

What is remarkable is that Burt's airplanes don't stall. A stall occurs when the angle between the airflow and the wing becomes so great that the wing loses lift and stops flying. I witnessed such an accident years ago near Pensacola, Florida, when a fellow flight instructor suffered an engine failure soon after takeoff.

He turned back toward the runway. Then his turn became tighter, his angle of bank steeper. Suddenly the airplane flipped on its back and lazily spun into the ground, killing both instructor and student.

Burt's brother Dick, a former Air Force fighter pilot, is the test pilot of the Rutan Aircraft Factory. One day I sat in the backseat of a VariEze while Dick, manning the controls in the front, throttled back and set up a glide to simulate a landing approach. Then he cranked in 60 degrees of bank and pulled 1.8 g's with full back stick. This is the recipe for real trouble in most airplanes, but the VariEze obediently made a swift 360-degree turn. I asked Dick if I could give it a try.

This time I raised the nose above the horizon before steepening the bank and pulling back stick, doing my best to help provoke a stall. Once again the airplane turned smartly. "I've tried everything to stall it," said Dick, "and all I get is exercise. Other test pilots have asked me, 'What's wrong with this airplane? I gotta stall it and make it spin.' They get mad."

Back at the Rutan Aircraft Factory, Burt explained. The horizontal tail in front is actually a canard, which functions in this case as sort of an auxiliary wing. The canard, mounted at a greater angle on the fuselage than the main wing, does indeed stall and stops lifting. Then it drops a bit and starts flying again. Meanwhile—and this is the point—the main wing has never approached the angle of attack at which it would stall. (On the F-16 the angle of attack is limited electronically. Once a pilot reaches this maximum, the computer steps in and prevents him from increasing it further, no matter how hard he pulls on the stick.)

NASA aerodynamicists tested a VariEze model in a wind tunnel last year as well as a full-scale airplane in flight. "Remarkable, innovative, expert," was the verdict of Joe Chambers, head of the dynamic-stability branch at NASA's Langley Research Center in Hampton, Virginia.

In 1979 Dick Rutan, flying a special edition of the VariEze with extra fuel, set a world distance record for aircraft weighing less than 2,200 pounds—4,800 miles in 33 hours and 33 minutes. That's three minutes more than Charles Lindbergh took to fly the Atlantic Ocean. Dick's flight would have spanned the Pacific.

Burt Rutan is not one to let convention fuzz up his thinking, so an admirer says, and canard-equipped airplanes may look a bit odd to those who've made up their minds how an airplane should look. Aerodynamic excellence aside, his airplanes have an elegance and a simplicity that put me in mind of a—well, of a Tiger Moth. □

Strategic hide-and-seek *has a new player, the secret Stealth. Painting* ***(left)*** *depicts what such a U. S. bomber/reconnaissance aircraft could look like, based on well-known principles as interpreted by expert Richard Hallion. To foil radar: a minimal cross section, curved surfaces for signal deflection, and composite materials with nonreflective coating. To foil infrared sensors: shielded exhaust above wing.*

PAINTING BY NATIONAL GEOGRAPHIC ARTIST WILLIAM H. BOND

Poland's Mountain

ARTICLE AND PHOTOGRAPHS BY YVA MOMATIUK

People

AND JOHN EASTCOTT

Fierce love of the high country *tempers a hard life for Józefa Szulc, left, and her family, who clear rocks, sow oats, and harrow during spring planting. While shortages and unrest beset their socialist nation, hardy folk called the "górale" fend for themselves beneath the wild peaks of the Tatra Mountains in southern Poland.*

WIND PUMMELED new snow into drifts along the only road in Murzasichle, a mountain village in southern Poland. My husband, John, playfully whistled at two huge sheep dogs huddled together in a nearby snowdrift and the animals sprang up, teeth glittering. Safe on John's back, Tara Yvushka, our eight-month-old daughter, giggled with delight. Obviously, the snarling white dogs fitted just fine into her marvelous world.

Across the road a girl sat on a porch, sheltered by the massive spruce logs of her house. A passing boy shouted: "Does the sun feel good on your pretty face?" and the girl looked up, smiling. The boy, suddenly afraid he seemed unmanly, hit her with a fast snowball. Dignity reestablished, he ambled away, his knitted hat perched rakishly.

A milkman riding by on his long sledge yelled the customary question: "Where are you going?"

The boy jumped sideways to make room for the steaming horse. "Downhill," he replied, as if all destinations in Murzasichle reflected the land's acute angles and one could only go up or down.

One could also come back. After spending 15 nomadic years abroad, mostly in the United States, I had just returned to Poland's Podhale region, the fondest place of my childhood, for one is never too young or too old to breathe sweet air, to lie in a flowering meadow, and to live among people of merit.

Although born and raised in Warsaw, I used to come often to Podhale, a vacation wonderland undulating between the Czarny Dunajec and Bialka Rivers and adjacent to the northern slopes of the Tatras (map, page 112). I was mesmerized by the land and its people, who are called *górale* (gore-AH-leh): *Góra* means "mountain." Highest group in the great bow of the Carpathians, the Tatras appeared enormous; and the dark forest below, impenetrable. Rivers often flooded stony fields, winds downed towering trees; a sunny day was a state of grace.

Sorrowing Christ *carved on a góral grave marker (***above***) reflects Roman Catholicism's strong influence. Pope John Paul II, revered as an honorary góral, often skied in the Tatras. The soul of the people lives in their mountain meadows, the "hale" they cherish for the folklore handed down by generations of shepherds. Like them, Jan Łowis strains the milk of his flock to make cheese (***right***).*

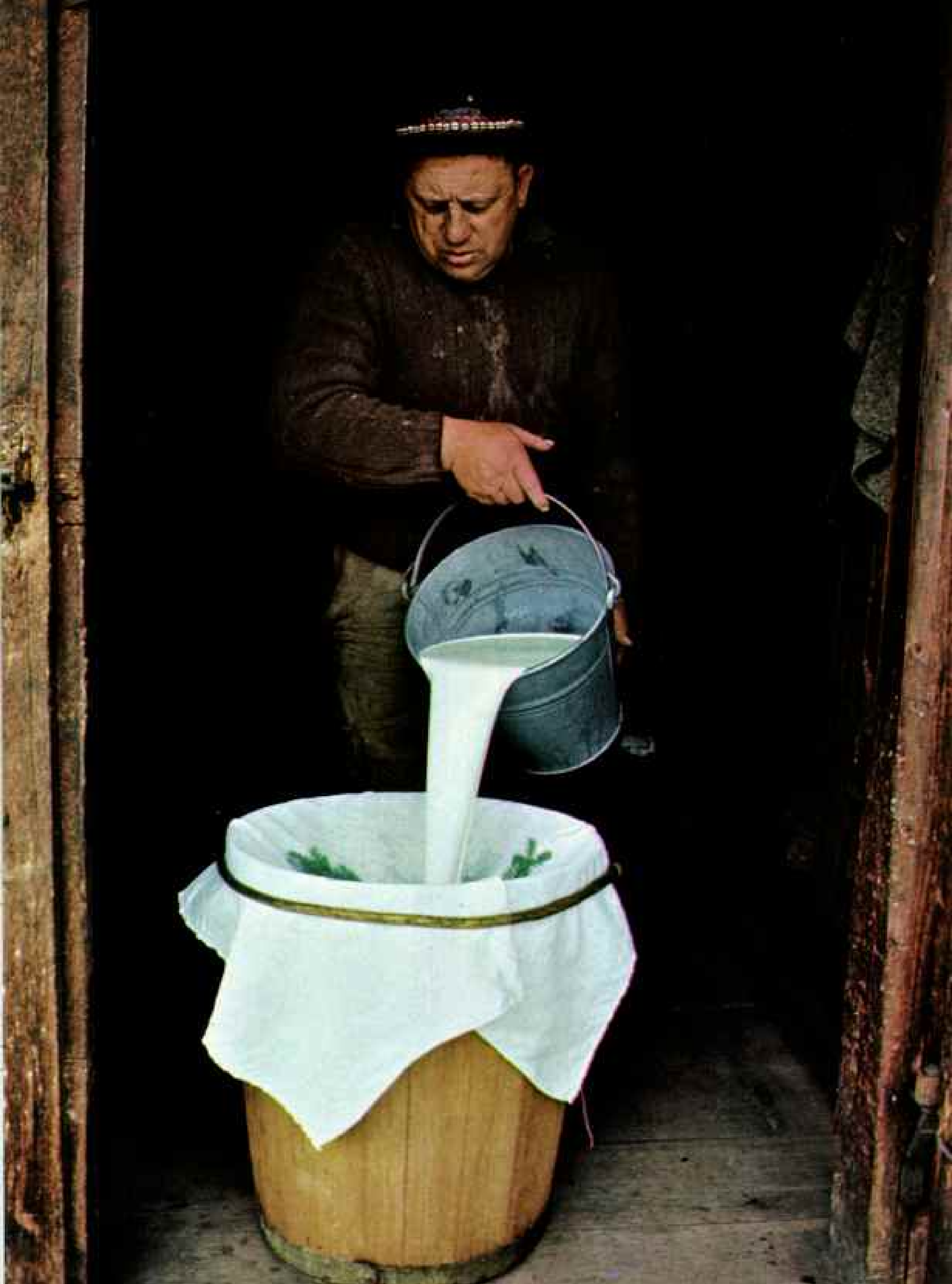
Molded by this harsh environment, the górale are fiercely loyal to the land that nourished them poorly but gave them their roots and their pride.

Proud, yes, like all Poles. And, like their countrymen, discontented. The tension we felt last spring erupted in late summer as labor unrest swept Poland. The world watched in suspense. Striking workers won major, unprecedented economic and political concessions, including independent labor unions. Only time can reveal the full import of these breaches in the Communist government's monopoly of power.*

In Murzasichle we sought my childhood friend, Józek Łukaszczyk-Studniar. Like many górale with the same last name, Józek uses a sobriquet. "Studniar" means, roughly, "the one who has a water well." The well was still there. And now a car! And a new house! Will he know me?

