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NATIONAL GEOGRAPHIC

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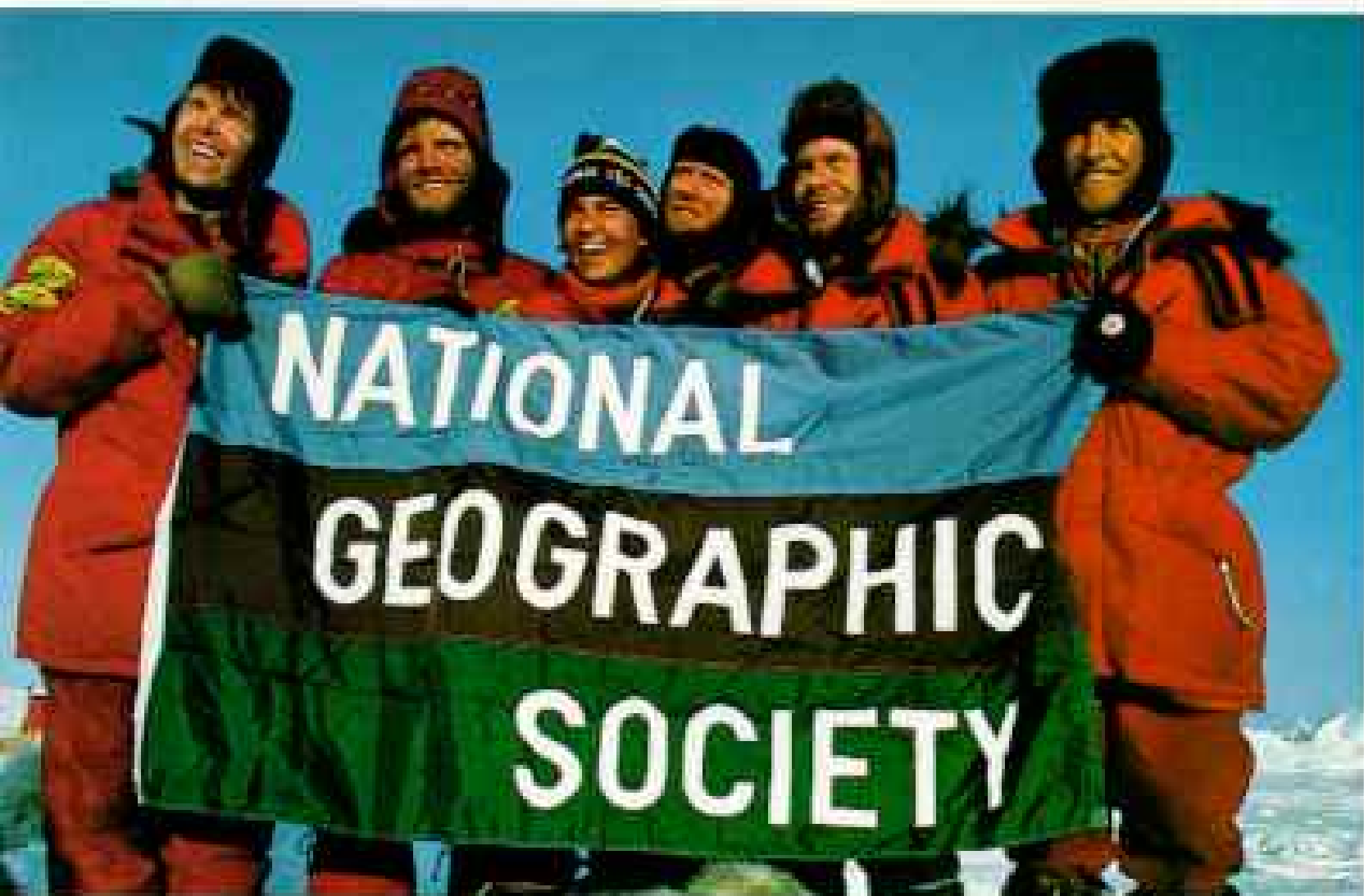
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NATIONAL GEOGRAPHIC

September 1986

IN THIS ERA of international travel, it's not uncommon to meet a friend in a remote part of the world, but this April there was a very uncommon encounter. Quite by chance, Dr. Jean-Louis Etienne, skiing alone to the North Pole, encountered the Will Steger team on the trackless, shifting ice of the Arctic Ocean—also headed for the Pole.

If there was ever a year for this to happen, it



AT THE NORTH POLE. (ABOVE, LEFT TO RIGHT): WILL STEGER, PAUL SCHURKE, ANN BANCROFT, BRENT BODDY, GEOFF CARROLL, RICHARD WEBER; (BELOW): JEAN-LOUIS ETIENNE

was 1986. Six other parties announced plans to get to the Pole but failed. Another group did get there. Three U. S. Navy submarines surfaced at the Pole on May 6—just five days after the Steger party arrived. They were testing equipment and signaling U. S. presence in Arctic waters. The Steger group and Etienne were testing themselves.

Thousands of passengers now cross over the Pole every month on airliners, and untold numbers of Soviet and American sailors pass under the ice every year. But to reach the Pole on your own is still the terrible test of human will, intelligence, and physical condition that it was when Peary, Cook, Nansen, Amundsen, and others were vying to be the first to reach it.

We're proud that both parties carried the Geographic flag, as others have done before. And our special congratulations go to Ann Bancroft, the first woman ever to walk to the North Pole.

Wilbur E. Garrett

EDITOR



BY JIM BRANDENBURG (TOP); MICHEL FRANCO (ABOVE)

North to the Pole 289

Five men and a woman reach the top of the earth in the first successful dogsled expedition without resupply since Peary's in 1909. Co-leader Will Steger tells of their trek, with photographs by the author and Jim Brandenburg.

Skiing Alone to the Pole 318

French doctor Jean-Louis Etienne makes a solo dash across the Arctic ice.

The Intimate Sense of Smell 324

More than our eyes or ears, our nose stirs our deepest memories, reports Boyd Gibbons. Photographs by Louie Psihoyos. Participate in a special Smell Survey to help scientists learn more about this mysterious sense.

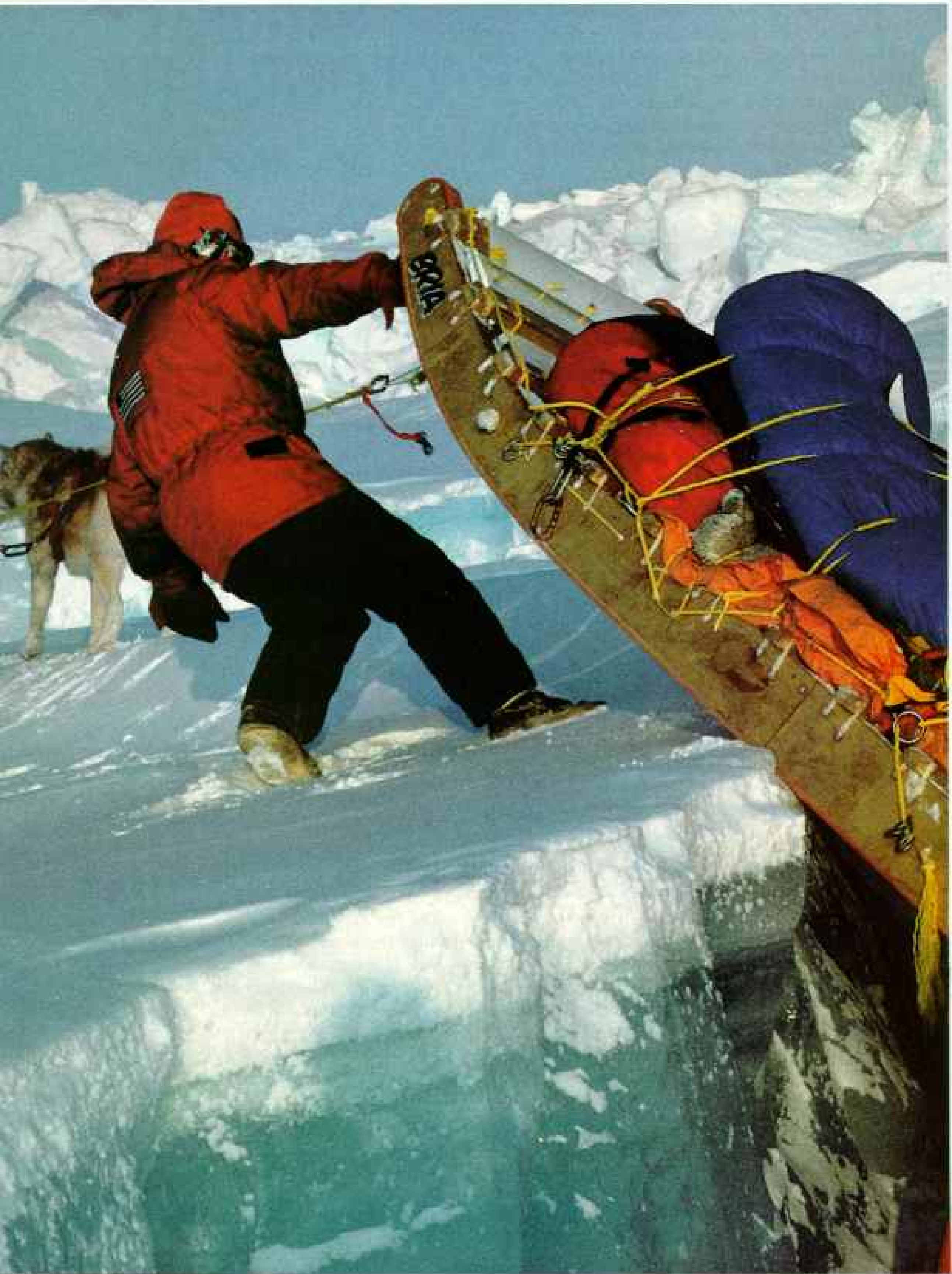
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The few survivors of a community that totaled three and a half million before World War II tell their stories to Polish journalist Małgorzata Niezabitowska and her husband, photographer Tomasz Tomaszewski.

Meteorites—Invaders From Space 390

Most shooting stars of the night sky burn up before impact, but a few strike earth with cataclysmic results. Kenneth F. Weaver and Jonathan Blair document what can happen.

COVER: Ice encrusts dogsled explorer Brent Boddy on his way to the North Pole. Photograph by Jim Brandenburg.





North to the Pole

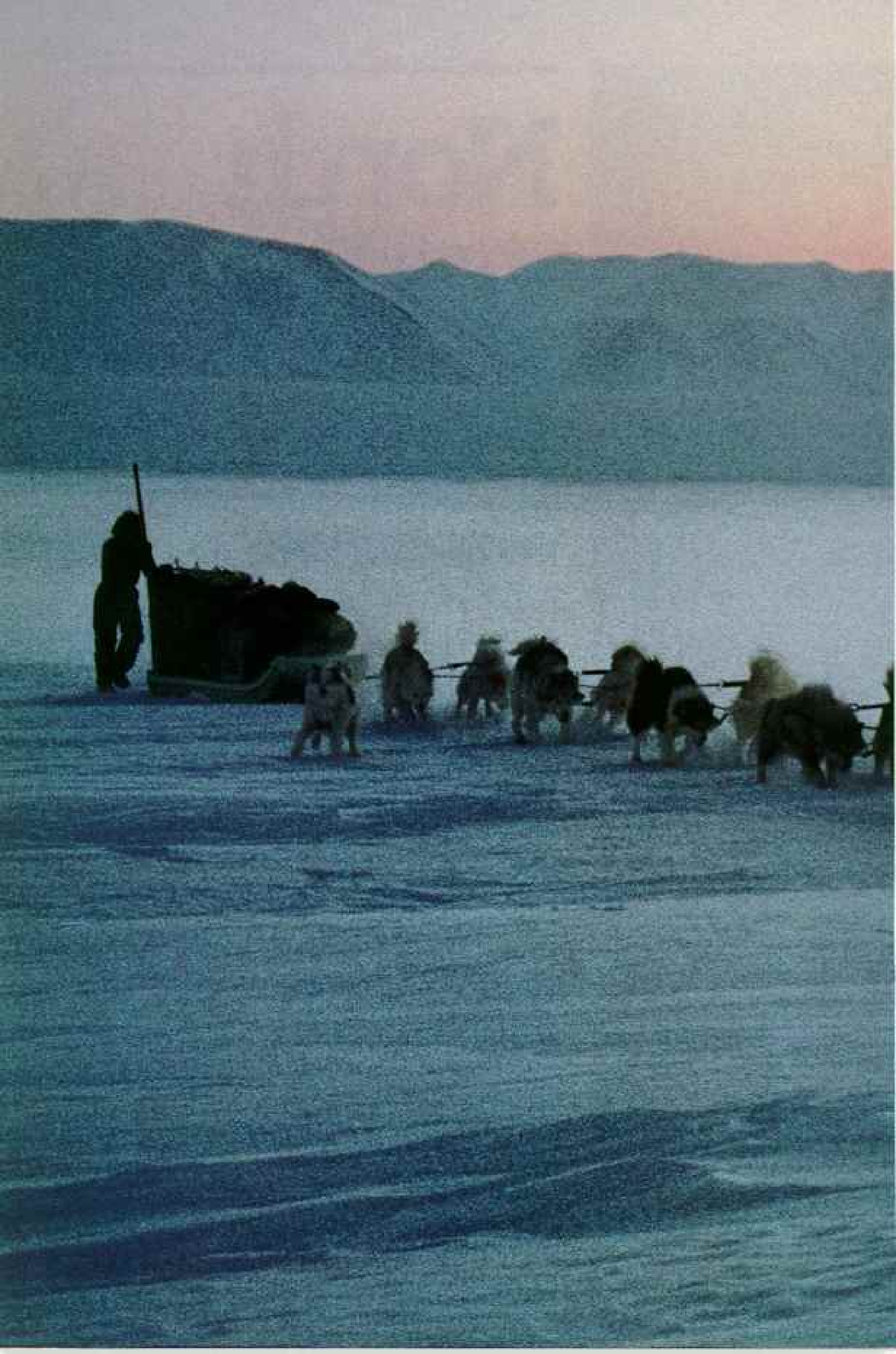
Five men and a woman
make Arctic history

Caught in the massive grip of Arctic ice, members of the Steger International Polar Expedition strain to haul a dogsled over a fissure, part of their unending struggle with the frozen Arctic Ocean to reach the top of the world. By this date, April 20, 1986, their 44th day on the ice, they have covered 300 miles from their jumping-off point on Ellesmere Island in Canada's high Arctic. Expedition co-leader Paul Schurke (right) uses a sextant to check progress. Eleven days later they reached their goal. Not since Robert E. Peary in 1909 had a party attained the North Pole by dogsled without resupply.



By WILL STEGER

Photographs by the author
and JIM BRANDENBURG







WILL STEGER (OVERLEAF AND ABOVE)

◀ *Off and running at minus 68°F, the expedition departs from northern Ellesmere Island on March 8 (overleaf). Beyond one of the five sleds looms a ghostly vapor trail created in the turbulent wake of the dogs' perspiration and breath, trapped by an inversion between cold air from the mountains and the even colder ground.*

Improvising a ferry, the team uses a small ice floe to cross a lead of open water (above) north of latitude 87° amid warming weather. Peary sometimes crossed leads by using the same technique (right). He dreaded such sudden breaks as a "nightmare. . . the unknown quantity of the polar equation."



THE PEARY COLLECTION (BELOW) © NATIONAL GEOGRAPHIC SOCIETY



AS PAUL said later, it was like an earthquake at sea. With the sound of a mighty rushing wind, the ice around us suddenly began to heave and buckle under titanic force. Sections of ice the size of city blocks smashed and ground together, forming pressure ridges like giant hedgerows over the Arctic Ocean's frozen surface.

Somehow our team—seven men, one woman, five sleds, and 49 dogs—dodged and scrambled through the maelstrom until it gradually subsided. In the silence that followed, our woman team member, Ann Bancroft, remarked grimly: "I'd say that ocean was very much alive."