Józek stood in the middle of the kitchen by a big stove jammed with bubbling pots, talking to his wife. His tanned face had changed little. Blue eyes met mine, indifferent for a second— *(Continued on page 113)*

*See "Springtime of Hope in Poland" by Peter T. White in the April 1972 NATIONAL GEOGRAPHIC.



Ghostly solitude *of a spruce forest . . . a vision to gladden górale hearts. Spruce builds and heats their homes, gives birth to song through musical instruments,*

and decorates their lives. Many of their traditional woodlands are now enclosed by Tatra National Park, where eight villages own and manage about 7,000 acres.

Hallmark of a góral home, *an elaborately decorated and dated central beam, the "sosrgb," is set in place by a carpenter in the village of Witów* ***(above)****. The owner earned funds for construction by working for two years in the United States. There and in Western Europe, thousands of górale have found a pipeline to prosperity since about 1900, when poverty and overpopulation plagued Podhale.*

For wealth that endures, the people look to their timber, which they craft into a renowned style of log house. During a proud spring ritual in the village of Chochołów—a national monument—a resident laboriously cleans the exterior of her home, beam by beam ***(left)****. Newer houses feature planking added for insulation, a handsome frame for a playful girl in her church finery* ***(right)****.*


Rysy
2,499 m
8,199 ft
Hala Gąsienicowa
Mt. Kościelec
2,155 m
6,568 ft
CZECHOSLOVAKIA
POLAND
TATRA MOUNTAINS
TATRA NATIONAL PARK
Kościelisko
Zakopane
Murzasichle
Witów
CZECH.
POLAND
PODHALE
Chochołów
Biały Dunajec R.
Czarny Dunajec R.
Białka River
Dunajec River
Nowy Targ
CZECH.
POLAND
Baltic Sea
EAST GERMANY
POLAND
Warsaw
VIEW TO THE SOUTH
Prague
Wadowice
Highest range of the Carpathian Mountains, the Tatras hug the Podhale region on Poland's border with Czechoslovakia.

Joy of the dance *returns to Polish-born author Yva Momatiuk* ***(above,*** *center), visiting the home of childhood friend Józek Łukaszczyk-Studniar, who dances at left. As a girl, Yva frequented the Podhale region* ***(left)****, homeland of the górale, who number perhaps 150,000. Historically free spirited, they enjoyed special privileges during Poland's feudal era. Later, after their prized forests were sold, persevering górale bought them back. Today sports lovers hail Podhale's chief resort, Zakopane, as Poland's winter capital.*

(Continued from page 106) only a second.

"Yva!" and he hugged me. Then he held Tara the way one holds one's own. From beside the stove a small man looked up at me. I touched his gnarled old hands.

"Grandfather." Only his lips moved, as if at 80 he tried to save his strength:

"Well, child . . . how is it out there for you? Can you make a living?"

And I thought: Yes, for a góral that is a fundamental question. In the old man's youth, Podhale—"under the mountain meadows"—was the poorest region of Poland. The soil is inferior, the climate severe. In the months before harvest the górale would eat the new shoots of spruce trees, cooked chopped straw, and *warmuz*, a mixture of sorrel, thistle, and nettle.

The strong ones went south to look for work in the fertile valleys beyond the Tatras—and sometimes returned in sadness carrying a solitary loaf of bread. In a bad year, when untimely snow or frost destroyed crops, whole families, too proud to beg, sometimes starved to death. Folk songs lamented the harsh life:

Although poverty is hitting,
I won't tell anyone.
I will sing among people
And cry at home.

All this has changed. Górale no longer rely on farming. Many commute to work in factories near Nowy Targ. Others find employment in Zakopane, a busy resort town of 29,000, called the winter capital of Poland. A large network of cottage-industry workers, under a contract from the government agency that promotes native crafts in Poland and abroad, produces handmade gifts, clothing, and furniture. Yet past hardships are remembered and still feared.

Józek's family assembled, greeting John warmly and bringing food: marinated mushrooms gathered months earlier, sausage, delicious apple pastry, and cold milk.

Polish hospitality calls for ample food, and woe to the guest who declines. Yet the guest who grabs food without being encouraged disgraces himself. In Podhale a host plays the role of *nukac*, "the one who urges." One wedding guest, a story goes, returned home after a three-day feast disgruntled and hungry. "Was there no food?" asked

Mud is part of the bargain at a weekly market in Nowy Targ. Here górale converge

his wife. "Yes, but no nukac," he growled.

We learned that since my departure in 1965, Józek had worked for a fire department and a grocery store, and had even sold his wood carvings on the streets of distant Warsaw. Now he and his wife, Zosia, were running a year-round, full-board guesthouse. Firing of stoves falls on grandfather, who likes the *dudki*—money—and the sight of leggy girls in bikinis.

Tourism Aids Free Enterprise

Although the Communist government does not encourage free enterprise, it is flourishing. In the past decade, the tourists visiting Podhale and the Tatras have averaged 2.7 million annually. Zakopane has played host to competitions of the International Ski Federation—the World Cup included. A 420-foot hillside provides one of the largest natural ski-jumping facilities in the world.

The first vacationers discovered Podhale in the middle of the 19th century. The sleepy village of Zakopane gradually changed to a modern, chaotic resort town, a haven for artists and writers, climbers and skiers. Physicians praised the mountain air and promoted sanatoriums, mostly for treating tuberculosis. Polish patriots, trying to free partitioned Poland from her three occupants, found safety here, for the Austrians who occupied Podhale—unlike the Prussians and Russians—were lenient. Lenin vacationed here in 1913-14 before he went on to Russia—and the revolution.

Most working Poles receive four weeks of paid vacation, subsidized by their offices, factories, and schools. Many come to Podhale on their group holidays. By Western

to buy and sell anything from homemade woolens to clothing sent by U. S. relatives.

standards services are scant, but the Poles cope admirably. Plans for the region include modern tourist centers in villages strung along the range of hills parallel to the Tatras. These centers would ease the pressure on overcrowded Zakopane and provide new jobs for górale.

I was a different kind of visitor, remembrance bound. Toward evening grandfather fired the stove in our room. Metal beds were new to me. I thought of creaky wooden beds and sweet-smelling straw pillows and mattresses; at night, tiny and strange inhabitants of the meadows would munch on stalks near one's ear.

Józek, understanding my nostalgia, reached into his mother's dowry trunk, and that night I slept in a feather bed made from prime Polish goose down, considered by many to have no equal.

Morning brought a special peace, the kind that comes with fresh snow. The sound of icicles, shattering like crystal glasses, amused Tara. The snow had changed the log houses of Murzasichle into white mushrooms. Their small windows faced south seeking warmth from the sun.

Homes Reflect Folk Art

A classic góral house, or *chałupa* (page 110), is sculpted from spruce and fir logs and held together by superb fit. It has a large central hall, a "black room" for everyday living, and a "white room" used only for festive occasions and dominated by beds piled high with embroidered pillows.

The houses have carved beams, pegged doorways, and little crosses with magical meaning—charms that appear unexpectedly in obscure places. Because górale are

both gifted craftsmen and bold designers, they often turn ordinary objects into art. Mieczysław Biernacik, a burly Zakopane blacksmith and chairman of the Polish Folk Artists Society, spoke to us of this:

"The history of our folk art can be traced to the country's geography of hunger. The few rich peasants had no incentive to create art. The poor górale had to find something to live for, and so they learned to see, to imagine. When I take visitors to the mountains, they don't notice rocks that look like madonnas or roosters or sleeping knights. That's what a góral sees." He nodded with satisfaction.

"Our folk art has simplicity, a smoothness of design. If you are born under a ceiling beam with a carved rosette, spanked with your nose buried in the embroidered front of your father's trousers, and have your tears dried on your mother's flowery skirt—you can never escape. These things will show in your work 30 years later."

Blacksmith Biernacik designed the embroidery for his daughter's wedding corset, but iron is his love.

"They say gold is precious, copper flexible. Ah, but iron! Hot, it is soft and graceful, like a woman. Cool, it becomes strong, masculine. These days, blacksmiths use grooved hammerheads to give iron a handmade look: It's like trying to blow life into a corpse. Old masters strived for a smooth surface by hitting close, every few millimeters. This restraint and perfectionism bespoke the truth of a handmade object."

I weighed that against the new brick houses that I saw springing up in Podhale.

Deep is Poland's debt *to a well of góral creativity. The old art of glass painting is kept alive by Ewelina Pęksowa (**right**); the design she holds, traced from a sketch below, brightens the nation's mail as a stamp (**above**).*

*With his pulse on the unquenchable góral love for music, master craftsman Franek Marduła (**left**) tunes the back of a violin in progress. For resonance, he chooses dense wood from spruce trees that grow slowly in mountain shadows. Górale songs often echo a tradition to which the Marduła clan belongs, that of the "zbójnicy," storied mountain brigands who once preyed on wealthy landowners.*

Taking piety in stride, *a milkman crosses himself before an altar set up outside a home in Chochołów along the route of a Corpus Christi Day procession celebrating the Holy Eucharist.*

Were they examples of professional pride?

"A man is born lazy and bad," said the artist, turning philosophic. "He has to work hard to overcome this and keep his pride. I could take you around and point out prosperity periods in Podhale: These houses were built from smuggling; these from making wood, leather, and woolen goods; these from running guesthouses. The biggest have been paid for with American money, and the newest status symbol is the number of bathrooms. In Poland, the U. S. dollar's buying power is multiplied so much that we say: 'The dollar is having kittens.'"

Many Answered America's Call

The American connection in Podhale is an old one. At the end of the 19th century the region was distressed. Overpopulation had forced people to farm even barren plots. Mining jobs dried up as iron ore in the Tatras ran out. Desperation set in.

When the góral is dying,
No one is crying;
Only this cold rain
That whips the summit rocks.

By 1910 every fifth inhabitant of Podhale had left for the United States, driven by poverty and dreams. The newcomers mined coal in Pennsylvania, gutted animal carcasses in Chicago, and suffered from homesickness so severe that even the sound of a familiar mountain tune sometimes provoked suicide. Some never adjusted and returned to Podhale even poorer: To bring them home, their families had to sell land.