The date was March 16, 1986, our ninth day on the ice. We were bound from Canada's Ellesmere Island for the North Pole, a straight-line distance of 478 miles (map, facing page). In those nine days we had chopped, scraped, and hauled our way 20 miles into the ice, to a point known as the ice-shear zone. Here a stretch of relatively stable coastbound ice meets ice constantly driven by powerful forces of wind and current. The result is an area often beset by open leads, some of them mile-wide gaps of fog-shrouded black ocean. In 1906 one such lead barred the way of explorer Robert E. Peary for several critical days, a major factor in turning him back and delaying his attainment of the Pole for another three years.

After first threatening us, the shear zone actually helped us on our way. The morning after the icequake the area directly ahead proved to be a recently frozen lead, a strip of smooth glare ice running due north as far as the eye could see. "Look at that gorgeous skating rink!" exclaimed Brent Boddy (cover photograph). "At this rate we'll be at the Pole in a week."

Of course Brent knew better, as did the rest of us. After 12 miles the lead petered out, and it was back to chopping and hauling our way painfully through the jumbled ice. Using lumberjack peaveys as levers, we pried the sleds forward foot by foot, urging the dogs—"Hut! Hut!" Pry, push, grunt, curse, and repeat the cycle hundreds of times a day. It was hard going, but none of us expected less; together we combined more than half a century of Arctic experience.

At 41 I was the senior member and co-leader of the expedition. For more than half my life I have taught winter camping skills in my native Minnesota and have logged more than 20,000 miles of travel in the far north, mostly with dog teams I have raised and trained myself.

My partner, Paul Schurke, a 30-year-old wilderness instructor, was my co-leader and joint organizer of the expedition, the planning of which had occupied us for three years. Paul and I direct the Lynx Track Winter Skills School at Ely, Minnesota.

No expedition is stronger than its individual members, and Paul and I had chosen the very best: Brent Boddy, 31, a veteran dog driver and trail outfitter from Canada's Arctic settlement of Frobisher Bay; Canadian cross-country skiing medalist Richard Weber, 26; Alaskan dog driver and carpenter Bob Mantell, 31; and Arctic wildlife specialist Geoff Carroll, 35, also from Alaska. The two remaining members were our lone woman, Ann Bancroft, 30, a schoolteacher and crack mountaineer from Minnesota, and Bob McKerrow, 37, an Antarctic expert from New Zealand.

Despite our training and experience, that first week on the ice was a painful introduction to polar travel. Temperatures of minus 70°F present a constant danger of frostbite, and the slightest wind can cause eyelids to freeze shut. One quickly learns that no part of the body functions separately from the rest. Wearing a face mask, for example, conserves overall body heat and thus protects the hands for longer periods of exposure. At such temperatures pain accompanies nearly every task, and the tendency is always toward haste. To understand patience, one must lash sleds at 70 below.

In order to reach the Pole without resupply en route, we had to load each of our five wooden sleds at the start with 1,350 pounds of food and equipment. Clearly such loads could not be manhandled over the ice, and for the first three weeks we relayed back and forth with partial loads.

As a result we traveled three miles for every mile gained. Bob McKerrow calculated that our trail through the ice combined a

total of 636 mukluk and paw prints for each step forward.

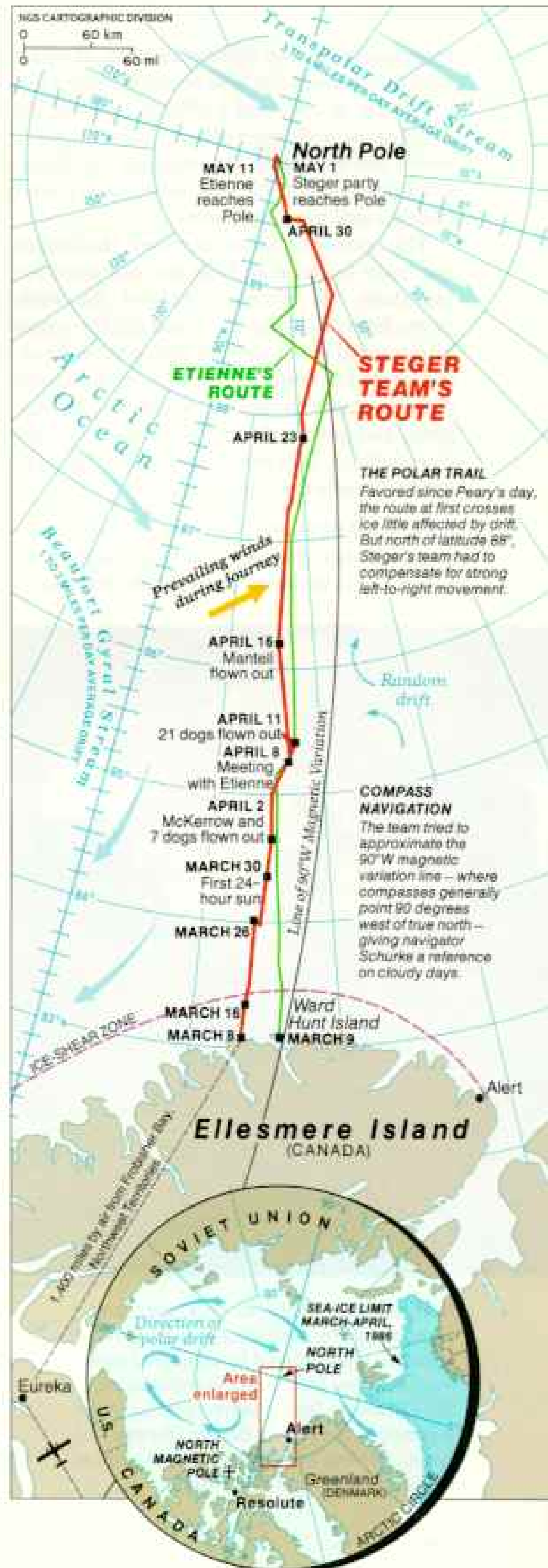
Each day our eight team members and 49 sled dogs consumed 126 pounds of fuel and food. The former consisted of white gas for our stoves, the latter included high-energy nut bars, cheese, butter, oatmeal, noodles, and that staple of polar travelers, pemmican—a mixture of dried beef and lard.

For variety each member of the team was allowed to bring a small amount of a favorite treat. I chose frozen lemon juice for a



WILL STEGER

"We were exhausted every day," says Schurke (above), co-leader with Will Steger of the team. After three years of planning, the explorers set out during the "window" between March, when the sun first shines within the Arctic Circle, and May, when a perilous thaw begins. They munched a thousand punishing miles—about double the straight-line distance—succeeding after nearly two months. On April 8 they encountered French explorer Jean-Louis Etienne (map, route shown in green) on his solo journey (page 318).



morning drink and dried seal meat. It was a mistake. Late in the trek my sweet tooth got the better of me, and I offered to swap for some of the delicacies others had brought—Ann's brown sugar, for example, or Richard's hard candy. No one seemed interested in dried seal meat, however.

The farther north we traveled, the lighter our loads became and the less our need for big sleds. We simply trimmed the sleds down bit by bit (page 308) and fed the wood into a small stove we had brought for heating. It was so cold that those of us who kept daily journals would warm our notebooks, pens, and pencils directly over the stove before making an entry. Soon after the icequake I made the following one:

DAY 11 (MARCH 18)—*The Arctic has an uncanny way of teaching you, forcing you, to live in the moment. Early in the trip our*



BOB BY JIM BRANDENBURG

Arriving first-class, 49 dogs, gear, and team members, including Bob McKerrow (above), were relayed by chartered aircraft from Eureka, Northwest Territories, to the Ellesmere Island starting point. After unloading, the planes depart (facing page), leaving the explorers on their own in dim twilight and bitter cold.

moods swung wildly with each change in conditions. For hours we'd fight our way through a hellish chaos of huge rubble, suddenly breaking free onto a path that seemed endless. Despair would flash to exhilaration. "Finally the worst is behind us," we'd gasp. An hour or two later we'd strike another maze. . . . Another slump. Another heavy dose of doubt about our prospects. . . . We found ourselves expending as much precious energy fighting doubt as we did fighting pressure ridges. But now in the second week we've learned to stop groping for some elusive highway of smooth travel to the Pole and settle in for the long, hard grind northward.

One of my chief concerns was what drivers know as dog burnout. If we taxed our five teams too heavily, exhausting their strength and spirit, we would have to lay over one or more days to allow the dogs to recharge. With limited food and fuel, the one thing we could not afford was extra days.

Each time we cut off a section of one of the sleds, it was a special occasion. On these "party days," as we called them, we would bask in the added heat of our wood stove, the pungent aroma of smoke recalling autumn days at home. At such times we were grateful for small comforts, and though we could never dry our perspiration-soaked clothes completely, we drove out enough moisture to boost our morale.

Our confidence grew in direct proportion to the miles, and we became a team of instinctive problem solvers. When the abrasive "corn" snow and rubble ice wore holes in our moose-hide mukluks, we cut patches from our sled covers and stitched them in place with dental floss.

One thing we could not do: Walk on water. Open leads appeared, and when they crossed our path, they were an obstacle to reckon with. The boats we had brought for such occasions had broken in the extreme cold, but the same cold proved our ally, freezing the leads sufficiently in a matter of hours for us to cross over with the sleds.

Unlike freshwater ice, which is rigid, sea

A book by Will Steger and Paul Schurke on the North Pole expedition will be published next spring by Random House.

ice takes the form of a resilient, rubbery skin that will support a loaded sled on a thickness of as little as two or three inches. Crossing a newly frozen lead is like traveling over a huge water bed, with the ice directly underneath sagging but not breaking and occasionally setting up wave patterns across the surrounding surface.

During the last few weeks of our trek, when the temperature reached a relatively balmy minus 20°F, the leads often failed to freeze over, and we spent long hours making detours in search of ice bridges.

On normal days we followed a routine of ten to twelve hours of battling the ice and the remainder making camp, feeding the dogs, having dinner, sleeping, breakfasting, breaking camp,

getting under way again. We were four to a tent—close quarters, as my journal reveals:

DAY 20 (MARCH 27)—Inside . . . steaming teacups balanced precariously on the rim of the stove box. A two-gallon pot of melting snow teeters on the tiny white gas stove. Any quick clumsy move would spell disaster. Steam billows from the warm gray slurry of pulverized meat and fat mixed with the morning's leftover oatmeal—our pemmican supper—as we dish out our portions. . . .

We talk little—the roar of the [stove] gas jets makes conversation difficult. What a confined world this is! Bob's knee is touching my left elbow, Richard is blocked from view by hanging mittens and boot liners, Geoff huddles in the corner. . . . Tight spaces; some men sew, some write, some drink tea and wonder.

Such intimacy was hardest on Ann,





The horizon vanishes in a whiteout caused by a low overcast, so tents go up and dogs bed down (above). Both fast Arctic huskies, trained by Steger and Bob Mantell, and Canadian Eskimo dogs, valued for their endurance, were used to haul gear.

Steger says, "It was like an ice cave in the tents," where Richard Weber thaws a meal of noodles and pemmican, or dried meat mixed with fat (left). The fat-laden 7,000-calorie daily diet provided slow-release energy. The team wore specially designed polar suits insulated with newly developed man-made fibers. They also slept in them, to cut down sleeping bag weight and as a survival aid in case a lead suddenly opened under a tent.



EDWARD WEER (CHILD), WILF STEGER

While several men favored beards, style had nothing to do with Steger's clean-shaven look (right)—he wanted to keep his whiskers from freezing to his face mask. The cold was murder on batteries for equipment. Dog tired and worried about oversleeping, the explorers kept travel alarm clocks warm by wearing them under their hats at night.

Strict ground rules governed contact with the outside world. By radio and satellite signals they apprised supporters of their situation and position but received no information in return. Aircraft picked up two injured members, as well as surplus dogs and equipment, but delivered nothing.

North to the Pole



though she never complained. I later found that she had made a similar journal entry:

Now it's really claustrophobic! Tough to move the arms. Mittens inside my polar suit to dry, I now must look like a mummy. Certainly feel like one.

By the end of the third week we were about 80 miles from Ellesmere Island, with some 400 to go. The vital question of where we were from day to day fell on Paul Schurke, our expedition navigator. In line with our rule of no outside navigational aid, Paul relied on sextant and chronometer to plot our position at regular intervals.

Though we carried a small transmitter whose signal could be picked up and pinpointed by polar-orbiting satellites, we were never told of the results. Our occasional

radio contact with colleague Jim Gasperini at base camp in Resolute far to the south was strictly one way: We would tell Jim how we were doing, and he would relay the news to friends and family, but in return we received neither position fixes, weather forecasts, sea-ice reports, nor anything else that would benefit our progress.

In short, we were determined to reach the Pole by manual navigation alone and by the power and perseverance of ourselves and our sled dogs.

The dogs were an exception to our rule against outside aid. As we moved northward and our loads lightened, we would cut back a sled and eventually eliminate it, and thus there was no need for the dogs that pulled it. In the early days of polar exploration excess dogs were usually killed and fed to the other dogs, or even eaten by the explorers themselves.

Such treatment was out of the question for our dogs, and we had planned two airlifts along our route by ski plane to remove animals we no longer needed. The first airlift took place on Day 26 (April 2), when we were roughly a hundred miles out from Ellesmere Island.

To our sorrow the same flight evacuated Bob McKerrow, who could no longer continue. Sixteen days earlier, while Bob was crossing a pressure ridge, his sled had suddenly careered into him, injuring several ribs. We all hoped Bob would mend, but the pain worsened day by day, and he began spitting up phlegm in a way that suggested internal injuries.

The night before the airlift was scheduled, Bob sat up for hours, wrestling with a decision that only he could make. By morning he had made it. "For years," he told us, "I've wanted to be the first New Zealander at the Pole. But I've got a wonderful family back home to think of. I know I'll still feel fulfilled if I leave you now, and I may be a lot healthier for it in the long run."

It was a tearful good-bye all around as Bob boarded the plane with seven weary dogs. There was a quick thumbs-up from him through the window and then he was gone.



BOTH BY WILL STEWART

Shredded by rough ice, Geoff Carroll's moose-hide mukluks (above), like nearly everyone's, were patched with heavy nylon sewn on with dental floss. Her wind pants frozen solid, Ann Bancroft (facing page) races to change clothes after plunging waist deep through the ice. In two days she felt warm again.





There were good days, and days like this—sheer torture, as Mantell's sled inches over pressure ridges and rubble ice created by grinding floes. Thus they



WILL STEUER

battled the first 100 miles, hauling lightened sleds through obstacles, off-loading, backtracking for the remaining gear, and fighting the same ice to move forward.



During our first three weeks on the ice, the total minutes of daily sunlight grew rapidly. Three days before Bob's departure, Richard Weber and I shared a memorable experience, and I later recorded it:

DAY 23 (MARCH 30)—*While Richard and I returned from . . . relaying a load forward to our camp, we witnessed an amazing phenomenon. For three hours, between 10:30 p.m. and 1:30 a.m., the sun's orb, half under the horizon, half above, rode across the northern rim of the pack ice. As we walked, we wondered when the sun would set. It never did. This marked the beginning of five and a half months of continuous sunlight at this latitude, which we estimate to be 84° 30'.*

It was a moving sight, one we shared with great Arctic explorers of the past such as Nansen and Peary, as well as more recent ones like my friend, the late Naomi Uemura. They had made great sacrifices and had been drawn forever north by the polar spirit, which I noted was now urging us on:

It was this spirit that revived my tired body on the long northern trip back to camp, gave me energy and freshness that not only enabled me to walk effortlessly, but also to see my surroundings on the polar sea with new clarity. . . . My dogs pulled the load on into the 13th hour, crossing ridge after ridge. As we crested each, my eyes caught the sun—half under in winter, half above in summer. I knew then that we had crossed the barrier of hardship that tried to prevent us from reaching this point of harmony between day and night, cold and warmth.

If we had crossed a major barrier, there were others ahead, most of them all too familiar. The severe cold remained, occasionally accompanied by storms, the leads and pressure ridges continued to plague us, and at times our progress was agonizingly slow.

In addition to Paul's chronometer and sextant we had two natural aids to navigation. If we set our watches at the local time of the meridian we were following, then our shadows would point directly north at noon and due south at midnight. The second aid was provided by the winds, which blew



RICHARD WEBER (ABOVE); JIM BRANDENBURG



Trail's end came early when an aircraft picked up Bob Mantell, swabbing frostbitten feet (facing page); severe cold had penetrated his sealskin mukluks. Mantell and Steger, who earlier shared a 7,500-mile far northern trek, embrace in an emotional farewell (above). Bob McKerrow (top) was also evacuated, with ribs cracked by a careering sled.



predominantly out of the southwest. In some places the winds created sastrugi, or long wavelike ridges of hard snow, that ran northeast and thus gave us an additional reference for true north.

Such visual aids, however, could be wiped out in seconds by fog, low overcast, or blowing snow. These whiteouts obliterated all visual clues of depth, height, and distance and made us feel as though we were suspended in skim milk.

The maxim of polar travel when whiteouts develop is to make camp and sleep until visibility returns. Late in our journey we tested that maxim and lost. When we were only 30 miles from the Pole, heavy cloud cover and light fog enveloped us. By then we were hell-bent to reach our goal, and we traveled blindly on, trying to navigate by means of the wind, which kept shifting, and sastrugi we could barely see.

Six hours later when the sun blinked through the clouds, Paul saw our dogs' shadows and knew instantly that they were in the wrong place—we were traveling more west

than north. We followed the maxim then, made camp, and slept. Paul's later position fix confirmed we had been off course.

On Day 32 a wild coincidence took place—we ran into the French polar explorer Jean-Louis Etienne (page 318). We had left at different times from different jumping-off points, and our routes were not coordinated. Yet in the hundreds of thousands of square miles of trackless polar wastes we nonetheless crossed paths. I noted it in my journal:

DAY 32 (APRIL 8)—Richard was scouting as usual and ran into ski tracks that I figured were two days old. There is only one person on the polar sea, and that is Jean-Louis, traveling solo to the North Pole by skis, pulling a sled. We lost the trail rapidly—the storm here had done a good job covering it up, and it was heading over terrain too difficult for our dogs. . . . Later in the day. . . . I heard something. My dogs made a

lunge at forty-five degrees to the right, and I caught a dark figure simultaneously. It was the Frenchman. He was camped on the other side of a pressure ridge. . . . Heard our dogs and went out to investigate.

On April 10 Jean-Louis pushed on ahead of us, traveling far lighter thanks to regular resupply by air. Nevertheless, our route and longer hours of travel got us to the Pole ten days ahead of him, but we were delighted that he, too, succeeded.

On Day 35 we had the final dog pickup, airlifting out 21 animals and keeping 21 others in three teams of seven each. The sled loads were now down to 700 pounds each, we had come only 170 miles, and we had nearly twice that distance still to go. We faced a real crisis, and my journal reflects the argument that ensued over it:

DAY 35 (APRIL 11)—*Paul and I feel the handwriting is on the wall. We are not going to get seven people to the Pole. . . . The only way . . . is the way Peary did it—the mountain-climbing, pyramidal approach, gradually cutting back on the team's size, and thus payload, to ensure that at least a few members reach the top.*

Brent, Geoff, and Bob share these feelings. . . . Ann and Richard cling desperately to the hope that we can still get all of us there, disregarding the dismal-rations arithmetic that we are faced with.

In the end we compromised, jettisoning some 300 pounds of precious equipment, including two sleeping bags. We zipped four single bags into two doubles and slept three people in each, a situation that was to yield a memorable passage in Ann's journal:

Our 2nd nite sleeping 3 in 2 bags. I slept a little better. Paul and Brent on either side snoring and making all kinds of noises. . . . Last nite I slept on Brent's side almost entirely. He said we held hands. No wonder I had such good dreams!

High hopes against harsh realities, and then suddenly another loss, as I recorded:

DAY 39 (APRIL 15)—*Tonight Bob Mantell, who rarely acknowledges pain, made a tearful announcement. His feet are badly frozen, every step is hell for him, and he feels his disability may hold us back. . . . He is*

Tipping the balance, Richard Weber saves weight by shortening a sled (facing page); its wood burns in a stove to dry clothing in a tent. By latitude 84° 30' enough food had been eaten that full-length sleds were unnecessary. Nonessential items were later abandoned, including sleeping bags (below) that weighed 50 pounds each, mainly from accumulated frozen perspiration.

BOTH BY WILL STEER



about as tough as a man can be. To hear him moaning as he crawls into his sleeping bag at night is to know of real suffering.

There was nothing to do but airlift Bob out. To me the loss was even more wrenching than that of Bob McKerrow, for the original idea of the North Pole expedition had occurred to Bob Mantell and me in 1982, when the two of us were holed up and waiting out a blizzard during a dog-sledding journey across Canadian barrens.

The irony was that on the previous day we had made decent time—we were now at 86° north, roughly halfway to the Pole. But on Day 40, which was April 16, the plane landed in the ice and Bob left us. Now we were six, with 21 dogs, and barely enough food to reach the Pole.

Six days earlier my dogs had contributed to the problem by staging an early morning burglary. While we slept, my lead dog, Chester, had chewed through the team's restraining rope, and half the animals got into the pemmican stored on the back of the sled.

We lost 20 precious pounds of food, but it could have been worse. If it had been Geoff's ravening bunch, they would have eaten everything. A few weeks before when they had gotten into an equipment pack, they tried to eat the stock off the expedition rifle.

After the slump when Bob left us, our fortunes took a turn for the better. Trail conditions continued to improve, and with the gradually lightening loads the dogs were pulling steadily for 8 to 12 hours with no sign of burnout. At the same time we hit a few of what we fondly called our "wild cards"—firmly frozen northbound leads that cost us and the dogs little effort to travel along. On one such lead we made a memorable 15 miles in less than three hours.

As the sun inched steadily higher, the temperature rose with it, and the thermometer now hovered around minus 20°F. The cold was losing its stabilizing grip on the ice, and we began to encounter more and more fractures. Fortunately most were still narrow and could be easily bridged by the sleds, but the number and width of the leads were growing. The challenge we now faced was more one of speed than of weight. We were desperate to reach the Pole before the spring thaw. It had already dumped Ann in the water a week earlier, on Day 38, as I had noted:

Ann fell in a lead today. We encountered an active crack, some 20 feet across, that was slowly opening. Half a mile to



The right stuff: After slipping into a narrow lead, a dog prepares to scramble out (below). Bred for hardship and well insulated by their thick coats, the dogs easily withstood such common mishaps. But had a sled gone through the ice, the expedition would have ended immediately. Probing gingerly with a harpoon, Brent Boddy (right) tests a recently refrozen lead; just a couple of inches of tough sea ice was enough. "It was rubber ice," says Steger, "like sledding over a giant water bed, with a standing wave pushing up in front of us."



BOTH BY JIM BRADENBURG



the west we found a point where the lead narrowed enough so that we could jump across. Ann blazed trail, positioning herself on the lip of the lead to make the jump. Unknowingly she had stepped out onto a hanging cornice of snow. It gave way as she began to jump. She plunged into the black sea water. . . .

Through quick action Ann saved herself from going under by throwing her arms wide and catching the edge of the lead. Somehow she wriggled back onto the ice, soaked to the waist, her outer pants already frozen stiff as stovepipes.

It was no time for ceremony; Ann quickly stripped off her wet things and donned dry clothes grabbed by Paul from his sled. Fortunately she suffered no permanent injury, but she told us later it was two full

days before she began to feel warm again.

On this occasion, as on all others, we treated Ann like any male member of the team, and she would not have it otherwise. Earlier she had considered the prospect of being the first woman in history to walk to the Pole and had written in her journal that the thought failed to impress her:

DAY 29 (APRIL 5)—I truly never think of being the first female to the Pole. I'm basically so busy trying to get there. . . . When I do get time, I worry about being a good representative. Don't want to let friends down in anyway.

On another occasion, when Ann's performance fell slightly short of her incredible demands on herself, she wrote a line in her journal that each of us echoed silently many



times on the trek: *I hide my tears behind a face mask and a cold day.*

Now at last we were on a dash for the Pole. On Day 50 we made the best mileage of the trip—38 miles in 18 hours. We were at 88° 45' north, less than 100 miles from the Pole. Despite long days of travel the dogs' spirits held, and I recorded my pride in them:

My veterans know something is up. They have been in a number of situations where food is short and have pushed it; they know there is rest and food after the long march, and they have figured it out now. Some of the dogs also know that when the dog food runs out and we start feeding them our food,



the end is near. Last night I unharnessed Chester and he fell asleep in my arms. . . .

Then, suddenly, three days later, everything seemed to come apart:

DAY 53 (APRIL 29)—*Panic nearly struck today. Having now entered our last degree of latitude, our hopes, dreams, years of planning and preparing have relied increasingly on the accuracy of the sextant and the chronometer and the skill with which they are used. After we traveled 18 hours straight in our dash to the Pole, Paul announced with quivering voice that the last two sun shots conflicted badly and thus he did not trust the position fix that resulted on the charts. While he frantically inspected the [sextant], searching for some flaw that could account for the error, the rest of us collapsed in exhaustion and desperation, knowing we were helpless to assist.*

There followed what all of us to this day regard as a minor miracle:

Hours of restless sleep went by while Paul, in the other tent, dissected portions of the instrument with his Swiss army knife. Suddenly a glint of light reflected off a speck of frost. On closer examination Paul found that the frost formed by condensation on a tiny adjustment screw had wedged a delicate mirror out of alignment. He corrected the error and, swept by euphoria, took a series of shots that placed us back on track—some 30 miles from the Pole.

After weathering such crises, I felt a renewed kinship with my teammates and the overwhelming power of the human heart:

I think about those who died in loneliness in the polar reaches. Alone, desolate, exhausted, starving. I need to be among sparkling red human hearts. The warmth of the human heart I crave. . . . as beautiful as the polar snow is, blowing high in the air by

"Like dominoes back-to-back," says Steger, right, napping with Richard Weber and Geoff Carroll in two joined sleeping bags. Such togetherness was mandatory here on their final push, since they had cast off sleeping bags frozen stiff. To save time, they used a sled for wind shelter rather than pitch a tent.

ANN BANCROFT



Suddenly, the Pole: Jubilant and relieved explorers await transport from their objective on May 3 (above). An approaching aircraft's navigation system (right) shows their latitude—89° 59' north—and longitude.

The previous day they had

known they were close but nevertheless were preparing to move out when Schurke took a sun shot with the sextant. A celebratory "bear scare" firecracker accompanied his announcement: "We don't have to travel today. We're here!" They signaled a satellite that



put their position, amazingly, within a few hundred yards of 90° north.

The polar weather report? Only 15°F, clear, and calm. The crew was a little giddy. “For us, it was like Hawaii,” says Steger, “almost shirt-sleeve weather.”



JIM BRANDENBURG (TOP); KENT ROBERTSON



First woman to trek to the Pole, Ann Bancroft breaks out champagne (right) en route home. Her apple came from the suitcase behind her, a "surprise box" also yielding candy, cookies, oysters, and fast-food hamburgers. The provider was Sue Hendrickson-Schurke (facing page), greeting Paul with their daughter, Bria. Emotions finally unravel for homeward-bound Steger (above). Like all seekers of the Pole, the team members discovered nothing tangible—only what was within themselves.



the wind, shimmering against the low, yellow, eternal sun which never sets, as beautiful as my surroundings are, the human heart is still the home of warmth, and the most beautiful of God's creations.

For the past 54 days we had been traveling over a surface in constant motion toward an invisible goal. But by the morning of Day 55—May 1—we were within 20 miles of the Pole, and we could no longer hide our elation. We frolicked along like kids on parade. The dogs caught our spirit and pulled the nearly empty sleds along at a fast clip. Pressure ridges became our playgrounds. We maneuvered the sleds through them with as much bravado as we could muster, while an imaginary panel of judges scored our performance. Every mark was an E for Excellence.

Near midnight one of Paul's fixes placed us within ten miles of the Pole—realization of our objective in the Arctic's vast reaches. Even so, we traveled on for several hours and stopped to sleep by the sleds, planning to check our position in the morning.

At 9:00 a.m. on Day 56, Paul got up to take a sun shot. We awaited word on how far we had still to go. But Brent, who was outside, got the word from Paul first. The next thing we heard was an explosion—Brent had set off a "bear scare," a small charge to frighten away polar bears, in celebration:

We were at the Top of the World!

Content with the victory but too exhausted to celebrate, we treated ourselves to the greatest luxury of all—we crawled into our bags and went back to sleep.

The next day—Day 57—Jim Gasperini confirmed by radio that we had indeed reached the Pole. Three ski-equipped Twin Otters left Resolute for the 11-hour flight to pick us up. Within a day four of us were back in Minneapolis, enjoying a hero's welcome.

The celebration left us feeling honored, overwhelmed—and a little curious. Why had our expedition caught the imagination of so many people? It was neither the first nor the longest polar journey, nor would it, surely, be the last.

As we looked over newspapers for the time since mid-January that we had been

out of touch, we began to get a clue: The world had been stunned by disasters—particularly the loss of the *Challenger* shuttle and the Soviet nuclear accident at Chernobyl. We realized that man's faith in technological wizardry had been badly shaken.

By contrast, we six had pushed long and hard to meet our goal through sheer determination and the collective will of our dogs and us together. For many people our journey symbolized a reaffirmation of that will—the power of the human spirit.

Just before we reached the Pole, we had put down our thoughts in a brief declaration that Ann had read aloud the morning the pickup planes arrived. It said in part:

"As we, six adventurers from different parts of the world, stand where the lines of longitude of all countries meet, we believe this journey stands for hope—hope that other seemingly impossible goals can be met by people everywhere."

Perhaps that says it all. □



ALL BY JIM BRANDENBURG



Skiing Alone to the Pole





JIM BRANDENBURG (ABOVE); JEAN-LOUIS ETIENNE

MILE AFTER frozen mile I struggle against the cold, the polar sea, and terrible fatigue. For 39 days I have skied toward the North Pole, towing my small sled. At rare intervals a ski-equipped aircraft has landed on the ice to resupply me, events that enabled photographer Jim Brandenburg to take this picture (*above*).

On this day—April 16, 1986—I reach 86° 10' north

(map, page 297). My starting point on Canada's Ward Hunt Island lies some 200 miles behind me, though I have traveled far more than that because of endless detours and constantly shifting ice. The Pole lies more than 260 miles ahead, but how many days' travel? I refuse to think about it.

Today the cold is not too bad, minus 24°C (−11°F). In the beginning it was minus 52°C (−62°F)—dangerous weather for a man traveling

alone. I suffer frostbite on the nose and face (*left*), and exposed fingers soon go numb.

As I battle northward, I smile grimly at the memory of Arctic "experts" who assured me that polar ice becomes smooth some distance from land. I know now that the surface is continually broken by frozen waves of ice, by massive pressure ridges, and by leads of open water. One thing my 39 days have taught me—the Arctic is no place for dreamers.

By JEAN-LOUIS ETIENNE



GRUELING TUG-OF-WAR (above) matches my strength against the relentless grip of polar ice. Fully loaded, my sled weighs 110 pounds, including enough equipment and food to last me two weeks under way—longer if it has to.

Fog proves as serious an obstacle as polar storms, for in these latitudes a compass can be unreliable, and if one loses sight of the sun, one can lose all sense of direction. Fortunately, bad weather held me up only ten days out of the 64 it was to take me to reach the Pole. Despite open leads and pressure ridges I average

more than a mile an hour overall. Toward the end I covered 19 miles in one memorable ten-hour period.