Many stayed in America, however, and prospered. Today they send money to Poland and invite relatives to the U. S. These come, work a few years, save every penny, and return in glory, some carrying $15,000 or more in cash.

The official Polish exchange rate is about 30 zlotys per dollar—but the pervasive black market pays four times as much. Hard currency can buy imported and domestic goods in special government stores, whose prices reflect black-market rates. Jeans sell like hotcakes, and a bottle of vodka costs only a single greenback.

Weather can be less stable than the black market. During our visit, winter persisted into spring, and in April men with horse sledges kept returning to the forest for wood cut the previous fall. One morning we rode along. Logging is always dangerous—loads can overturn and pin the men.

"There are no strong ones or smart ones in the forest," our driver said after a time. "I've been coming here for 18 years, and every day I pray I will make it home alive. Now they teach in schools that there is no God." He

spat contemptuously. "Look! He is in this forest, watching."

Long ago the virgin forest fell under the axes of settlers and miners. The Polish Tatras became a national park in 1954, and timber cutting is now strictly supervised. Within the park, eight villages own and manage nearly 7,000 wooded acres.

Trees for Making Music

Certain spruce trees here are used to make violins, cellos, and basses, instruments that require a resonant box to create sound. The best "resonance trees" grow under the worst conditions on harsh northern slopes. Annual growth rings are stunted and tight, and the wood is dense. Still, the trunks must be large and straight; planks for making the upper, critical plates of instruments are air-dried for eight to ten years.

"Without experience, one would make a rain barrel instead of a violin," Franek Marduła, one of Poland's foremost violin makers, told us (page 116). His violins are found in music chambers all over the world and command up to 40,000 zlotys in Poland, where the average monthly salary is 4,500 zlotys. An unassuming man, Marduła opens his little workshop to everybody. His son Stanisław and other students, some of them from Western Europe, cram the little room to learn from the master.

Franek Marduła was a member of Poland's Winter Olympic team when World War II broke out. He made one of his first violins while a prisoner in a Nazi camp in Germany, fashioning tools from tin cans and gluing scraps of spruce for the upper plate. For other parts he used birch, boiled for two weeks, then dried. A knothole was filled with a heart-shaped inlay: He dedicated the violin to his wife.

Then a fellow prisoner walked from cell to cell playing the national anthem: "Poland hasn't perished yet. . . ." In those bleak days, Marduła's violin made grown men cry.

It is not surprising that great instruments come from this region: Podhale is music. Górale sing on their way to hay meadows, while tending sheep, courting, waiting out a rain. Some women criticize a rule of Tatra National Park: "They tell you not to sing there—it might scare the wild animals."

Whether professional or amateur, a góral makes music for pleasure. When the internationally acclaimed baritone Andrzej Cuhruś-Bachleda returned from a recital in New York's Carnegie Hall, he sang for us in his Zakopane villa. Graying, leonine head tossed back, foot tapping the rhythm, his shining eyes and rich voice challenged the mountain mists:

Erected by village will, *a wooden church in Murzasichle is ringed by an Easter procession* ***(right)****. When, 25 years ago, górale asked for a permit to build it, socialist officials said no. Undeterred, carpenters night after night cut beams in secrecy, then assembled them at the church site. Result: a finished edifice that authorities were forced to accept.*

Sugar lambs, hard-boiled eggs, and other Easter-basket treats ***(above)*** *are shared by the entire family.*

Why did you come here
Gray fog, gray fog;
You, who covered the path
To my loved one?

Bachleda's baritone filled the room the way the sun does. Music had come to him in the church in Zakopane, when he worked the organ bellows as a boy and his mother sang in the choir.

The church was begun a hundred years ago, after Zakopane's first pastor, the forceful Father Stolarczyk, ordered hot-blooded young men of the town to repent their indiscretions by delivering stones for the construction of the church. As the errant village lads carried in their heavy penances, the priest mused:

"Even if we can build a whole church in this fashion, I wonder whether God will really like to live in it." Particularly stubborn sinners were treated to corporal punishment by the pastor—and he was a big man.

In those days folk beliefs were strong in Podhale. Foul weather was caused by *planetnicy*, strange creatures whom God ordered to ride and muster rain clouds. To make a sick horse well, it had to be walked diagonally across a sheet taken from the matrimonial bed. People occasionally were

suspected of casting bad spells; the spells could be remedied by spitting three times and inhaling smoke from three burning matches. During our stay, modern, car-driving górale warned us: "Don't let old women look at your daughter!" But the old women looked, touched Tara to their hearts' delight, and she remained fine.

Today, superstitions notwithstanding, górale practice Roman Catholicism with zest. They recently lost their beloved Archbishop Karol Cardinal Wojtyła to the Vatican. Now Pope John Paul II, he was born in Wadowice, just north of Podhale, and is considered an honorary góral. He used to ski and hike in the Tatras and knows the people intimately.

Anticipating the papal visit in 1979, people were in a daze. They made vows to improve their behavior, wrote welcoming songs, sculpted and painted gifts for the exalted visitor, and decorated their houses. Some even swore off vodka.

Church Erected Despite Orders

On Easter Sunday, worshipers in Murzasichle trod in snow during the procession around the church. The cold lent an edge to their singing voices.

A lovely wooden church had replaced the roadside lean-to where Masses were held in my childhood (pages 120-21). The congregation used to block the road. Irate motorists blew their horns, disturbing services, so the villagers asked the authorities for a permit to build a church. It was denied.

Górale are a law unto themselves. People donated a building site and their labor. Sentries stood guard at both ends of the village, signaling with white sheets when police approached. Hidden in the forest, carpenters cut, planed, and notched spruce beams up to 50 feet in length. These were carried to the site after dark and dropped into place. The fit was perfect.

The police posted notices, even fired some volleys. Finally government officials arrived for a showdown. The górale received them with characteristic diplomacy. Suddenly a fat, loudmouthed woman parted the crowd. Carrying a large, menacing rock, she breathed fury and shouted abuse. The visitors left in a hurry.

The seasons changed during our visit. The daughter of our neighbor was married. A wedding without two or three days of merrymaking does not count. Homemade sausages, hams, pigs' feet in aspic, sheep cheese, pickled cucumbers, meat and fruit pies filled the white room. The wedding vodka was made of 180-proof *spirytus* mixed with sweet tea.

Most people agree that drinking does them no good, but they forsake this truth easily. Sadly, there is never any shortage of vodka in Poland. My nursing of Tara was not considered an excuse: "Have a drink, she will sleep better, poor thing." John, a New Zealander, was overwhelmed by Polish drinking habits. He would empty his glass under the table or excuse himself by citing Polish laws that strictly prohibit drinking and driving.

Yet the górale liked John. At the wedding a woman offered to buy him from me. When John suggested a price of 100 złotys ($3.30), she protested. "That cheap? Even if he isn't any good, that's still too little for a tall, handsome man." The wedding crowd grew merrier, women resplendent in corsets, embroidered blouses, and flowered skirts. Men wore white felt trousers and eight-inch-wide brass-studded belts. Musicians—three violins and one bass—kept to a wild rhythm. The popularity of Podhale folklore has encouraged many dancing and singing ensembles who perform locally and abroad.

Wedding or not, the chores had to be done. The bride's parents quietly milked the cows, while the floor trembled under the dancing feet behind the wall.

Party Line Not Always Convincing

Wedding festivities only briefly set aside harsh realities. In the Communist Polish People's Republic any public criticism of the ruling party is forbidden, and censorship is enforced. People continue to distinguish between the official line and their own understanding of facts.

The story is told of a political lecturer who sought to convince the górale that collective farming was best. When united, he said, people could sleep longer, enjoy the benefits of modern machinery, have ready cash to spend and even a discotheque for evening entertainment. The land? It would remain forever theirs. A strapping góral got up:

"Yes, comrade lecturer, it is all good and true. I am most impressed and could really use more sleep and money. I especially like the idea of a discotheque. But that kind of landownership would be as if you had your fingers cut off and put in your pocket: You would still have them, but by God you couldn't touch anything."

Paradoxically, although salaries in Poland have improved, shortages of goods are very real. Many times we tried to buy items in Zakopane that are readily available in any Western country. "*Nie ma*—There isn't any," was the standard answer. Foreigners, it occurred to us, might be excused for thinking that Polish salespeople use "Nie ma" as a greeting for their customers. Zakopane boasts more than 300 shops, yet often we could buy no meat, no toilet paper . . . the list went on and on.

Once in a narrow lane I met a woman carrying a bloodstained backpack on her herculean shoulders.

"Meat?" she whispered, and I gasped.

"How much do you have?"

"A whole calf."

She offered to sell me some of the veal, acquired in a black-market deal.

Connections Count

Such deals are commonplace. Someone will ask, in jest, if you know what is the harshest punishment in Poland? Answer: to live two years without connections. Connections can get you a new car, food, building materials—anything that is in short supply or poorly distributed. When our rented car's battery was stolen, we learned that none had been available in stores for more than 18 months. Connections provided one—for a hundred dollars.

Puzzled, we asked a priest how he reconciled Christian teachings with such blatant disregard for the country's laws. "It troubled me for years," he replied. "Then I realized that my people were only taking what was rightfully theirs."

Poland is the world's 11th largest producer of meat. Why, then, the meat shortage? Poles, who like to rationalize, blame the situation on steep dollar debts that the country must repay, on the Soviet connection, which allegedly takes Poland's food, even on last summer's Moscow Olympics.

Poland's Mountain People

Passion for color *threads the generations. For an old friend, a tailor in Murzasichle sews traditionally designed felt pants* ***(above)****. Wool from local flocks is soaked and pounded by mallets until smooth and thick as a blanket. A finished pair of boys' trousers* ***(below)****, like those for men, blazes with embroidery. In full ensemble* ***(overleaf)*** *a boy arrives at a Kościelisko church for his first Communion; his sister gets a steadying hand from the carriage driver.*

No strangers *to Poland's empty shelves, Zakopane shoppers line up outside a meat market* (**below**). *Amid widespread strikes over scarce goods and high prices last year, the górale—as always—improvised. With antifreeze unavailable, a homemade tractor was maintained* (**above**) *by filling it with water each morning, then draining it nightly.*

But these are only their speculations.