To maintain a daily check on my position, my partner and base-camp manager, Michel Franco, and I used a complex communications system. Each night in camp I would activate a navigational transmitter that broadcast an automatic signal. The signal would be picked up by a U. S. polar-orbiting NOAA satellite and relayed to the Argos Processing Center at Toulouse, France. There the data would be received and stored in the Argos computer.





JIM BRANDENBURG (ABOVE); JEAN-LOUIS STIENNE

At base camp in Canada's far northern outpost of Resolute, Michel could consult the computer by telephone to obtain my location. He would then transmit the position to me by voice radio—along with welcome messages from friends.

For high visibility in emergencies I wore a blue or red parka, and my sled carried a crimson cover overlaid with the flag of France. The cover bore the initials UAP for my principal sponsor, an insurance company in Paris.

Part way through my trek I met the Steger polar expedition (page 289). It was a

chance meeting against million-to-one odds, and I encountered the team's tracks once more as I neared the Pole (left). Though more than a week old, the paw prints of Steger's dogs appeared clearly in relief. I removed my skis and sled harness long enough to photograph the scene. By that time Steger and his crew had reached the Pole and been airlifted out, but the sight of their tracks lifted my spirits.

During one of my five resupply flights (above), Michel helps me switch sleds and equipment beside the ski-equipped Twin Otter. Twice he took the used sled back to

base camp and repaired it for the next exchange.

Enthusiastic reports in the United States described such supply flights as involving beautiful women, champagne, caviar, and luxurious hot baths aboard the aircraft. Alas, the truth was less glamorous. A woman friend did fly in with a gift of smoked salmon, but after weeks of dried fare such as cereal and fruit, my stomach refused to accept the gift. As for hot baths, a Twin Otter on the Arctic ice quickly becomes a deep freeze, and I was forced to settle for a hasty scrub with a damp sponge.



VICTORY at the Pole on May 11, 1986, is tempered by bad weather that delays my pickup flight nearly four days. I pass the time photographing myself peering through the tent flap (*above*) and cooking the inevitable dehydrated meal (*top right*). My face reflects more fatigue than triumph, though I later struck a proper pose beside the French flag (*right*) for Michel when he flew in with the pickup flight. I had also brought along a small National Geographic Society flag, which has flown proudly at the Pole before.

I was the first to trek to the Pole alone and under his own power. The late Japanese explorer Naomi Uemura reached the Pole alone in 1978, but he used dogs to pull his

sled, as well as air supply. Will anyone ever reach the Pole under his own power, entirely unassisted? Perhaps, though the day is still in the future. To succeed, one would have to carry or haul nearly 500 pounds of food and equipment more than 600 actual route miles. Yet technology may one day overcome such odds. Less than 20 years ago my own trek would have been impossible. Thanks to modern lightweight materials such as Du Pont's Kevlar, my sled weighed only six and a half pounds, compared to the 100 or more pounds of a traditional Inuit wooden sled. Specially prepared foods—nutrition is one of my fields as a medical doctor—made it possible for me not only to subsist but also to perform hard physical labor

for more than two months on a daily ration of 2.2 pounds of high-energy food (4,000 calories). Despite the hardship and exertion, I lost only 13 pounds during the trek.

To my mind reaching the Pole calls for an effort that is 30 percent physical and 70 percent mental. Only such a balance can match the multiple challenges of severe weather, constant fatigue, extreme low temperatures, open water, and barrier ice.

For me open water proved the greatest obstacle. With a body weight of only 140 pounds, I could traverse ice too thin to support a loaded sled and dog team, but open leads were another matter. At times I could only scout their edges in search of an ice bridge, often leaving my



MICHEL FRANCO (BELOW) / JEAN-LOUIS ETIENNE

sled behind. On several occasions new leads opened behind me, temporarily separating me from my sled. The polar ice is never still, and I think of the Arctic Ocean in spring as a gigantic jigsaw puzzle forever in motion.

Toward the end of my trek bad weather forced me to camp for a day or so. In that brief time a strong north wind drove the ice pack several miles south, so that I was not simply standing still but actually losing ground. Then in one of those reversals I have come to expect of the Arctic, the wind died abruptly, the drifting ice slowed, and from a distance the North Pole beckoned me: "Come now, you can make it."

And so I did. □



The Intimate Sense

By **BOYD GIBBONS**
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by **LOUIE PSIHOYOS**

*Smells are surer
than sounds or sights
To make your
heart-strings crack.*

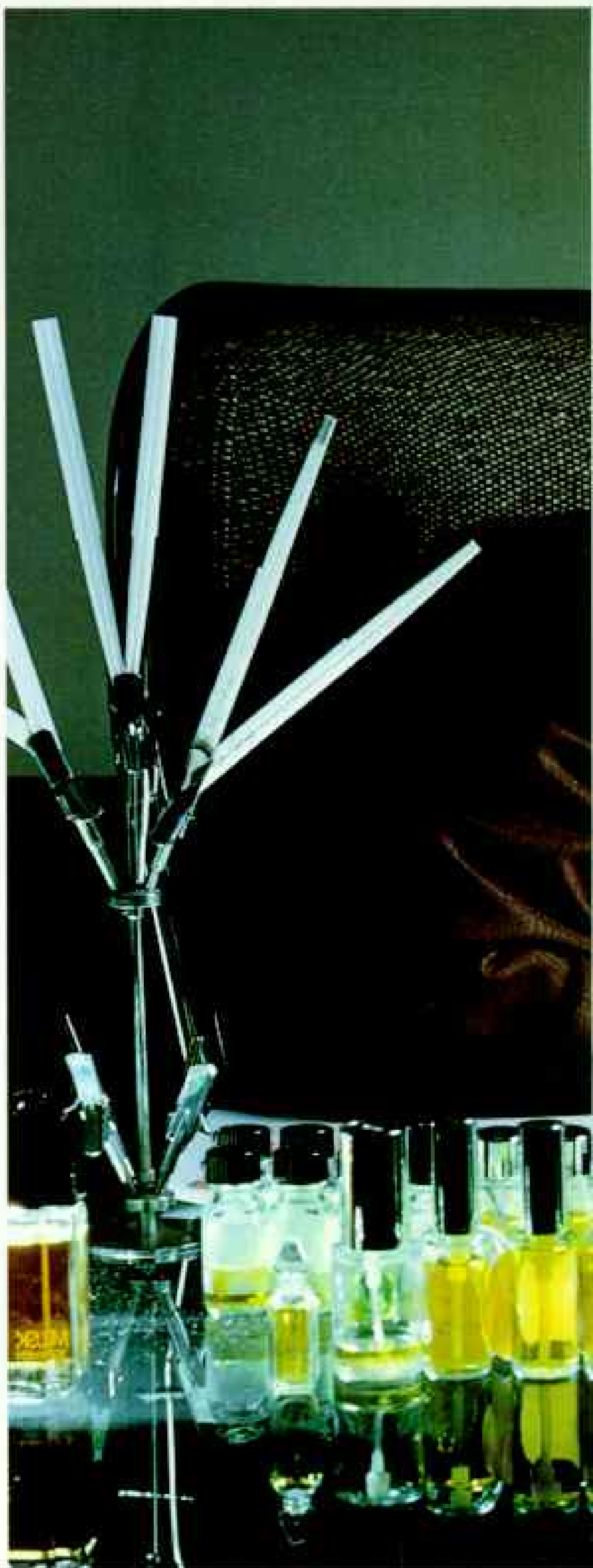
—RUDYARD KIPLING

ON THE WALL outside my bedroom hangs a photograph of my grandfather, in his brown hat and windbreaker, standing with my father and me. My grandfather died years ago, and his image in the frame, caught in a moment of posed reunion, often reminds me of my boyhood, when he doted on me as his hunting and fishing companion. Yet the recollections are vague and distant.

Recently, however, I took his old deerskin hunting vest out of the closet and on an impulse pressed it to my face and sniffed. Abruptly there came over me a rush of emotion and memory as intimate as it was compelling. No longer was I an adult squinting across a chasm of years at dim events: Suddenly I was a boy again, and there in all but the flesh was my grandfather, methodically reloading his shotgun as the flushed quail sailed beyond the mesquite.

This was no hazy reverie. I could feel his whiskered cheek against mine and smell his peculiar fragrance of age, wool, dust, and a

"You smell to recognize, to be prepared, and, of course, to enjoy," says Bernard Chant, chief perfumer for International Flavors & Fragrances, Inc., of New York City. Utilizing the sense that we least understand, he sniffs a cologne he is creating for a perfume company.



of SMELL



Bacchanalian delights for ancient Romans were heightened by exotic aromas suffusing the air of their elaborate banquets and orgies. Perfumed white doves (right) often fluttered about the room, releasing scents into the air and onto the guests below. Rose water helped raise the Roman bath, like this one in Ostia Antica near Rome (below), to its apogee of sensuality.



touch of Old Grand-Dad. Momentarily I was once more on the floor of my grandparents' breakfast room, the linoleum cool against my belly as I sketched B-17s, then sneaking down the hall into my great-uncle's gloomy bedroom hung with mounted pheasants and deer heads—musky and mysterious. The epoch slowly faded as I lay curled up in the backseat of my grandfather's Ford, returning from a long hunt in Mexico, half-listening to the men up front and Fred Allen on the radio, drifting into a sweet exhausted sleep.

All this from the whiff of a vest. I was not

consciously trying to recall my boyhood. Such is the involuntary power of the sense of smell, my boyhood was recalling me. In *Remembrance of Things Past* Marcel Proust wrote: "But when from a long-distant past nothing subsists, after the people are dead . . . taste and smell alone . . . remain poised a long time, like souls, remembering, waiting, hoping, amid the ruins of all the rest; and bear unflinchingly . . . the vast structure of recollection."

Psychology textbooks devote few pages to the sense of smell. This suggests that olfaction, as the scientists call it, is not very



important to visually oriented, thinking humans, and that what value smelling may have once had for us faded when we began walking upright and looking around.

But to Gordon Shepherd, a Yale University neuroscientist, people vastly underrate their sense of smell. "We think our lives are dominated by our visual sense," he said, "but the closer you get to dinner, the more you realize how much your real pleasure in life is tied to smell. It taps into all our emotions. It sets the patterns of behavior, makes life pleasant and disgusting, as well as nutritious."

All the nuances of flavor—that which distinguishes Peking duck from sea gull, or a fine Bordeaux from grape juice—come from sniffing aromas or exhaling them through the nose as you drink or chew food. The taste buds of your tongue and mouth apparently detect only salt, sweet, bitter, and sour. If you pinch your nose, you'll have difficulty telling if you're eating a slice of raw potato or apple.

Odors reach into all our emotional life, drawing from the deepest caves in our minds. Odors suggest, stimulate associations, evoke, frighten, and arouse us, but



NATIONAL GEOGRAPHIC PHOTOGRAPHER VICTOR S. BOSWELL, JR.

"Through smoke," the literal meaning of perfume, reflects the origins of the art of perfumery. It began with early civilizations, probably the ancient Egyptians, who burned the resinous gum from such desert plants as myrrh and frankincense and smelled the aromatic smoke. The pharaohs burned incense to please their gods, as depicted on this temple frieze at Karnak, and were embalmed with fragrant spices.

they seem to lie below conscious thought until someone like the poet Baudelaire parts the curtain:

*In bed her heavy resilient hair
—a living censer, like a sachet—
released its animal perfume,
and from discarded underclothes
still fervent with her sacred body's
form, there rose a scent of fur.*

A man might tell a strange woman that he likes her perfume, for we put on fragrances to be noticed. But our culture tends to discourage him in polite company from telling her how much, like Baudelaire, he is aroused by her aroma.

What we lack is not a profound sense of smell, but encouragement to talk about intimate odors. And we lack a vivid vocabulary with which to describe all odors. We fall back on simile and metaphor. This Médoc is elegant. The aroma of balsam is Christmas. Rattlesnakes smell like split cucumbers. Most languages are devoted to the ear and eye—what is rosy and thunderous—not the smell of an approaching snowstorm. Unlike pictures or snatches of music, odors lack features, and we often stumble at identifying even familiar ones—the "tip of the nose" phenomenon.

THE MORE memorable olfactory phrases frame the repulsive: Franklin's "Fish and visitors stink in three days," Shakespeare's "Something is rotten in the state of Denmark." When Germans detest someone, they say, "*Ich kann ihn nicht riechen*," literally "I can't smell him," meaning he stinks.

We would find it hard to choose between enduring a pain or a stink. The stench of a dead rat would probably empty a theater as quickly as a ringing fire alarm. Most horrible smells warn of danger. Hydrogen sulfide gas is so toxic you'd die from inhaling a lungful. But you don't because of its rotten-egg stink.

Women identify odors better than do men, perhaps because they have paid more attention to odors—cooking, sniffing meat for freshness, using spices and perfumes. Children sniff and taste everything. Old people throw more spices on their food as olfaction diminishes.

Trygg Engen, a noted psychologist of smell at Brown University in Rhode Island, told me, "Odors arouse man. Then things happen, and, depending on whether the experience is pleasant or unpleasant, the odor will be remembered as good or bad."

Once when I was a boy, I was momentarily separated from my parents in an Old West museum. I raced in panic around buggies of rotted leather and mannequins in musty Victorian clothes, convinced that I would never see my parents again. To this day that peculiar museum odor unsettles me, for in it I smell death.

Food associations can be extremely powerful. "My wife once got sick after eating

scallops," Engen said. "Her illness was a coincidence, but she can't eat scallops now. The association is too strong. Why is the smell there forever? Like the shyness of rats toward poisoned bait, it's so you won't ever do that again."

Rats sniff carefully before taking even a tiny bite of anything new. Then they sit and wait to see what may happen before nibbling again. Animals have to protect themselves from being poisoned and will rarely touch any food that smells like what once made them sick.

Odors help bond mothers to their newborn. A mother cuddling her infant will invariably brush her nose in the baby's hair to inhale its sweet aroma. She can probably identify her baby by its smell as much as by its cry. A mother rat licks her nipples so that her blind pups can follow the scent of her saliva to the milk. Wash the nipples, and the pups are lost. After a ewe gives birth to her lamb, a chemical released in the ewe's brain tells her, "Pay attention, this odor is important to remember."

Although jasmine seems to be universally seductive and hydrogen sulfide repellent, our reactions to most odors are highly personal. Houses, like ant colonies, develop a "nest" odor, and as a kid I was uneasy entering one friend's house because of its strange smell. Yet my friend was unaware of the odor, having become habituated to it (just as we don't hear a ticking clock unless we are anxious about getting to sleep). He could smell other odors, but his brain had turned off the message of this one as being inconsequential. A nurse I know loves the odor of tar; it reminds her of when the roads of her hometown were first paved, suffusing her in warm memories of growing up. But the odor of tar saddens Louie Psihoyos, the photographer of this story. His father, a roofer who smelled of tar, fell to his death from the gables of a house.

Some odors are downright irresistible. On a trip away from home the German poet Goethe carried the bodice of his lover, so that her fragrance never left him. A woman told me (and she didn't find this easy to admit) that when her husband leaves for the office in the morning, she slides over to his side of the bed because she feels comforted by his residual aroma.

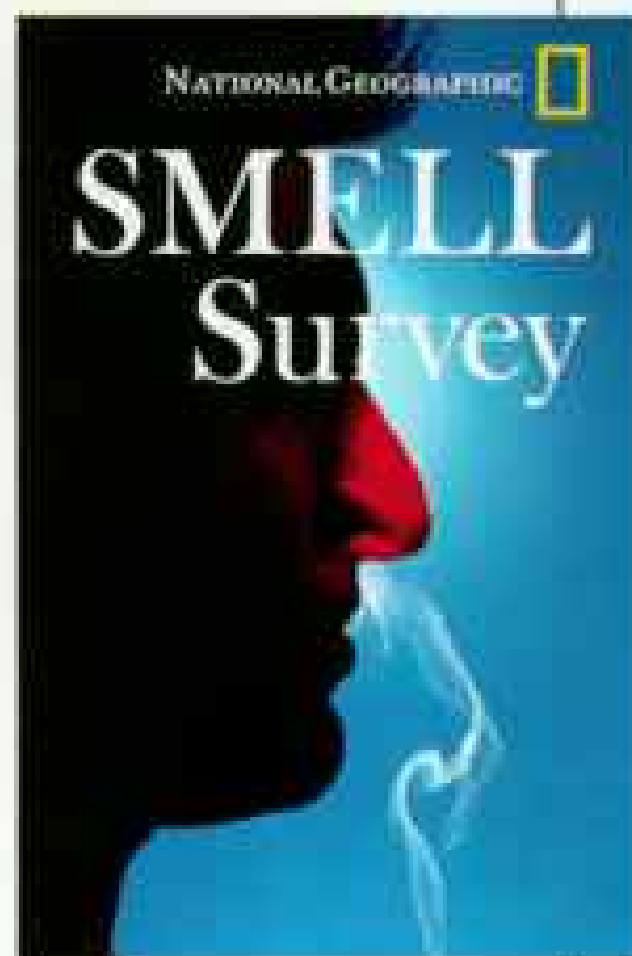
Welcome to the NATIONAL GEOGRAPHIC Smell Survey

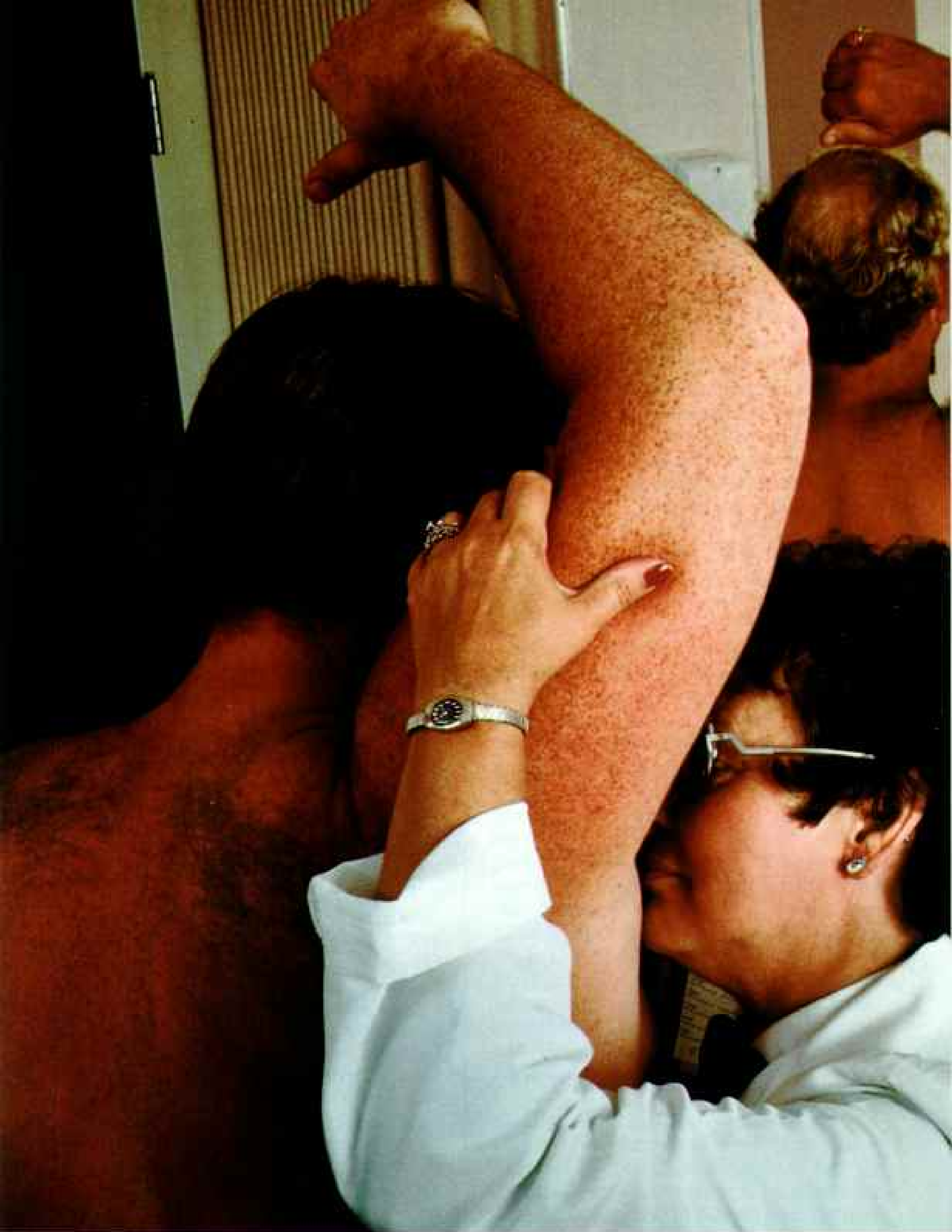
SMELL AND EMOTION are so entwined with experience that each of us may perceive the same odor with far different feelings. Depending on one's early exposure to horses, the aroma of a stable might delight one person, frighten another, and sadden a third. Society tends to inhibit talk about smells, and words for odors don't come readily to mind, but odors emphatically evoke strong feelings.

When we embarked on this story, we puzzled over why smells are so provocative, why we have trouble finding words for even the most familiar odors, and why some of us are "odor blind" to certain scents. We discovered that scientists studying this most elusive sense ask the same questions, and more. This prompted us to conduct the Smell Survey included with this issue, consisting of a questionnaire attached to six scratch-and-sniff panels.

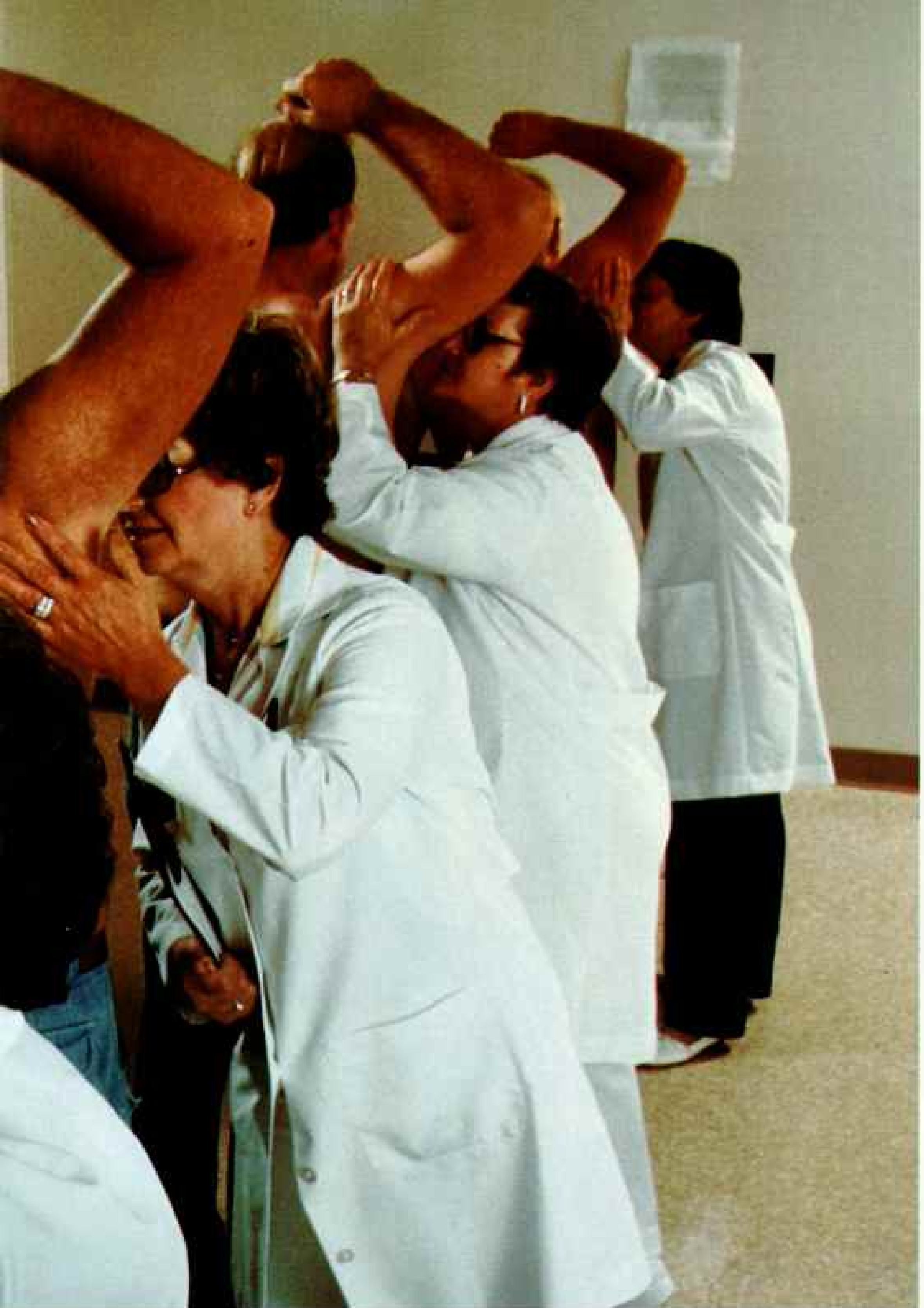
To select the scents and design the questionnaire, we enlisted the assistance of Dr. Charles Wysocki and Dr. Avery Gilbert, two olfactory scientists with the Monell Chemical Senses Center of Philadelphia. The scents come to us through the generosity of two major fragrance companies: Firmenich SA of Geneva, Switzerland, and International Flavors & Fragrances, Inc. To give you some idea of the power of odors, we needed only 27 grams—less than an ounce—of one of the odorants to microencapsulate it on the nearly 11 million copies of this survey. Results of the survey and identification of the scents will appear in a future issue. We encourage you to participate.

—THE EDITOR





It's the pits that produce our strongest body odors. Before testing the efficacy of an underarm deodorant, Thelma Williams, foreground, and her fellow odor judges at Hill Top Research, Inc., of Cincinnati, Ohio, first sniff the natural odor of paid



volunteers. Body odors are produced by bacteria metabolizing secretions from various skin glands. "Our judges," says Thelma, "must have the olfactory acuity to distinguish very minor differences in malodors."

THE SENSE OF SMELL is at the heart of remembering and emotion. It's a matter of anatomy.

Odors are volatile molecules. They float in the air. When you sniff, they rush through your nostrils, over spongy tissue that warms and humidifies the air, and up two narrow chambers where, just beneath the brain and behind the bridge of the nose, they land on a pair of mucus-bathed patches of skin the size of collar buttons. Here, in a process that's still a mystery, the molecules bind to receptors on tiny hairlike cilia at the ends of the

olfactory nerves, or neurons, which fire the message to the brain.

When I smelled my grandfather's vest, the signal traveled immediately into the limbic region of my brain, the core of emotions and memory—where my grandfather resides. The signal crossed but a single neural connection, or synapse: at the olfactory bulbs. (Sensations of sight, sound, and touch reach the limbic lobe less directly, across more synapses.) The bulbs lie just above the nose, and are extensions of the brain that filter out the trivial and send the



essential impressions into the limbic lobe.

Wanting to see this anatomy, I called on Dr. Michael Shipley, a neurobiologist at the University of Cincinnati College of Medicine. On a lab bench he set the head of a human cadaver, sliced in half like a melon. From the base of the brain, just above the nose, he removed the two bulbs. They were tiny, and I asked him if this meant that evolution had diminished our sense of smell. "That's an interesting question," he said. "The amount of brain tissue in man devoted to smell is still very great. Although we don't

seem to be very aware of smells, they have a very privileged and intimate access to those parts of the brain where we really live."

The brains of primitive animals were mostly limbic lobes, or "smell brains." In evolving humans the limbic lobe was gradually covered with neocortex (cerebral cortex), the thinking cap of gray matter. But the limbic region persists, with profound effect on our body chemistry. Through control of the hypothalamus, the master switchboard for the pituitary gland, the limbic region influences the entire endocrine system of hormones that regulate body metabolism, caloric levels, insulin, stress, repulsion, arousal, sex, and much more.

Odors and hormones stimulate each other. When young women begin living together as roommates in a college dormitory, they often discover that their menstrual cycles synchronize. The signal is apparently in the odor, however faint, of their sweat. In the same manner, a woman who has irregular periods often becomes regular the more she is around a man. Her sense of smell is keenest during ovulation, lowest during menstruation. Female animals that periodically smell male urine will move more quickly into puberty than females that don't. If a mated female mouse smells the urine of a male of another colony, she will immediately terminate her pregnancy.

Olfactory neurons are wired to the limbic lobe, endocrine system, and throughout the cerebrum; return circuits also send messages back to the bulbs, amending the pleasure of pancake aroma as your brain signals that your stomach is full.

Neurons to the ear are separated from the outside world by a tympanum, those to the



The smell of battle was sweet for Napoleon, who lavishly drenched himself with eau de Cologne. Shortly before his defeat at Waterloo he placed an order for toiletries with Houbigant-Chardin, France's oldest perfume house. The bill of sale is part of the company's Napoleon collection, which also includes his hat, gloves (usually scented), his niece's fan, perfume bottles, and an incense burner of that era. As he lay dying on St. Helena, scented smoke from burning pellets suffused his room.

LOUIE PERHOYDS WITH STARLET DARLAND

eye by the cornea. But olfactory receptors are a special kind of neuron because they sit right out in the environment exposed to everything chemical and reach directly into the brain itself. And unlike the body's other nerve cells, olfactory neurons constantly replace themselves.

One of the men who discovered this phenomenon of replication is Dr. Pasquale Graziadei, a neurobiologist at Florida State University in Tallahassee. "If you damage a nerve cell of your brain," he told me, "you will never regain it. Lose the cells of your spinal cord, you have paralysis. Blow the neurons in your retina or your ear, and you cannot repair the damage. Since olfactory nerve cells can be replaced, the sense of smell has to be very important. Nature doesn't ever do anything for fun.

"To some extent the brain depends on the nose for its own development. I removed a tadpole's nose, and part of its brain failed to develop. I removed the olfactory bulb of a mouse, and the new neurons tried to recreate the bulb in the brain. The system is very plastic. Remove 90 percent of the bulb, and the animal smells very well. But chop off even half your hearing, and you lose all the highs and lows of music. Redundancy protects what is essential for survival. A blind rat still lives very well, but without a sense of smell he can't mate or find food."

ODORS that induce psychological or behavioral changes in the same species—fright in a catfish, sexual arousal in a bull—are called pheromones. And nowhere do such odors have more profound an effect than among the bees, wasps, ants, and termites: Pheromones are the chemical messages that these insects use to organize their complex societies.

The queen honeybee preserves her monarchy by exuding an odor that inhibits worker bees from laying eggs and constructing queen cells. The same odor draws drones to the queen on her mating flight. Should you be stung by a honeybee, the odor of the stinger (it smells like banana oil) might invite more unwelcome company, as it is an alarm pheromone that can trigger a mass attack from the hive.

Fire ants blaze trails to food by dragging their stingers across the ground to lay down

a scent trail for the colony to follow. Biologist E. O. Wilson, of Harvard University, told me, "One milligram of the trail pheromone of the leaf-cutter ant is enough to lead a small column three times around the world." Termites discovering a breach in their mound emit an alarm scent that brings masons to the hole.