May arrived with no end to the snow. Yet fieldwork had to begin.

In Podhale horses pull carts, carriages, sledges, harrows, and plows. Some górale also make use of homemade mechanized equipment. They build threshing machines, hay blowers, and tractors in their backyards. A typical tractor might be made from a recycled two-cylinder engine, a drive shaft from a Polish car, axles taken from a Romanian jeep, and the gearbox from an old U. S. Dodge; the cost is half that of a comparable factory-made tractor. Still, only the short blades of the horse-drawn plows can work the shallow soil, and only people can scatter the seed and pick countless stones with their bare hands.

Poland is the world's fifth largest dairy producer, and Podhale's milk is fat and sweet. Since the average farm here is only about six acres and yields meager crops, the government recommends dairy, wool, and meat production. Cash bonuses are given to owners of Polish red cows, and recently pensions have been awarded to farmers who have supplied sufficient produce to the government distributors. Two-year agricultural courses are now obligatory for children who will inherit the family farm.

Sheep used to graze in the Tatras until banned in the 1960s by national park officials. The mountain meadows had belonged to the Podhale villages as long as anybody could remember. The park's ban stirred bitter resentment.

"When these so-called mountain lovers took the *hale*—meadows—away, some older shepherds died from sorrow," my old friend Franek Szlaga told us. His bold, dark face brings to mind Wallachian shepherds who came here in olden times, following the Carpathian range. Their pastoral methods, utensils, vocabulary, and music survived centuries and shaped the life that Franek knew best. He recalled spring marches up the valleys with sheep, dogs, and music; he spoke of living in low huts, and the tang of cheese smoked over the fire. It was freedom, and he loved it.

Shepherds Enriched Village Culture

Górale believe that their independent spirit and rich culture came from meadows where shepherds fought predators and climbed over deadly precipices, but also created new songs, dance steps, sculpture—anything that could be proudly presented in the village when the sheep went home from the hale in the fall.

Now Franek, like many górale, ships his sheep by cattle trains to graze in other mountain regions. He works in Zakopane's bus depot and uses his vacations to join them. But it is not the same.

"Listen, girl: God made one man for this, another one for that, and me for the hale." The peaks over Murzasichle drew his eyes like a magnet. "The sun is dancing on Kosista. Oh my God, every little rock, every ridge and ravine I walked with these sheep."

Poles who cherish Podhale often fear that the country's economic upheaval will alter the górale and destroy their unique contribution to the nation's culture. They point to

brick houses, plastic furniture, Western clothing, and new cars. They worry about young people who seek education and jobs elsewhere and grow apart from their land and traditions.

Yet what is considered traditional today was new a hundred years ago. And the górale are standing their ground. Their roots go deep and strong. They feel that being a góral is an honor, a special gift. Why else would poet Stanisław Nedza-Kubiniec speak of his distinct mountain dialect with such pride?

And you are:
sharp—like the steel of a brigand's knife,
beautiful—like morning light at dawn,
miraculous—like a rose blooming
among locks,
sweet—like a girl by the campfire.
Hey, my dear
in love I fell with you, to death.

In June the snow started to go. One could

Poignant moments: *Last born of 11 children, Staszka Pradziad awaits her wedding* ***(above)****. After the rites she and her groom snuggle in a horse-drawn wagon* ***(right)****, rolling home for two days of feasting and merriment strenuous even by Polish standards. Along the road villagers have erected gates where the couple must leave small gifts before they may pass—an old and honored góral custom.*

almost hear the grass creak, it was growing so fast.

We hiked to Hala Gąsienicowa in the High Tatras. There, as a young climber, I used to jump a certain boulder on my way to yet another route. I believed it brought me luck. I remember now a day that men came to rebuild the path, and I pleaded with them not to throw my boulder down the cliff, for I would then certainly perish.

That evening, returning to the place, I found my stone, dedicated to me and my black hair, beside the new path. Scratched words read: The Black Lady, May 1963.

We walked up this June day. *Halny*, the warm, violent wind, was upon us. John and Tara noticed young chamois frolicking on snow patches and watched them, delighted. My boulder was there, its carved letters now obscured. I jumped over it once more. For luck, for memories, for the górale, who know life. □

The Indomitable Cockroach

By ALLEN A. BORAIKO

Photographs by BATES LITTLEHALES

BOTH NATIONAL GEOGRAPHIC STAFF

i will admit that some of the insects do not lead noble lives but is every man s hand to be against them yours for less justice and more charity —archy

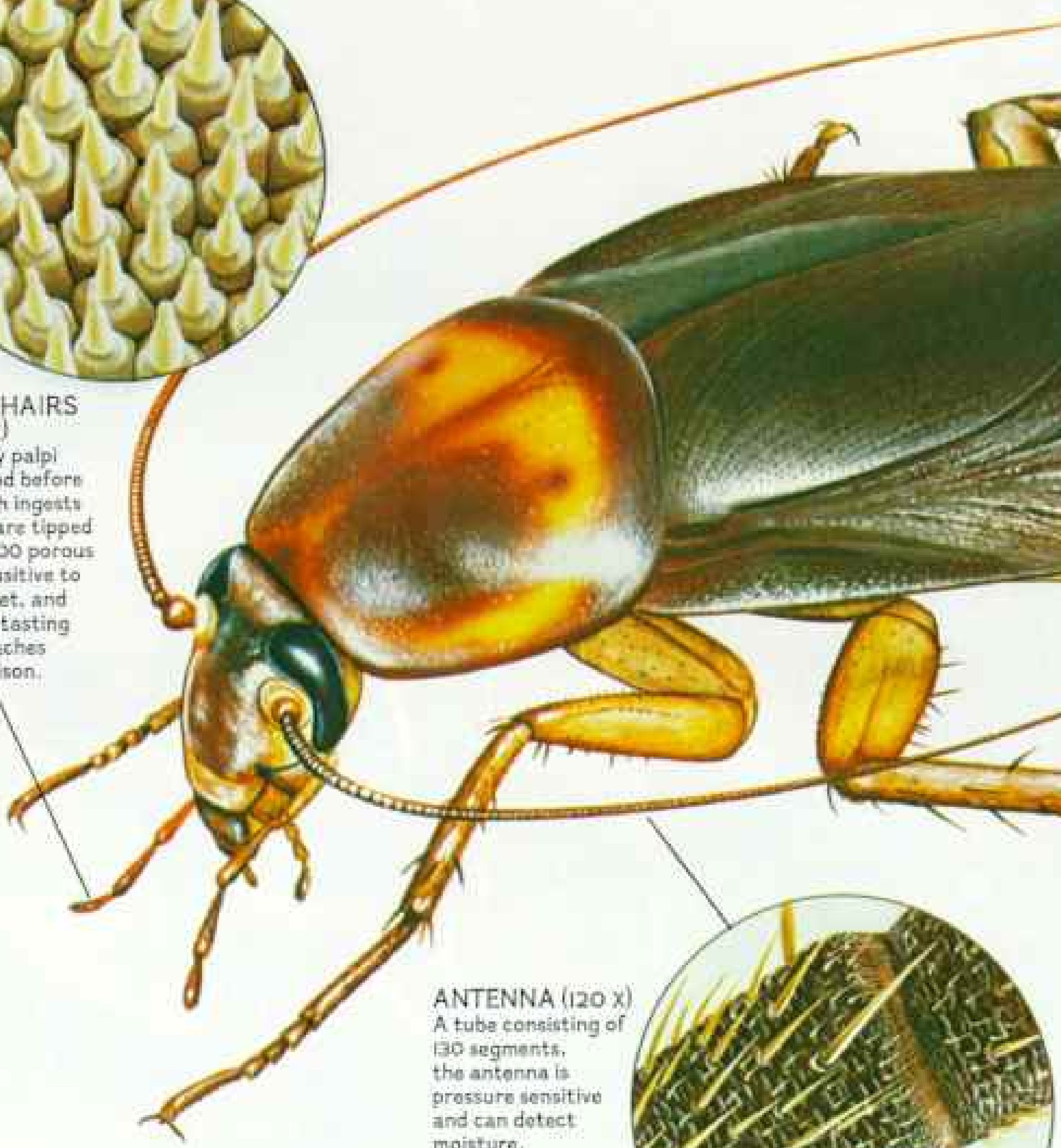
A PLEA FOR TOLERATION like no other, it came from a fictional cockroach named archy. In the 1920s archy nightly broad-jumped across the typewriter of columnist Don Marquis at the New York *Evening Sun,* chronically missing shift key and punctuation marks, and always admonishing vengeful two-legged vertebrates to keep their place. Remember, archy pointed out, cockroaches have the more ancient lineage, for "insects were insects when man was only a burbling whatisit."

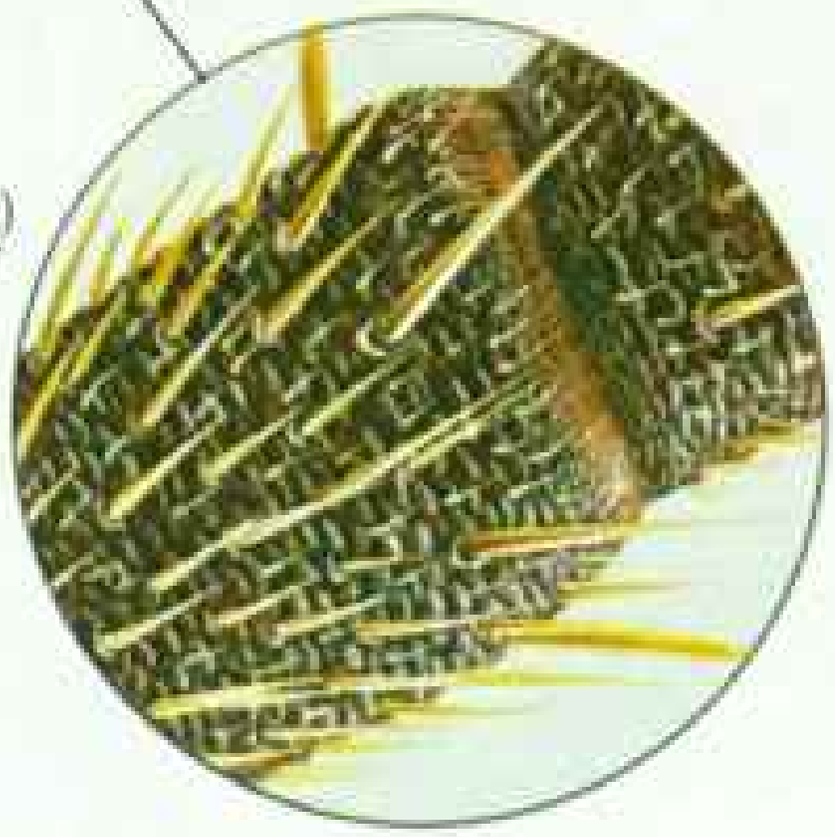
For years that most celebrated cockroach of all entertained countless readers with oft poetic whimsy. But for most of us, archy's real-life counterpart is nothing to laugh about. Hard to like, cockroaches are even harder to ignore. Although we call them water bugs, Croton bugs, palmetto bugs, and half a dozen other "we-don't-really-have-cockroaches" names, these glossy black or tan pests stubbornly remain true to themselves—and to us.

One early actor in this love-hate drama came briefly to rest at Harvard University's Museum of Comparative Zoology. There professor emeritus Dr. Frank M. Carpenter cradled a flat gray stone that escaped dynamite and

With meticulous grooming, *an American cockroach combs sensitive hairs covering its waterproof body. The emphatic "ugh" that a roach usually evokes fails to pay tribute to its elegant design and remarkable capacity for survival.*

TASTE HAIRS (1,500 X)
Maxillary palpi taste food before the roach ingests it. They are tipped with 2,000 porous pegs, sensitive to salt, sweet, and acid. Pretasting helps roaches avoid poison.





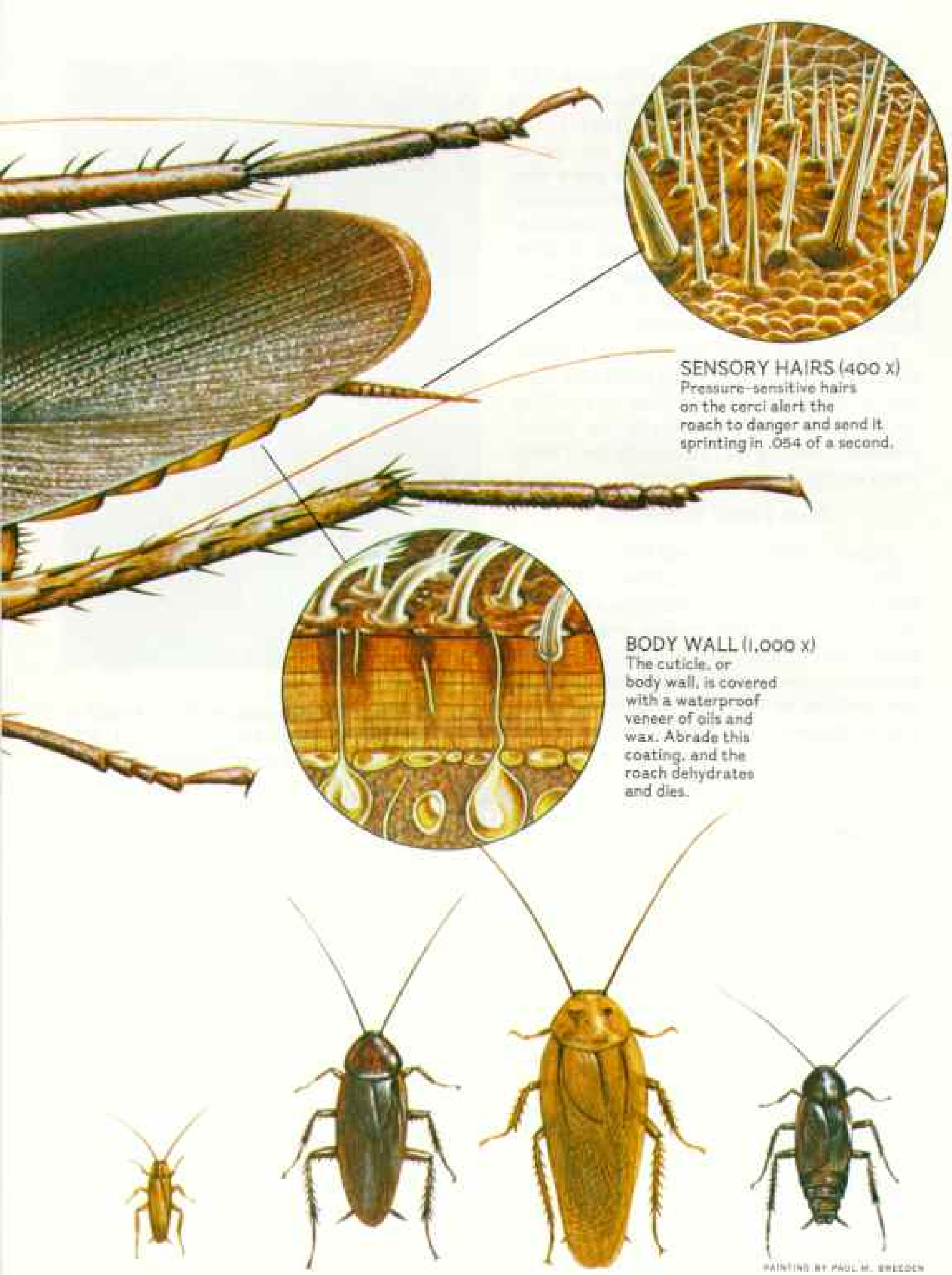
ANTENNA (120 X)
A tube consisting of 130 segments, the antenna is pressure sensitive and can detect moisture.

Design for survival

*NOTHING succeeds like a cockroach when it comes to surviving. Lacking food, a roach can subsist on glue, paper, or soap. With nothing to eat, the American roach (**above**) can draw on body stores and live as long as three months. It can last a month without water. Lightning-fast responses and receptors sensitive even to another roach's footfall enable cockroaches to thwart a human heel in hot pursuit. They can tolerate many times more radiation than man, perhaps because of their thick body walls, and one species can survive freezing for 48 hours.*

World travelers, roaches thrive everywhere but in the polar regions, having hitchhiked aboard ships, submarines, and planes. The United States harbors about 55 species, including the common pests depicted life-size at right.

But this irrepressible insect is a health menace. Roaches carry viruses and bacteria that cause such diseases as hepatitis, polio, typhoid fever, plague, and salmonella, which they may track from one place to another.



SENSORY HAIRS (400 x)
Pressure-sensitive hairs on the cerci alert the roach to danger and send it sprinting in .054 of a second.

BODY WALL (1,000 x)
The cuticle, or body wall, is covered with a waterproof veneer of oils and wax. Abrade this coating, and the roach dehydrates and dies.

PAINTING BY PAUL M. BREEDEN

GERMAN
Perhaps the most common species, *Blattella germanica* needs warmth and moisture; kitchens and bathrooms are favored environments.

SMOKY BROWN
A southern species, *Periplaneta fuliginosa* prefers the outdoors and lives in greenhouses, woodpiles, garages, and crawl spaces.

MADEIRA
Common in Florida, and now a pest in New York City, *Leucophaea maderae* is fond of fruit and plagues grocery stores.

ORIENTAL
Preferring northern climates, *Blatta orientalis* is found in cellars, behind cabinets, and in drainpipes.

power shovel in an Illinois strip mine. The stone bore the unmistakable impression of a cockroach 300 million years old (right).

"Cockroaches have survived dinosaurs, ice ages, and who knows what since they first appeared early in Upper Carboniferous times," Dr. Carpenter told me. "Astonishingly, there's almost no difference in form between ancient cockroaches and those in our homes. They're the only insects to have lasted so long with so little change."

Fingering the fossil imprint, Dr. Carpenter added, "Millions of years from now there will be creatures as roachlike as anything today. Other than destroying the planet, probably nothing we can do will have much effect on the cockroach."

Pests Travel Worldwide

An extraordinary counsel of despair? Not really; more the expression of resigned admiration. Dr. Carpenter traces cockroaches back more than 320 million years, easily among the oldest insects alive. Resilient, adaptable, they survive by being generalists—willing to scavenge almost anything, able to live and breed almost anywhere.

Cockroaches sample food before it enters their mouths and learn to shun foul-tasting poisons. Opportunists, they will dine on wallpaper or television cords, and will turn cannibal if desperate. In a pinch the American cockroach can get by for as long as three months on water alone; one month on nothing at all.

Most of the 3,500 known species flee from danger, but one rolls up into a ball when threatened, and the Florida roach sprays attackers with an irritating fluid.

Some cockroaches snorkel and prowl stream bottoms, others burrow beneath deserts, and one tiny species inhabits fungus gardens kept by tropical leaf-cutting ants. To get around, it hitchhikes on queen ants during their mating flights.

Virgin female Suriname cockroaches clone themselves, producing generation after generation of genetically identical females. Prolific to a fault, a pair of German cockroaches and their offspring could, in one year, multiply to 400,000 insects.

Mercifully, only a dozen or so cockroach species are domestic pests in the U. S., and only five are truly common. From ancestral homes in Africa and Central Asia they have fanned out over the globe in camel caravans and slave ships, airplanes and submarines. Because of these trailblazers, cockroaches abound everywhere but in polar regions:

• German cockroach (*Blattella germanica*). The species that householders most often carry home in grocery bags, small, fleet Germans need only a leaky faucet and a bowl of dog food to become an enduring kitchen embarrassment. They can squeeze into cracks a sixteenth of an inch wide and are the most cosmopolitan of all roaches.

In the archive of insects, *the cockroach is among the oldest living entries. A 300-million-year-old fossil imprint found in Illinois* ***(above)*** *shows that roaches have changed but little since their world debut more than 320 million years ago. A younger, amber-encased example, 30 million years old* ***(right)****, once crawled along the Baltic shore.*

"Insects were insects when man was only a burbling whatisit," observed archy, the typewriter-hopping roach immortalized by journalist Don Marquis. "I do not see why men should be so proud."