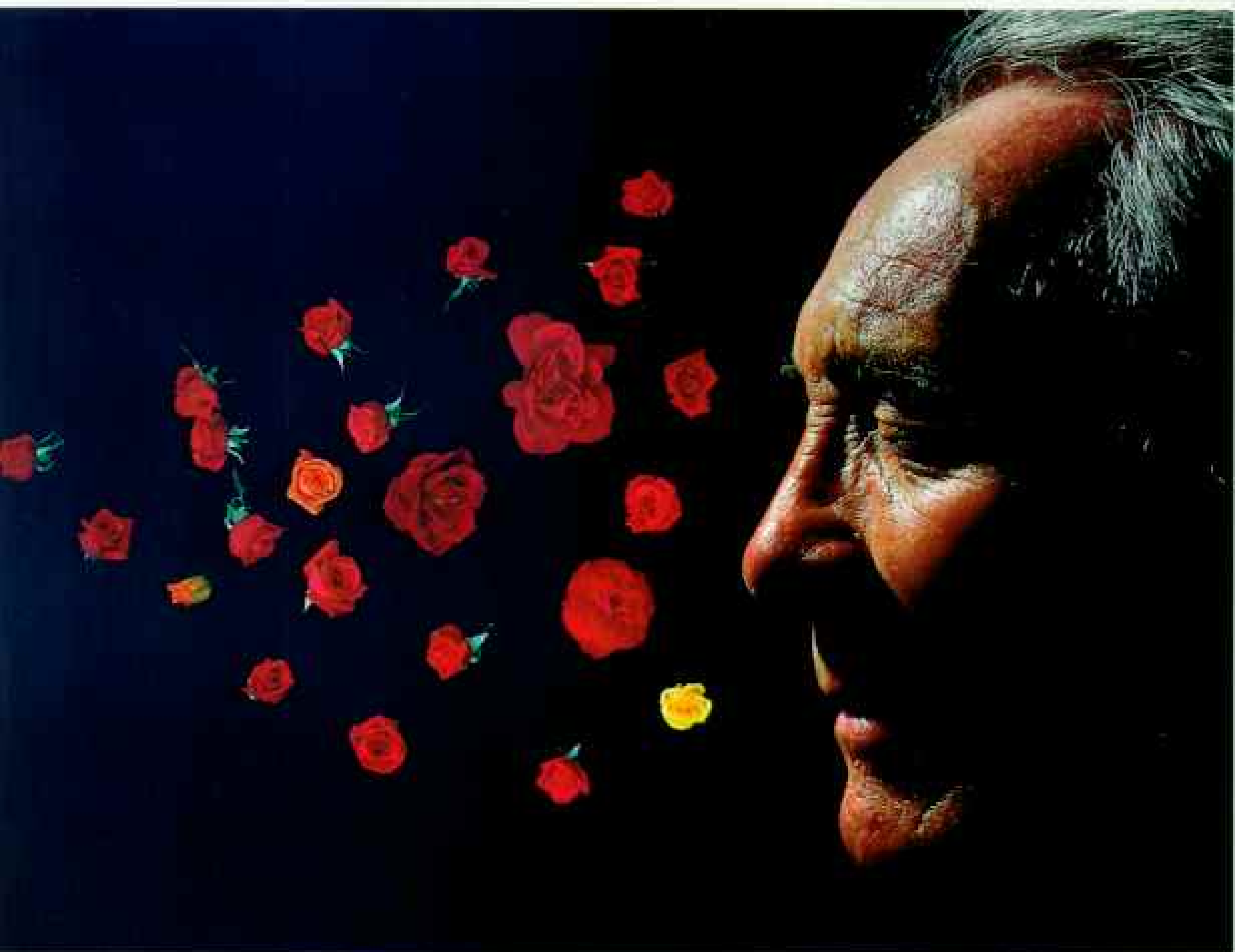
Scientists initially believed that insects respond to a single chemical stimulus, but pheromones are often very complex blends of compounds. The female oriental fruit moth carefully combines a chemical inhibitor with her sexual pheromone to appeal to males (moths smell with their antennae) of only her own species and to discourage males of closely related species. This is probably how she maintains genetic purity.

After hatching in a river, salmon may roam thousands of miles at sea, then return to the river of their birth, where they swim upstream following an odor, imprinted perhaps years earlier, to the stretch of water where they were born.

When Jelle Atema, a sensory biologist at the Woods Hole Marine Biological Laboratory, wades in the Cape Cod marshes, minnows nibble his ankles. "We're just leaky bags of amino acids," he said, as we squished around in a marsh. "That's what the fish smell. This water is literally packed with odors." Atema dropped a piece of mussel in the water, and its drifting odor attracted minnows. Mud snails locate food the same way. But crush one in the water, and the burst cells emit a fear odor, sending the others in slow motion back into the mud.

Unlike humans, fish often have as elaborate a sense of taste as they have of smell, but the functions differ. "Taste appears more as a reflex sense," Atema said, "a check for poison." To Atema, the catfish is virtually a swimming tongue and nose. A minnow dead in the water leaks amino acids that a distant catfish smells in its nostrils and tastes through thousands of taste buds dotting its body and whiskers. The cat swims up and tentatively tastes the minnow again with its whiskers before swallowing or spitting it out. Lobsters can taste with their feet and smell with their antennules, waving them constantly in the water the way elephants sniff the air with their trunks.

Most mammals' behavior is guided by the



"When I create a new fragrance, such as Eau Sauvage or Diorella," says the famous French perfumer Edmond Roudnitska, "I think of a scene, a flower—a seductive and original form. Like the artistry of music composition or painting, the creation of the perfume may take many years. I compose what pleases me."

sense of smell. (I learned this from Dietland Müller-Schwarze, a noted scientist of mammal pheromones.) By defecating, urinating, and marking with scent glands, the animals maintain their territories and identify one another. They use odors to give alarm, to select food, and to mate.

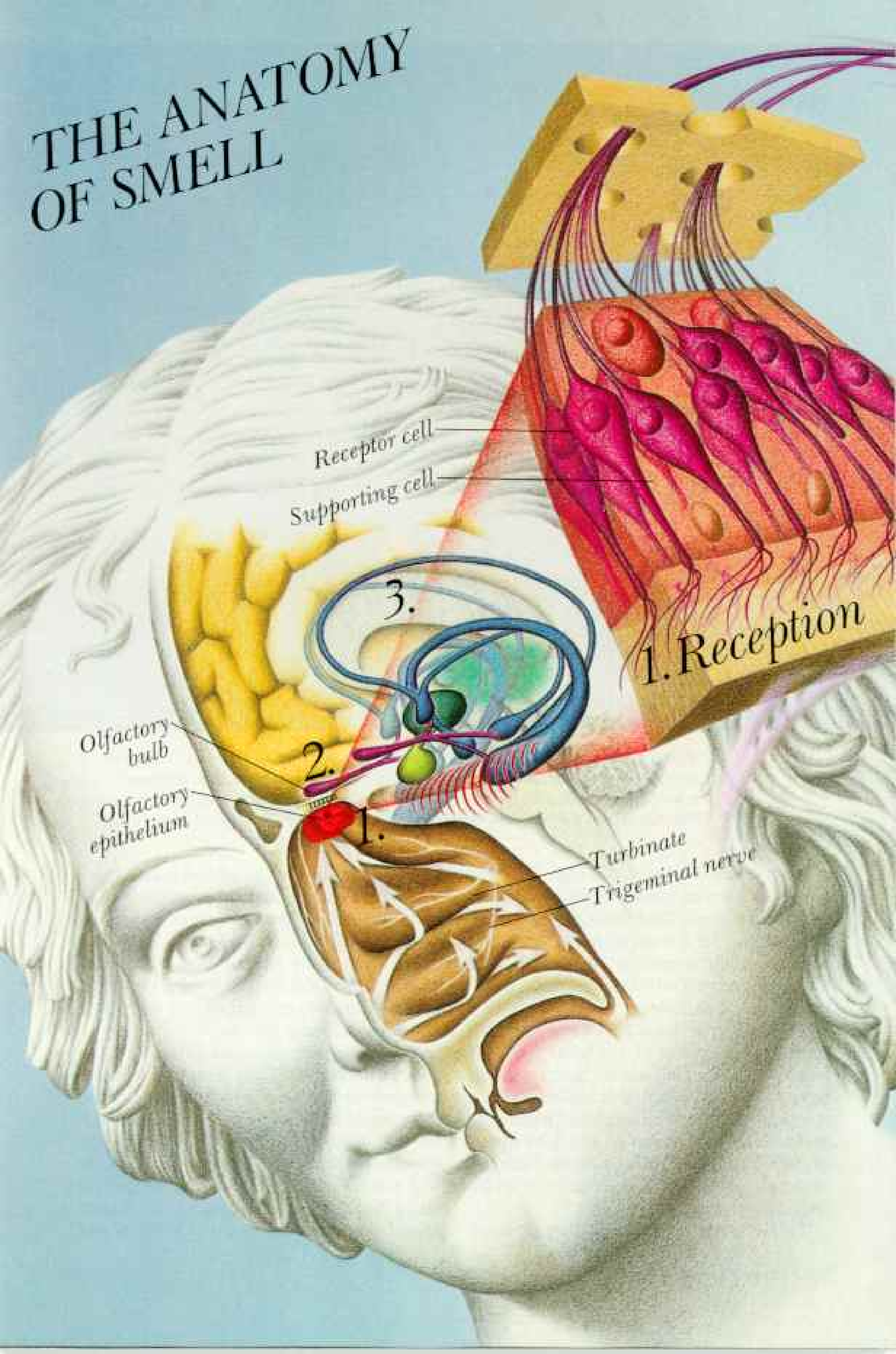
The beaver is tenacious about keeping strange beavers out of his labor-intensive neighborhood. He erects no-trespassing signs on his dam, lodge, and feeding trails by scooping mud from his pond and patting up mounds like hat crowns on which he squats to deposit a smear of castoreum from his anal and castor sacs. Castoreum has an intriguing resinous, animal odor.

Thomson's gazelles mark their territory

by depositing on long twigs and grass a tarry stuff from glands just beneath their eyes (page 346). Reindeer have scent glands between their hind toes; the glands help them leave scent trails for the herd. The odor smells cheesy. Rabbits mark with their chin glands. Cats rub up against you with their eyebrow and rump glands.

The molecules of some odors are too heavy to be sniffed. They must be licked and pumped into an olfactory apparatus called the vomeronasal organ; in most animals it lies above the hard palate of the mouth. (In humans it's thought to be vestigial.) A viper will pursue a vole by flicking its tongue along the scent trail and then into its vomeronasal organ through two slits in the roof of

THE ANATOMY OF SMELL



Receptor cell
Supporting cell

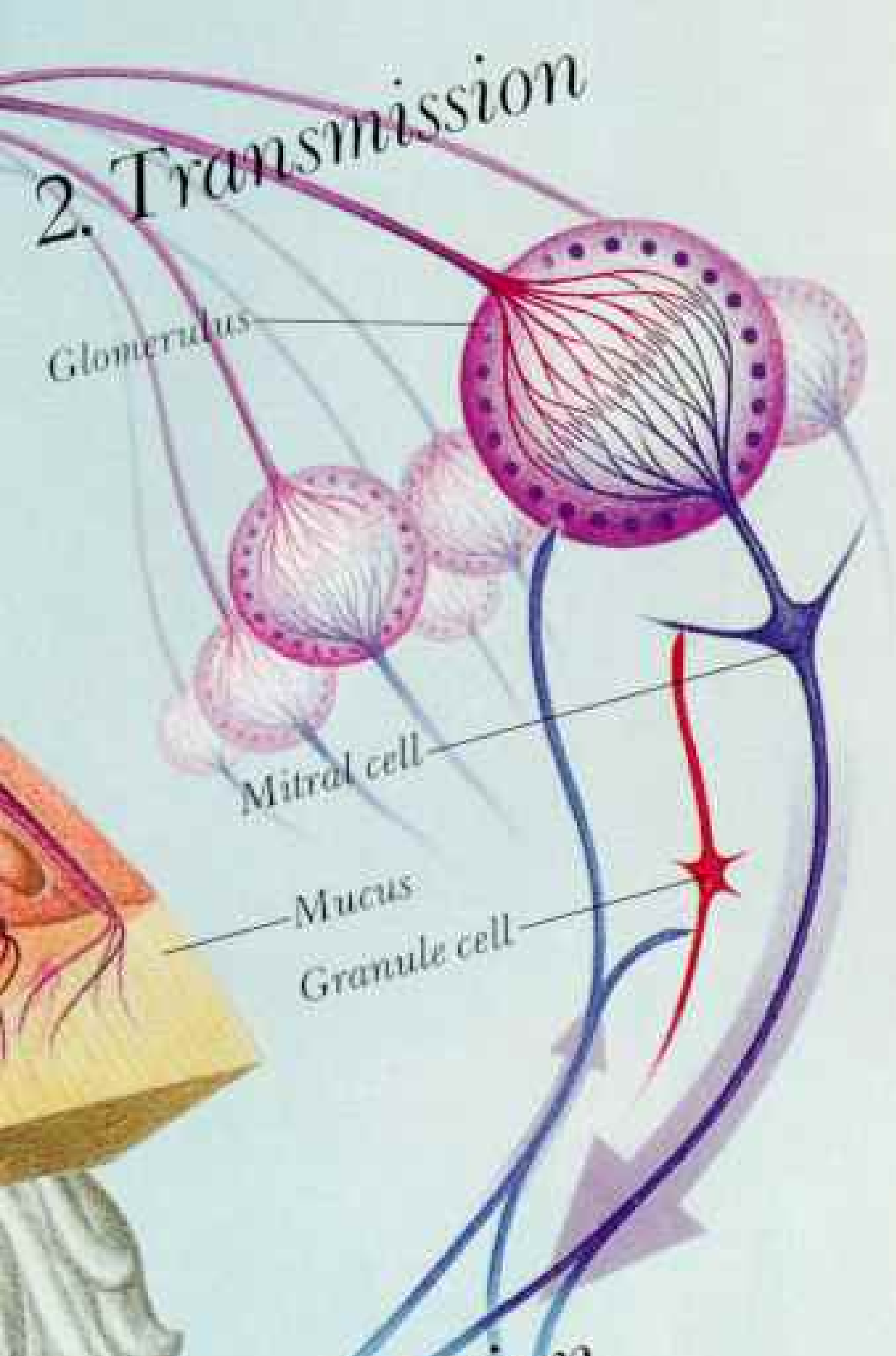
1. Reception

Olfactory bulb
Olfactory epithelium

Turbinate
Trigeminal nerve



2. Transmission



OUR MOST ELUSIVE SENSE, smell reaches more directly into memory and emotions than other senses: You smell rain on a dusty road, and suddenly an epoch from childhood is vividly evoked. What's going on?

Odors are volatile molecules released into the air. Our brain perceives odors when we sniff them through the nostrils or receive them up the back passage between mouth and nasal passages from food or drink. Air is warmed and humidified by flowing over fleshy turbinates, specialized bones shown at left in brown (numbers and colors relate nose and brain anatomy to the nerve cells shown in close-up). Trigeminal nerves, which trigger sneezing, react to irritating odors with a prickly sensation. Odor molecules reach the mucus-coated olfactory epithelium (red), which differs from the receiving ends of our other senses in that its neurons, or nerve cells, extend from the outside environment directly into the brain. And unlike other neurons, they constantly replicate. The odor molecules somehow bind to receptors on hairlike cilia, and the neurons fire messages to the brain's olfactory bulbs (magenta).

There in structures called glomeruli, mitral cells are assisted by other neurons in reducing the complexities of odors to essentials. The rest of the brain also sends messages back to the bulbs via granule neurons, modifying the bulbs' reactions to smells when, for instance, appetite is sated.

Mitral neurons send messages directly into the limbic system (blue), seat of emotion and memory—and the aroma of rain on a dusty road.

Some smells cause the limbic system to activate the hypothalamus and pituitary gland, stimulating the production of hormones controlling sex, appetite, body temperature, and other functions. The limbic system also reaches into the neocortex, site of the brain's higher processes, to stimulate conscious thoughts and reactions.

PAINTING BY ALLEN CARROLL, NATIONAL GEOGRAPHIC ART DIVISION

3. Perception

LIMBIC SYSTEM
Part of the brain involved with emotions and memories, to which smell, of all the senses, is most intimately tied. Also activates hypothalamus and thus hormonal system.

OLFACTORY CORTEX
Helps distinguish odors, such as the difference between burning leaves and burning tires.