BOTH BY FRANK W. CARPENTER, MUSEUM OF COMPARATIVE ZOOLOGY, HARVARD UNIVERSITY

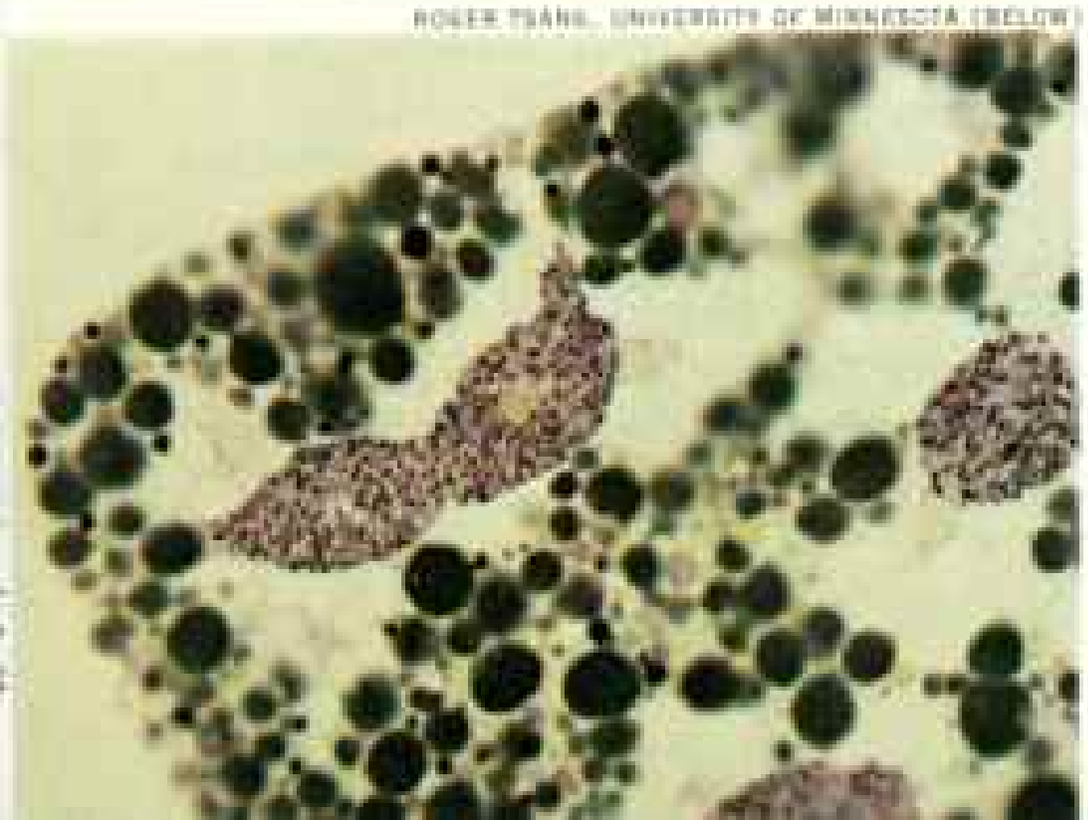
• American cockroach *(Periplaneta americana)*. The "Bombay canary" to generations of mariners, this large cockroach, one and a half inches long, has jumped ship at ports on five continents and moved inland. In 1925 Welsh coal miners discovered American cockroaches living nearly half a mile underground. More commonly, they infest restaurants, supermarkets, and bakeries.

• Smoky brown cockroach *(Periplaneta fuliginosa)*. Smaller and darker than the closely related Americans, smoky browns skitter through city dump and kitchen alike in Asia, South America, and the United States. In Houston they buzz streetlights; in Boston they girdle plants in greenhouses.

• Oriental cockroach *(Blatta orientalis)*. This hardy Russian native prefers cool basements and can winter outdoors. Despite the name, it is a greater pest in Europe than in the Orient.

• Madeira cockroach *(Leucophaea maderae)*. A newcomer to the United States by way of South America and the West Indies, the Madeira cockroach emits a noxious odor if disturbed. In recent decades this roach,

ROGER TSANG, UNIVERSITY OF MINNESOTA (BELOW)



Sounding off for science *and sex, a Madagascar roach is recorded by Dr. Margaret C. Nelson of Harvard University (**above left**). The male hisses through valves in its abdomen to court females. This species—like all roaches—also produces minute amounts of chemicals called pheromones to lure prospective mates by scent.*

*The male German roach detects the female sex lure by antenna contact. Three days after mating (**top**), the female produces an egg case (**center**) that she will carry for 20 days. To hatch, the nymphs inflate with air and split the case (**above**). Time from egg to adult: about ten weeks.*

*Collecting in specialized cells called mycetocytes (**bottom,** stained violet), bacteria passed on by the mother aid in development of the young.*

*Checkmate strategy in roach warfare produced defective eggs that will not hatch (**left center,** at right)—the result of mating a genetically altered male with a normal female.*

National Geographic, January 1981

one of our largest, has invaded New York City, possibly stowing away in the luggage of Puerto Rican immigrants.

At the University of Wyoming, entomologist Dr. Fred A. Lawson and I scrutinized one of these unshakable fellow travelers with a scanning electron microscope, an experience that would abash even the most self-confident exterminator.

"Cockroaches *are* primitive, but undeniably well engineered for what they do and where they live," said Dr. Lawson as he focused the scope. The highly magnified mandibles, or jaws, of an American roach came into view; deeply scalloped cutting blades, they overlapped like scissors. At their base they broadened into blunt nubs that grind together like a vise to crush food.

Scarcely picky eaters, cockroaches are nonetheless prepared to be finicky, explained Dr. Lawson. "A battery of sensory hairs must first accept anything a roach considers eating. That includes poison."

Beside and beneath the cockroach's mouth hang four fleshy feelers—palpi—studded with bristles. Many resemble delicately fluted spikes and pivot in ringlike sockets, depress at the least touch, and snap back. Other bristles, peg-shaped and porous, admit odor molecules on the basis of their size and shape, as a key fits a lock.

Such pressure, taste, and odor receptors give cockroaches most of the cues they need to survive. Even with eyes painted over, they function well, *if* their antennae—bearing thousands of moisture receptors, tactile bristles, and tasting and olfactory hairs—remain intact. Vibration sensors in its knee joints enable a cockroach to detect another's footfall, and humans trying to put a foot down on the cockroach problem create drafts that deflect the cerci—large segmented prongs jutting from the insect's abdomen. These flash nerve impulses directly to the legs, triggering a startle response that can get an American cockroach up and going in 54 thousandths of a second, faster than humans can blink.

Or swing a rolled-up newspaper. In a Texas hotel a German roach eluded my blows until a wild backhand decapitated the intruder. But the cockroach's fail-safe nervous circuitry converted my satisfying swat into a lesson in humility: That night the headless insect crawled from a wastebasket and into my open suitcase to deposit an egg case; by morning I was adoptive father of a dozen wraithlike cockroach nymphs.

Stalking Jungle Roaches

Many cockroach species have wings, and the fugitive impulse can inspire them to weak flight. The best, most colorful fliers glide by night in the tropics. They drew me, with Dr. Donald Cochran and Dr. Don Mullins, entomologists from Virginia Polytechnic Institute and State University, to Las Cruces, a biological research station in the sultry jungle of Costa Rica's southern border. There the sun was white, the air still, and American cockroaches had sensibly moved into the station's ailing refrigerator.

At dusk the jungle surrounding Las Cruces grew cool and expectant, and one evening we slipped into the exuberant tangle of trunks, leaves, and vines to trap cockroaches. The moon was full, but beneath the dense jungle canopy it shed no light. It would have been less intrusive than our glaring flashlights, less disorienting to the luminescent firefly beetles that flickered eerie green all around us.

More nightmarish creatures—whip scorpions, crickets with four-inch-long antennae, walkingsticks as large as dinner forks—eyed us from palms and tree ferns. A black light draped with a sheet drew scores of moths and beetles, but no cockroaches. Reluctantly, in fear of vipers, we began poking a heap of fallen palm fronds.

Commotion exploded. Dozens of cockroaches churned from the rotting leaves and swept over our feet. "That's a strike!" cheered Donald, swiping at his boots. He plucked furiously, whooped, and clapped the squirming catch into collection jars.

Don Mullins and I waded into the seething insects, lunging, snatching—swearing when some tried to sprint up our pant legs. One frenzied cockroach jetted an oily spray and wriggled through my fingers reeking of overripe bananas. Back at the station later that night, Don rattled a jar, and two beetles, a praying mantis, and a reddish brown cockroach tumbled out—all dead. Frantic to escape, the cockroach had fumigated itself and its companions.

Other nights we did better, bagging a

shimmering green banana roach and horsefly mimics: blue-bodied cockroaches with white stripes and bulbous red eyes. By expedition's end we had captured 62 species of tropical cockroaches, a respectable haul, but no threat to the world supply.

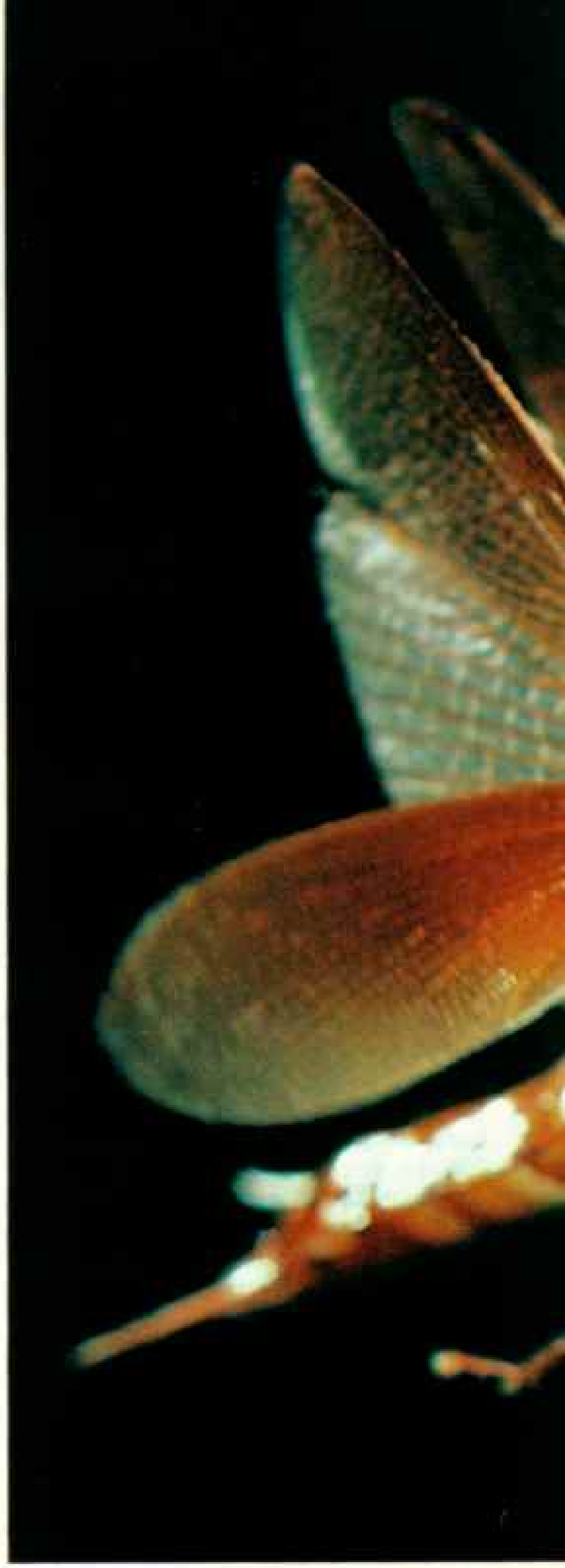
Duelers Also Hiss

"A lot of entomologists keep Madagascar roaches as pets," Dr. Margaret C. Nelson said as I stepped into her laboratory at the Harvard Medical School in Boston a few weeks later. Beats having them as enemies, I thought, as the neurobiologist handed over Atlas, a solidly built three-incher with horns. He seized my finger, waggled his abdomen, and hissed like an angry radiator.

Madagascars are named after their only home, the island off southeastern Africa. By harnessing these giant cockroaches to an oscilloscope (page 136), Dr. Nelson and graduate student Jean Fraser of Brandeis University have charted wheezes, rasps, and a come-hither hiss trilled by receptive females. To produce these outbursts, Madagascars pump their abdomens and expel air through a pair of modified breathing vents on their flanks. A good double-barreled blast can be heard 12 feet away, and hissing punctuates the duels that male Madagascars fight for territory.

"They may battle for half an hour, hissing 20 or 30 times," said Dr. Nelson as we watched two hefty Madagascars sound off and charge each other, butting heads like rams. Backing off, one insect suddenly lunged, thrusting stubby horns. His opponent sidestepped; not built for speed, he waddled—a cockroach sumo wrestler.

Stolid Madagascar roaches are more tolerable than most—unable to flit up a sleeve—and less likely to carry the universal baggage of common cockroaches: bacteria, viruses, and worms. Because the pest species are nocturnal, people seldom see them or fully realize how serious a potential health menace cockroaches are. They have been implicated as the cause of allergies and, like flies, spread disease organisms by walking or feeding on filth and depositing it at the next stop. Though not incubators of infection as are mosquitoes, they harbor bacteria causing typhoid, leprosy, plague, food poisoning, and a legion of other ills. Polio



Caught on the fly: *A thread attached by the photographer guided this American*

cockroach through a light beam that tripped the shutter. Many roaches have wings, but the muscle structure in most species limits flights to short-distance glides.

viruses shelter in cockroaches as do the eggs of parasitic worms.

Remarkably, cockroaches have never been conclusively linked to epidemics of human disease. And unsavory microbial companions aside, the insects are fussy.

They groom themselves as diligently as cats, brushing cerci with spiny hind legs, combing antennae, and rubbing against solid objects as horses rub against fence posts to scrape dust and dirt off their backs. Their fastidiousness preserves the epicuticle, a vulnerable coating of wax and oils that prevents a cockroach from drying out. Such a varnish is vital to species like the American roach, 75 percent water by weight. Abrade too much of this waterproofing, and within hours the insect withers away.

Some householders exploit this Achilles' heel by scattering diatomaceous earth—the chalky, sharp-edged shells of one-celled water plants—where roaches are most likely to pick up the abrasive dust. Powdered boric acid, the stuff of eyewash, has the same effect, and is poisonous to roaches as well. While not as potent as synthetic insecticides, these cheap dusts are longer lasting and less repellent to the cockroach, an insect that learns to shun some chemical poisons before picking up a lethal dose.

Termites are more destructive, rats more dangerous, but cockroaches are an exterminator's bread and butter, worth half a billion dollars yearly in repeat business. Egalitarians, the pests afflict rich and poor alike, and do-it-yourselfers annually strike back with another 150 million dollars' worth of dusts, sprays, and baited traps.

Caught in a chemical barrage, roaches have become resistant to many once deadly

The enduring world *of cockroaches counts such exotic citizens as Neostylopyga rhombifolia* ***(above)****, the harlequin roach, of Central America. The four-inch-long Blaberus giganteus* ***(left)*** *of Central and South America reigns as one of the largest roaches.*

poisons. Thomas Tuttle daily attacks this spontaneous genetic engineering at Racine, Wisconsin, in one of the world's largest commercial entomology laboratories.

"We screened nearly 3,000 compounds last year," Tom said, guiding me through the facility he manages for S. C. Johnson & Son, Inc., makers of Raid. Tom introduced his guinea pigs—400,000 German and American roaches luxuriating in jars provisioned with vitamin-enriched lab chow.

"We do everything but brush their teeth," he said. "Pedigree records ensure that we try different chemicals on insects of like age, a factor we can't control in field tests."

Tom favors multiple-housing complexes for the tests, where big blocks of identical units make it easy for cockroaches to seek out the good life. Though individual apartments are often spotless, Tom puts little stock in the protest "They're my neighbor's, not mine."

"People think that just because *they* won't eat dog food, roaches won't either," Tom said. "They forget that good sanitation is still the best cockroach control."

Where sanitation is poor, cockroaches may quickly get out of hand. The closed environment of ships especially intensifies infestations, and the insects are practically a naval tradition, like dress swords. Capturing a Spanish vessel in the late 16th century, English sea dog Sir Francis Drake took crew and countless cockroaches prisoner. In 1789 Captain Bligh of the H.M.S. *Bounty* ordered the hold of that unhappy ship swabbed with boiling water. Roaches were chewing up his cargo of breadfruit plants.

For modern sailors, too, ridding ships of six-legged bunkmates can be as frustrating

A firefly look-alike, *this Caloblatta tricolor* ***(above)*** *was collected in Costa Rica. The camouflaged Capucina patula nymph* ***(left)*** *lives in rotting logs. Scientists have cataloged about 3,500 roach species, but probably as many remain unidentified.*

Pest meets pest *as a mouse dines on a roach. Though small rodents and birds prey on roaches, man remains their biggest—and most exasperated—foe.*

as Captain Ahab's quest for the great White Whale. In 1978 the U. S. Navy alone sprayed its fleets with almost 10,000 gallons of pesticides. Seeking to cut chemical use and improve pest control, Navy entomologists more recently released 300 sterile male German roaches aboard a ship of the Atlantic Fleet. Chromosome mutations in such genetically altered males can prevent full development of most of the embryos in the female's pod-shaped egg case, and even the remaining mature embryos eventually die: Cockroach nymphs hatch only through a team effort, by inflating themselves with air and splitting open the egg case. Such genetic birth control works in the lab, but after a three-month shipboard test the Navy conceded the cockroach another victory at sea.

At the University of California in Riverside, I saw Dr. Michael Rust demonstrate electronic gadgets that impress neither roaches nor the Environmental Protection Agency, which regulates use of pesticides.

"EPA wants to ban these devices and asked us to test them," the entomologist said as he plugged in a blue metal box intended to drive away cockroaches by upsetting local magnetic fields. A blinking red light and a sonorous hum showed it was "working."

"We set it beside six large jars holding 20 cockroaches apiece," Mike recollected, "and let it run night and day. In half a year we had 5,000 insects."

Cockroaches may ignore electronics, but they find each other's pheromones—aromatic chemical lures—irresistible. Cockroach researcher Dr. Louis M. Roth stumbled on their weakness in 1952, discovering the sex pheromone of the female American roach. In 1966, working with another species, he isolated and named the male's sex excitant—"seducin."

The female version was especially potent, recalls Dr. Roth, now retired: "The scent from females 40 feet upwind drove males wild. They even tried to mate with water vials taken from cages of virgin females." He sacrificed 100,000 females to produce a few billionths of a gram of the compound.

In 1979 scientists at Columbia University synthesized the powerful attractant of the American roach; in 1975 chemists in Japan and at the University of Kansas manufactured the sex appeal of a female German cockroach. Hope glimmers that a smoke screen of artificial pheromone might divert males from seductive partners. But alas, German cockroaches must touch to exchange sex scents, and some lures only excite—not attract—males.

Cockroaches Won't Give Up

"Our struggle against cockroaches is not hopeless," consoles Tom Tuttle of S. C. Johnson. "We're holding our own, but not much more; they just seem to love to live with us. Everything has a purpose, but I really don't know *what* cockroaches have to offer—except a pain in the neck."