HYPOTHALAMUS
By regulating pituitary gland, it ties smell messages to internal body chemistry: the endocrine (hormone) and autonomic nervous systems.

THALAMUS
Apparently helps connect odor messages in the limbic system with higher thought functions of neocortex.

PITUITARY
Receives neural messages from hypothalamus and sends chemical messengers into blood, releasing hormones that regulate body functions.

NEOCORTEX
Part of brain involved with intellect. Gives finer discrimination to odor messages, relating them to other senses.





"Sort of musty" is how Henry Pavelek describes the scent of white truffles he seeks in an Oregon forest (left). Trufflers here usually depend on rakes and tree savvy to locate the delicious underground fungi on the roots of certain trees. European trufflers often use trained pigs and dogs. But under ideal conditions a practiced human nose can detect the odor of maturing Oregon white truffles. Pavelek and friends made short work of this truffle pâté (above).

its mouth. A bull will sniff the air and come trotting across the meadow to a cow in heat, but once beside her, he licks her vulva, and his vomeronasal organ probably prompts the final act. His hypothalamus triggers his pituitary, and the pituitary instructs his gonads to produce the hormone testosterone. Then he mounts her.

I was at Amboseli National Park in Kenya one morning with Keith Lindsay, who studies elephant behavior, when we drove up on a large bull—Ajax by name—tearing apart and eating a yellow acacia tree he had up-ended. Ajax was in musth, ready for action if he could only find an estrous cow. Dark fluid ran down his cheek from a gland between his eye and ear, indicating his excitement. A herd of elephants approached from

across the dusty plain. Suddenly the cows got excited. Rumbling like kettle drums, they ran up to Ajax, sniffed his temporal gland with their trunks, and urinated in big pools. Ajax paused, swung his trunk around to their vulvas, to the urine pools, and into his mouth. Having determined that the cows were just fooling around, Ajax continued tossing his salad.

BEN IS A NOSE propelled by a Labrador retriever. Each dawn he takes me for a walk, me with my nose in my morning paper, he with his nose in his, unfolding the olfactory mysteries of our neighborhood as he makes his deliveries. As he slams to a stop to vacuum carefully a blade of grass, this is apparently what he learns: "Hmm, dog urine, not squirrel or cat. Not mine either, nor a female's. A dominant male, probably an Airedale, healthy, contented as a clam, an adult. What's Rex doing still eating Puppy Chow?"

Ben has about 200 million olfactory receptors in his nose. That's 20 times the number in mine. When I walk in the house and smell beef stew, I suspect that he can read between the lines to detect carrots, potatoes, bay leaves, and chuck.

Dogs are being trained to sniff out everything from drugs and bombs to termites and iron ore. In Ontario, Canada, when instruments couldn't pinpoint where natural gas was escaping from a pipeline buried 18 feet underground, trained German shepherds, working in sub-zero temperatures over almost a hundred miles of frozen ground, found more than 150 leaks.

Detective Bob Noll, who until recently ran the K-9 program for the New York City Police Department bomb squad, says, "We always underestimate the dog. Only he knows what he's smelling. We can only be guided by his body language. You have to pay attention to him. You miss a bomb, and it lets you know."

Drug smugglers are learning that the dogs have their number. A drug runner with heroin concealed in her vagina walks off the plane, and a U. S. Customs dog identifies the seat she was in.

Customs agents say that Detroit builds smuggling compartments, not automobiles. Smugglers hide (Continued on page 344)



An exotic banquet reminds us that most subtleties of flavor are pleasures of the nose. In the restaurant of culinary genius Paul Bocuse, center, near Lyon, France, the photographer has arrayed models of fantasy among a dozen leading chefs of



EDDIE PEINHOYS WITH HELEN GUETARY

the Lyon region. Pierre Orsi (third chef from left) says, "It takes years and years of cooking to build your memory of ingredients by the nose. The aroma of cookies just out of the oven will tell me whether the butter was fresh or not."



Smells are difficult to describe, a shortcoming of vocabulary nowhere more apparent than in the lexicon of wines: Impressions of bouquet and flavor have often become shrouded in such high-hat patois that diners may shrink from the shadow of the wine steward. Burgundy vintner André Ropiteau (left), inhaling the aroma of a Meursault Poruzots in his mold-hung cellar (built about 1659) at Meursault, France, says he often smells suggestions of berries and fruits in most red wines, and flowers of the vine in some whites of Meursault and Puligny-Montrachet. But "elegant," "wonderful," and "super" also sprinkle his vocabulary for fine wines.

He might say something unprintable about a garlic-flavored cooking wine sipped by a brave soul (bottom right) at the Gilroy Garlic Festival in California's San Joaquin Valley (top right). At this "garlic capital" celebration tons of the herb are cooked and consumed in every conceivable concoction—from garlic-flavored ice cream to popcorn to wine. "Garlicky" is the only word that comes to mind to pilots in flight, who often smell the festival from miles away.



drugs everywhere: in the rocker panels, the horn, tires, drive shaft. They pull a piston and fill the cylinder with cocaine. They seal coke in vacuum cans and try to hide them in tanks full of gasoline. They attempt to mask the odors with after-shave, pepper, talcum, and garlic. They cover bars of hashish with chocolate. The dogs just smile.

San Ysidro, California, at the Mexican border, is one of the busiest ports of entry in the world: 24 lanes of traffic, 30,000 vehicles a day, and every contraband a car can carry. Clams, parrots, pot, hash, coke, heroin.

When Bo, a German short-haired pointer, crawled beneath a VW bus and bit the oil pan, customs K-9 officer Ed Lynch found more than two million dollars' worth of heroin in a sealed false compartment between the engine and gas tank. I was hoping to witness such a big hit, but it was a slow week, much to the frustration of the handlers. Nonetheless, the dogs were convincing enough with the nickels and dimes they turned up. Brutus, a black Lab, jumped in a red Thunderbird and started scratching at the compartment between the seats. His handler, Roy Gallagher, popped open the compartment and shone in a light. He found a few tiny flakes of marijuana.

SINCE NO ONE can interview a dog, experts still speculate as to just how a dog distinguishes your track from mine. All sorts of odors emanate from and mark us: shoe leather, clothing, cologne, and particularly our sweat, carrying such chemical messages as fear. Also, our bodies constantly shed microscopic flakes of dead skin, leaving a trail of decomposing, odorous confetti. In any event, dogs tend to follow the freshest scent, particularly vegetation crushed underfoot. Most dogs trail with their heads up ransacking the air, but I've seen a few trained to sniff cautiously every footprint to find their man.

Lanson Newsome cares only that his bloodhounds eventually find two feet in the track. Newsome is warden of the Georgia

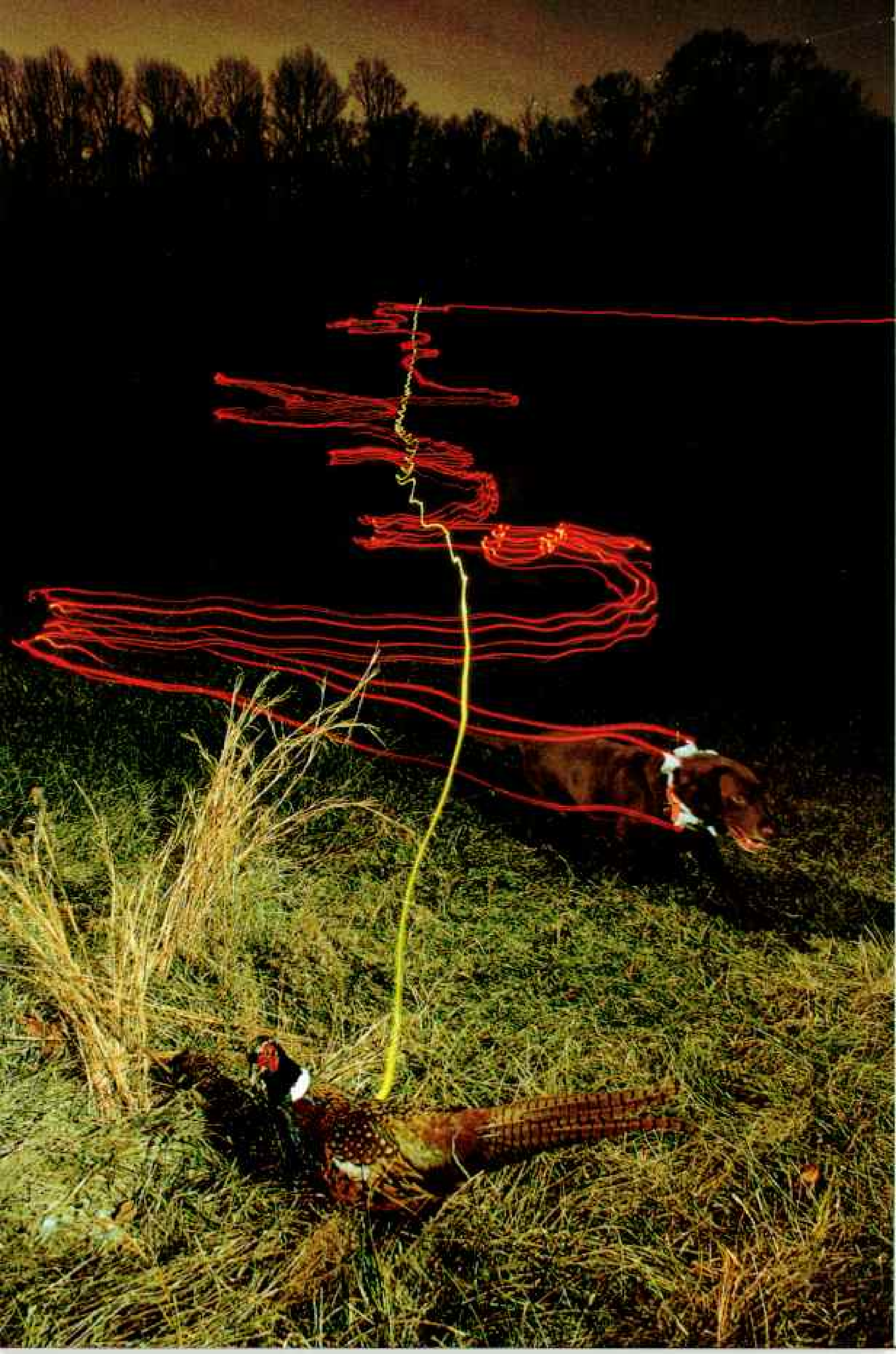
State Prison at Reidsville. "There's nothing like the thrill of hunting a man," he told me. "I've pulled a dog off a scent, thinking the man went this way or that, and the dog was almost always right. You have to learn that dog like you know your wife."

Heat and sun quickly dissipate a human track. Frost helps preserve it, and cool, moist conditions are ideal for tracking. Newsome doesn't believe stories he's heard of dogs following a track five days old. Most experts say that under ideal conditions even a well-trained dog will have trouble with a track more than a few hours old, and on hot pavement it's a matter of minutes. "You let a man over the fence and give him 48 hours head start," Newsome said, "and you better be able to track B. F. Goodrich, because he's going to be gone."

At the Monell Chemical Senses Center in Philadelphia, Kunio Yamazaki has trained some tracking mice to scent extraordinarily fine distinctions between self and nonself. With two lines of mice, which are exactly alike except for a single set of genes on one chromosome, Yamazaki and his colleagues found that males from one line prefer to breed with females from the other, identifying them from the odor of their urine. This minute genetic difference occurs on the chromosome at the precise location where the mouse is coded for immunologic marking, the chemical system that causes cells from one mouse to reject grafts of cells from another. Lewis Thomas, Yamazaki's former mentor and now president emeritus of Memorial Sloan-Kettering Cancer Center in Manhattan, speculates that olfaction and immunologic marking may be related, and that a trained tracking dog may in fact smell the difference between thee and me.

I add to this conjecture my youngest son, Andrew. When he returned home from an overnight at a friend's house, his mother asked if he hadn't come home with his friend's towel. Andrew immediately pressed it to his nose and sniffed. "No," he said, "it's mine."

"Nobody knows the odors I smell" is gospel according to Ben, the author's chocolate Labrador retriever. Wearing a lighted collar, Ben follows his nose along the scent trail, indicated by green-yellow light, of a pheasant carcass that had been pulled across a field to this stuffed bird. A strobe light catches Ben as he quarters in on his "prey."





The essence of animal communication is chemical, relying on odors produced by skin and body glands, feces, and urine. Cats, like dogs, mark territory by urinating in particular spots, as these cheetahs (above right) do by spraying a rock. Your own cat marks you with facial and rump glands when it rubs your leg. A buck Thomson's gazelle (above) claims his territory by placing on vegetation a sticky, black substance from a gland beneath his eye. Marking serves a number of functions: to create scent trails, to identify and reassure those who belong, and to warn strangers to stay out. Dominant females and dominant males do most of the marking. The messages are imperceptible to us, yet a guinea pig can smell a drop of urine and tell if it



came from another guinea pig; as well as if the other one is male or female, dominant or submissive, friend or foe, what it had been eating, its emotional state, and even recognize the other individual.

A wildebeest sniffing her newborn calf (right) is forming a permanent olfactory bond with her offspring, which is also smelling her odor. The scent releases a chemical in the cow's brain that sends a strong signal to her memory bank telling her that this is an important odor to remember: Cow and calf are in an annual migration with hundreds of thousands of other wildebeests, and lions on the perimeter are waiting to pull down any calves that become separated from their mothers.



ALL BY MITSURU IWAGO



Somerset Maugham inquired of one of H. G. Wells's mistresses why such a paunchy, homely writer had such success with women. He smells of honey, she said.

Body odors are the smell of acids produced by bacteria metabolizing skin secretions. The most repellent odors result from the apocrine glands, associated with underarm and genital hair and activated when we're frightened, excited, or aroused. Men have more and larger apocrine glands than women, blacks more than Caucasians, Caucasians more than Orientals. Varying skin

acidity controls the size of bacteria colonies, slightly altering the fragrance of the same perfume splashed on different people. Since skin glands secrete the by-products of what we eat, diet greatly affects how we smell to others. Nineteenth-century Japanese described European traders as *bata-kusai*, "stinks of butter."

During the World Wars, German soldiers claimed they knew the whiff of the English, and the English said likewise. More recently, North Vietnamese soldiers reported that they often smelled Americans before seeing



them. Jack Holly, a Marine Corps officer who led reconnaissance patrols deep into the triple-canopy jungles of Vietnam, told me, "I am alive today because of my nose. You couldn't see a camo bunker if it was right in front of you. But you can't camouflage smell. I could smell the North Vietnamese before hearing or seeing them. Their smell was not like yours or mine, not Filipino, not South Vietnamese either. If I smelled that smell again, I would know it."