Meanwhile the man-versus-cockroach conflict continues, and we humans might well wonder if there wasn't a note of smugness in archy's remark:

there is always some
little thing that is too
big for us

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Optional 3.8 Liter Turbo V6	27	19

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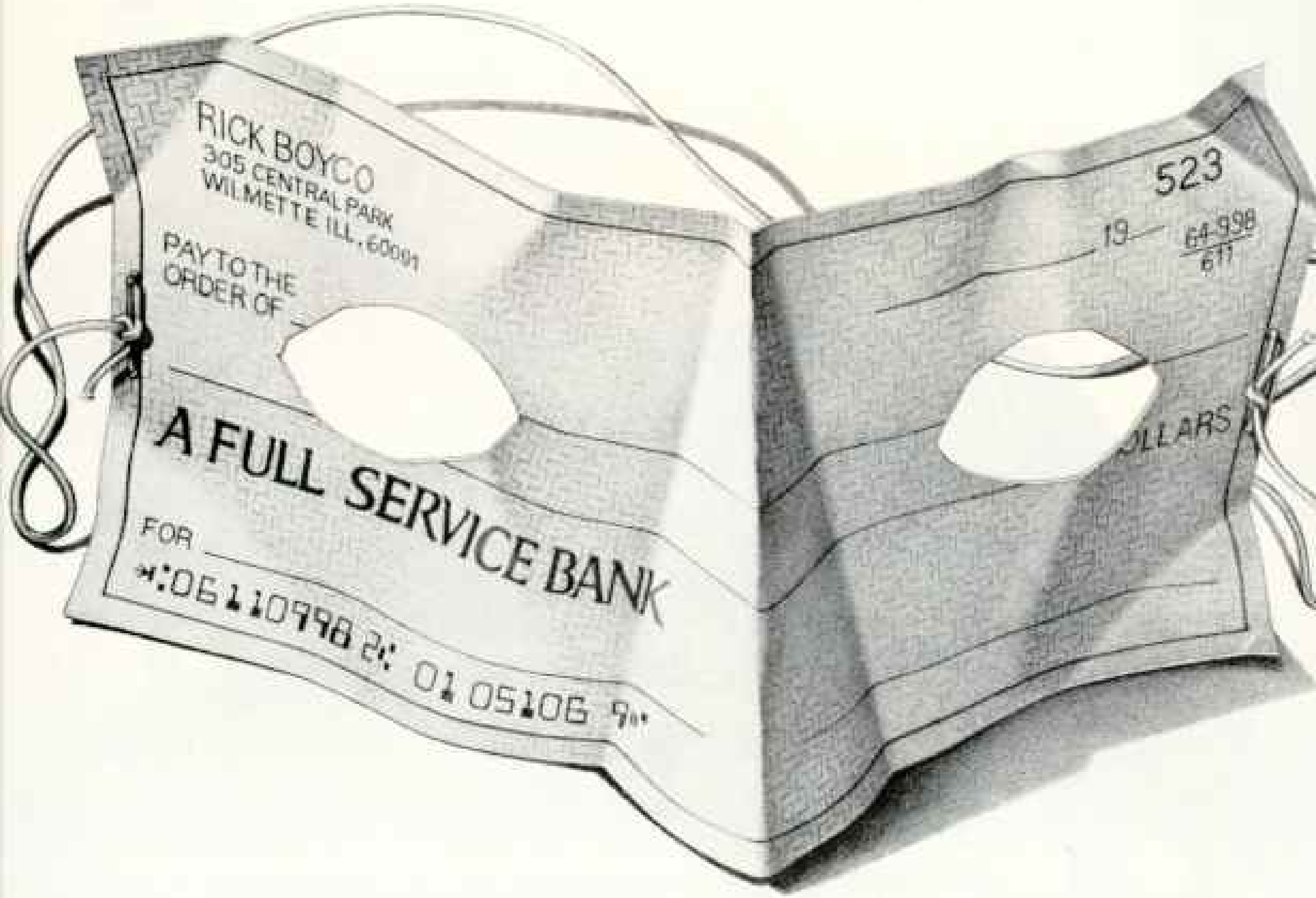
Buy or lease the 1981 Monte Carlo from your Chevrolet dealer. And let it gladden your heart, while its Chevrolet price eases your mind.

**Remember: Compare the "estimated MPG" to the "estimated MPG" of other cars. You may get different mileage, depending on how fast you drive, weather conditions, and trip length. Actual highway mileage will probably be less than the estimated highway fuel economy. Estimates differ in Calif. Chevrolets are equipped with GM-built engines produced by various divisions. See your dealer for details.*

1981 Monte Carlo.

A matter of personal pride.

Chevrolet



It's a savings account in disguise.

It looks like a checking account. It acts like a checking account. It does everything a checking account can do, exactly like a checking account does it.

But underneath it all, there's an unbelievable difference.

It's a NOW account, so it earns interest like a savings account. It actually lets you make money on the money you could never get a dime for before.

Of course, that's not as easy as falling off a log. There's a lot of figuring involved. Because just how much you get, or don't get, involves a few fairly complicated things. Things like the number of transactions, the minimum balance, even the average balance.

So it makes a whole lot of sense to sit down first with the folks at A Full Service Bank.® They invented modern checking and there's nobody, but nobody, with more professional experience at uncomplicating things.

Behind every success, there's good advice.

Look for this symbol.
We've got the answers.

ROWE FINDLEY (ABOVE); JAMES A. SUGAR

Vigil at the volcano

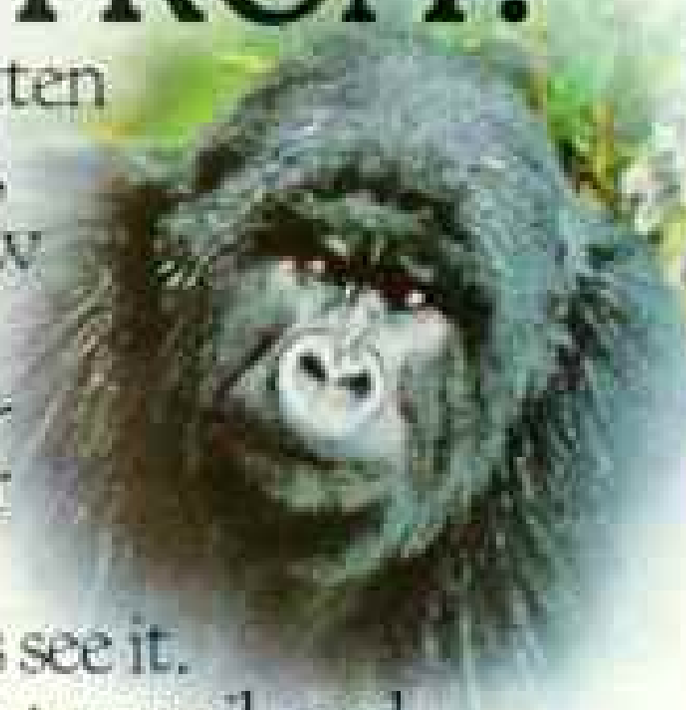
DROPPING ONTO the fuming crest of Mount St. Helens just a week before the volcano blew itself apart in May, photographer David F. Cupp (**above**, at left) records an ash-collecting mission inside the crater rim.

At Toutle Lake School, 25 miles west of the Cascade volcano, Assistant Editor Rowe Findley (**left**, at right) greets lodge owner Harry R. Truman and hears him declare that he will never abandon his beloved lodge near the mountain. The conviction later cost Harry his life.

Share such in-person reporting. Nominate a friend for membership below.

WHERE IS THIS YEAR'S EXCITING TELEVISION COMING FROM?

Filmmakers, once again underwritten by a grant from Gulf Oil Corporation, have been around the world. And now they're back with four new National Geographic Specials. Four more extraordinary examples of the most popular series in Public Television history.



This season, discover Africa the way the animals see it. The timeless treasures of Japan, our National Parks in turmoil, and the fragile world of gorillas. Gulf support of this American-made, award-winning television series began in 1975. Check your local listings and watch the discoveries continue.

Gulf

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It's a perfect night for sparkin' on the front swing.
For love that's still young.
Still full of Snap! Crackle! Pop!®

It's gonna be a great day.™ Kellogg's®

INTRODUCING DODGE MINI RAM. MORE MILEAGE, RANGE AND ROOM THAN VW VANAGON FOR THOUSANDS LESS.

Who moves more people than VW for less money? It's Ram Tough Dodge's new Mini Ram Wagon.

Compare Dodge Mini Ram 250 to VW Vanagon — passenger seating, mileage, fuel capacity and range, horsepower and rear loading area. Mini Ram gives you more.

Then compare factory-installed options like power steering and your choice of 6 sound systems: all available in Mini Ram. Not in Vanagon.

Now compare price. Mini Ram costs less than Vanagon. *More than $2,000 less*, comparably equipped. For panel-side van buyers, there's a Dodge Van with the same performance, efficiency and interior dimensions as Mini Ram Wagon at a price VW hasn't seen in years: just $6418.*

Underneath it all, Mini Ram is a Ram Tough Dodge Wagon. With the best rust protection of all wagons. There's 100% electrocoating, plus 370 sq. ft. of galvanized steel in critical areas... compared to VW's 4.

New Dodge Mini Ram Wagon. It does more than VW Vanagon and it does it for less. As a pure people mover, it just might be the best buy on the road today.

Here's how Mini Ram beats Vanagon

	Dodge Mini Ram Wagon 250	VW Vanagon
Sticker Price (MSRP at Dealer)	**$8,137.00***	**$10,690.00***
EPA EST. MPG	18 MPG**	17 MPG**
Horsepower	115	97
Passenger Seating	8	7
Overall Length	179.9"	179.9"
Wheelbase	109.6"	95.8"
Fuel Capacity	36 gal.	15.9 gal.
Est. City Range	648 miles**	270 miles**
Side Door Width	49"	42"
Removable Rear Seat	Yes	No
Factory Installed Air Conditioning	Optional	Not Available
Power Steering	Optional	Not Available
Color Keyed Carpeting	Standard	83% with tint glass

Satisfaction guaranteed or your money back. *If you're not satisfied with your new 1981 Dodge Mini Ram, just bring it back in 30 days or 2,000 miles, whichever comes first. When the dealer gets clear title, you'll get your money back, excluding license and insurance charges. Trade-in refund may differ from trade-in allowance on retail sales contract. Ask participating dealers for details.*

DODGE TRUCKS ARE RAM TOUGH

*Sticker price comparison excluding title, taxes and destination charges. Prices as of Oct. 15, 1980.

**Dodge Mini Ram with standard Slant Six engine. Use these numbers for comparison. Your mileage and range may differ. Call for lower Vanagon EPA mpg or 1981 est. pending EPA figures.