Some years ago my mother, a former nurse, suspected that a neighbor might have

stomach cancer when she detected the familiar odor of fermentation on his breath. In the days before high-tech medicine, physicians depended on all their senses, including their noses, to diagnose illness. An eminent diagnostician might arrive on a hospital ward, sniff, and announce that a case of typhoid fever must be in. Typhoid smelled like baking bread. German measles smelled like plucked feathers, scrofula like stale beer, yellow fever like a butcher shop. Patients with smallpox were said to smell like perspiring geese (whatever that is, since geese

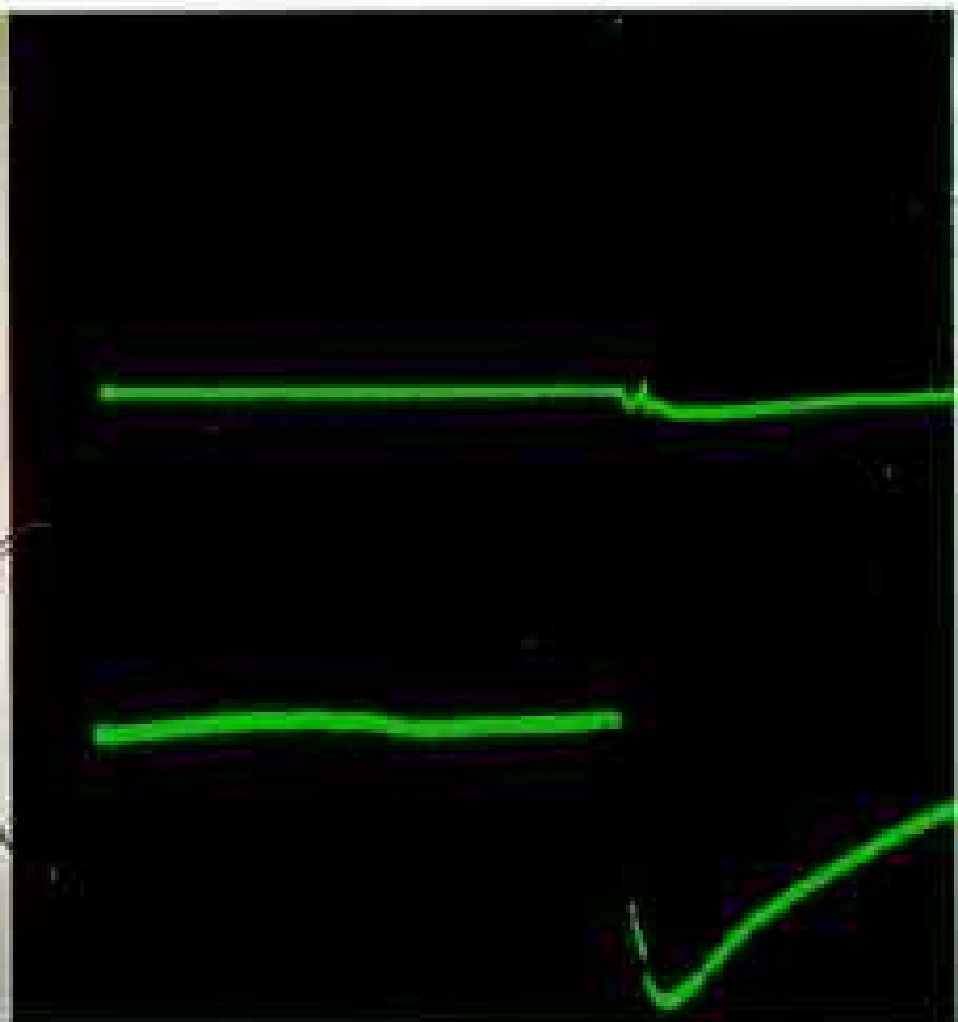


CHARLES KRIBBS

Home-stream aromas reach out to sea to the nostrils of salmon (above), which navigate by smell upstream to where they were spawned. The odors come from soils and plants along the rivers. But salmon can be manipulated to migrate to the hook. The Ohio Division of Wildlife imprints coho salmon fingerlings—not native to Lake Erie—with the scent of the chemical morpholine in hatchery water. Later, fisheries biologist Phil Hillman (left) drips morpholine into the Chagrin River near Cleveland, attracting adult cohos from miles out in Lake Erie to waiting unchagrined fishermen.



A sow in heat will stand to be bred if she smells the boar's saliva and body odor and feels his pressure on her back. Minnesota farmer Greg Bartz applies back pressure and sprays synthesized boar saliva at a sow he will artificially inseminate with the spirette he holds. Such chemical signals, called pheromones, virtually rule the insect world. An oscilloscope (right) records a strong nervous-system response by a male American cockroach, bottom, to a female's pheromone, and almost no response from her.



can't sweat). A surgeon on rounds will ordinarily smell the patient's bandage for infection by *Pseudomonas* bacteria. It has the musty odor of a wine cellar.

Dr. Mark Altschul, who began teaching at the Harvard Medical School in 1936 and is now honorary curator of the school's medical library, believes that the laboratory has drawn physicians away from their senses and their patients.

"Some doctors are afraid of patients," he said. "They're helpless without a lab. It gives them a sense of security they should not have. And I made my reputation as a lab man. You've got to sit down with a patient and talk with him, listen to him, touch and smell him. We didn't have to take a culture out of a baby's throat to know it was diphtheria. It smelled like diphtheria. You smell a patient's breath and know immediately if he's got kidney failure. Fruit flies gather around patients with cirrhosis of the liver, but there are no books by fruit flies."

The emergency ward at Bellevue Hospital in New York City does not allow leisurely diagnosis. "It must be done quickly," Dr. Lewis Goldfrank, chief of emergency services, told me. "We get people we don't know, or who can't speak, so we've got to use all our senses. Odor is important. The breath of a diabetic in coma smells sweet, like apples, although a fruity odor can also mean starvation. The odor of garlic may mean a spaghetti dinner or arsenic poisoning. Turpentine in the urine smells like violets. The odor of peanuts may tell you a kid has swallowed a rodenticide."

Medical textbooks give physicians little guidance for treatment of the two million or so Americans who suffer from anosmias, disorders of smell. Some are genetic, but most result from head injuries, viral infections, allergies, aging, or nasal obstructions. Disorders in the brain can distort odors, so that epileptics sometimes get auras of strange odors just before a seizure.

In an examining room at the University of Connecticut's Chemosensory Clinical Research Center in Farmington, Dr. Gerald Leonard inserted a fiber-optic scope up Nicolaus Weickart's nose. After food began losing its flavor, Weickart saw physicians in Frankfurt, Germany, where he lives, but they considered his complaints to be trivial.

Olfaction has attracted little research money and few scientists. "People sort of giggle about this field of smell," one research chemist told me. As a consequence, anosmic patients often get little medical attention and not much sympathy.

Looking up the scope, I could see gray polyps growing out of Weickart's ethmoid sinus and into his pink nasal cavity, blocking odors from reaching his receptors. He had a chronic infection, and simply clipping off the polyps' ends would not stop them from growing back. Dr. Leonard recommended surgery to scrape the infected tissue from the sinus. Weickart wanted to think that over, but he was troubled by what he was missing.

"I'm a lawyer and a collector of legal histories," he said. "I smell a book before I read it. You go into one of those damp bookstores in Italy, and you smell that old leather, the musty pages. You can smell a touch of history. Now I can't. It's very sad."

Joe Blanton, who answers correspondence at NATIONAL GEOGRAPHIC, is tall and affable, and except for an occasional whiff of Thanksgiving turkey and phantom odors no one else detects, he lives in an odorless world. "It's dangerous not to be aware of the gas being left on," he said, "but when people are groaning about bad odors, it's nice not to be able to smell them. I have no cravings for particular foods. I can't smell it cooking. Venison, veal, lamb, beef are just meat to me. I can't distinguish flavor, only texture and appearance. The nuances aren't there, so I just eat to satisfy my hunger."

His wife, Tracey, said, "It never occurs to Joe that part of the reason I like to cuddle is his smell. When we take walks in the forest or along the beach, I'll say it smells musty or fresh. These are intimate sensations, and Joe can't share them."

"And I'm a very sentimental person," Joe said. "It's always surprising to me that the ocean has a smell."

AT 3:30 A.M. in Lyon, France, Pierre Orsi picked me up at my hotel in his truck and headed for the market, the Marché de Gros. In gastronomy, he said, you must start with everything fresh. Pierre was buying food for his restaurant—the Pierre Orsi, two Michelin stars—and he was anxious to be first at the stalls.



A discerning nose allows dogs to be trained to identify almost any scent, including termites, which Sidney, a beagle leased to exterminators, has discovered in a wall he has scratched open (above). Escaping prisoners in Georgia may meet Mac, a bloodhound trained by James Phelps (facing page). "I charge the sheriff \$100 if I catch an escapee," says Phelps. "Don't charge for lost children." Only Mac knows what odors he follows—perhaps shoes, sweat, fear, or crushed vegetation.

Pierre bent over the crates of fish and sniffed their gills. "When fish is very fresh, it does not smell very much," he said, lifting a trout to his nose, then leaning to a ray. He rejected a crate of *lotte*, a Mediterranean fish, promptly ate a handful of shrimp and pronounced them excellent. Darting around the stalls, his black eyes flashing, Pierre loaded his truck.

At another market he sniffed melons and nibbled blueberries ("I make sorbet with

these"), then went into a florist shop to select tightly budded pink roses for his tables. He closed his eyes and sniffed them. "Never carnations in the restaurant. That's the smell of the dead."

As a boy, Pierre spent summers on a farm. "Caramel, roast-veal gravy, the smells were so good," he said. "We cooked rabbit and chicken in crockery and iron pots slowly on a wood stove. With the same ingredients I now cook with steel and electricity, and I cannot get the same smell in my kitchen I remember as a boy."

In his kitchen Pierre sniffed a soup and popped cookies in his mouth as they emerged from the oven. "I smell the knife and carving board each time I use them," he said, "because they may smell of garlic." He handed me a crystal goblet. "Smell it." I smelled nothing. "When I go into a restaurant," he said, "I always smell the glass and napkin. In a good restaurant they will smell fresh, no odor of detergent. The soap in my restrooms has no perfume, because when you wash your hands and then eat, you do not want the perfume to compete with the aroma of the food."

When his recipes call for vanilla, Pierre inserts a knife into a long, black vanilla bean and scrapes tiny seeds into the pot. Europe didn't learn of vanilla until Cortés found the Aztec flavoring chocolate drinks with it.

SPICES were used by the Egyptians 4,500 years ago to embalm bodies. Cumin, marjoram, cinnamon. It was thought that bad odors caused disease, and pleasant ones chased it away. Hung-over Romans—at least the rich ones—slept on pillows stuffed with saffron.

When the Black Death was devastating 14th-century Europe, physicians made their rounds entirely encased in black leather, their heads looking like basketballs with long beaks full of aromatic spices to ward off the plague and its stench. It's a wonder they didn't scare their patients to death. By the time Columbus sailed west, Europeans coveted Eastern spices to disguise rancid meat and put life into their meals. In a way the New World was discovered by a nose.

In James Thurber's spoof of wine snobbery, the host at a dinner party raises his glass and says, "It's only a naive little



domestic Burgundy without any breeding, but I think you'll be amused by its presumption." Wine talk today leans toward words of laboratory exactness—acidity, must weight. Somewhere between Thurber and the lab lies André Ropiteau, owner of a large white grape vineyard in Burgundy, France, who dips his nose in a goblet of Puligny-Montrachet and says, "I smell honey. You need only smell the bouquet. Most of the identification of wine is in the nose, and the taste is only confirmation." He sucked air through pursed lips, slurping and gurgling the wine, warming and sending its aroma up the back channel to his nose. For André, drinking wine is subjective, like making love, which is how he described an '82 Puligny-Chalumeaux. "You drink wine with your heart," he said.

THE EGYPTIANS discovered incense when someone burned resinous frankincense and smelled the smoke. *Per fumum*: through smoke. The Romans borrowed perfumery and the bath from the Egyptians and combined scent and sensuality with vigorous extravagance. Nero's wife, Poppaea, is said to have bathed in asses' milk scented with rose oil.

With the rise of Christianity the church banned public baths, and, it hoped, any fooling around underwater. For centuries stink was next to godliness. Yet even in the Middle Ages the rich wanted their perfumes, if only to obliterate odors of the lower classes. Perfumery gradually matured from resins and rose water to sophisticated blends of oils of fruits, spices, roots, mosses, and flowers, and the heavy animal scents of musk deer, whale ambergris, beaver castoreum, and civet.

Only a few of the old Paris perfume houses like Chanel and Guerlain still make their own perfumes. Dior and Rochas put their labels on fragrances made by Edmond Roudnitska of Cabris, France.

Surrounded by paintings and sculpture in a splendid hilltop house near the French Riviera, Roudnitska works at a pace so serene that in 40 years he has written all his ideas for perfumes—Diorissimo, Eau Sauvage, Femme—in one small spiral notebook. Thinking in terms of shape, form, and color, he takes years to compose a fragrance.

Roudnitska is the setting sun of the golden age of perfumery. Pausing before a Gauguin, he said, "The genius of Gauguin was the combination of deep blue with clear pink. It is a composition, like a compound of perfume. See, there's a little splash of orange. I do not smell when I create. Like a composer, I write the names of the products that will do well in my shape. I smell only the final compound."

Bernard Chant can't afford Roudnitska's repose. Chant is chief perfumer for International Flavors & Fragrances, in New York City, the largest company of its kind in the world. IFF is a chemical ghostwriter, creating everything from perfumes to flavoring for taco chips, behind its clients' labels.

On any day Chant may be working on fragrances for products as diverse as shampoos, colognes, or plastic trash bags. He is a sophisticated Frenchman with graying hair. He held in his hand a small chrome tripod to which were clipped three strips of blotter paper, scented with variations of a cologne he had been trying for months to perfect. As we talked, he would turn the wheel and sniff a blotter.

"In the mountains you can find tiny wildflowers that have a sharp, heady smell," he said. "I want to give this impression for the top note—what the consumer will perceive as she opens the bottle and puts it on her skin. It is fleeting and will give way to the main theme of the fragrance. Top note, main theme, end note must be one symphony. A good fragrance has to diffuse and last. If it doesn't project, you have no fragrance. I want it to come out and hit you. My wife will try it this weekend. If she becomes too polite, I will know she doesn't like it."

This cologne was composed of dozens of natural ingredients and synthetic compounds. Chant handed me a blotter of ambrein ("the warm note of amber"), then cardamom, then mandarin.

"Here is civet. Animal smells are long-lasting background notes, the fixatives that carry the other smells. Skunk has a very meaty smell. Civet is more fecal."

Amen. I'd gladly return it to the cat. But a dash of civet, like the cellos of a symphony orchestra, helps transform other ingredients into an elegant fragrance.

Great perfumers are artists, but training



Ventilating a smoker's office requires three times the air—and higher energy costs—for it to smell as fresh as a nonsmoker's, according to the Pierce Foundation of New Haven, Connecticut. In a Pierce test chamber, volunteers' smoke is measured and transmitted through a duct to odor judges outside the chamber.

makes a good nose. "We use thousands of ingredients," Chant said. "A young trainee must find a way to remember each one by comparing its smell to something he has been exposed to. Slowly he learns what that smell is all about, and eventually what is abstract takes on its own identity. You spend a lifetime learning how each ingredient changes identity when combined with others. In Egypt I woke up smelling a perfume I had never smelled before. I thought I had broken my bottles. It was all a dream.

"Through advertising we may have made fragrances seem too precious. A woman will reapply her lipstick or makeup throughout the day, but not her fragrance unless she is going out again at night. A man is even more

difficult. He is embarrassed to be seen trying on fragrances."

Behind such reluctance may be the fear of sending the wrong message. On the way out of the building I found myself on an elevator with a man in tight pants, an earring in his lobe, and eyes like Carol Channing's. He fluttered his big eyelashes and said, "Saaay, what is that *marvelous* fragrance you're wearing?" I mumbled something about IFF's nest odor, as I considered an exit through the roof.

WE MAY WEAR fragrances to give us confidence and familiarity, but Madison Avenue's panting message of perfume is an invitation to



Oil of rosewood from laurel trees in Brazil comes to the perfume industry by way of Amazon River traders and importers such as Stephen Manheimer (above) of New York City, who sniffs a shipment from the Brasil Jimmy trading company. Perfumes are composed of hundreds of natural products and many hundreds more synthetic compounds. "Synthetics have almost replaced rosewood oil," says Manheimer, "but the elegant effect of the natural oil in perfume makes it still important to go to all this trouble to get the original."

Fragrances are also being added to products as diverse as soaps, cat litter, and dolls (left) as companies discover that consumers will gravitate more readily toward a product that smells nice than toward one that has no smell at all.

the pillow. In the 1960s and '70s the youth of Aquarius threw out their Old Spice and White Shoulders and reveled in the muskiness of sex without guilt and soap, and soon there were fragrances on the market suggesting musk as the straightest line to the bedroom. Were science to find that there are human pheromones drawing men and women together like moths—and that's unlikely—the mystique of perfumes would probably go up in smoke.

Perfumers say that Germans like pine—fresh notes. So do Brazilians. The French, with more sophisticated perfumes, prefer exotic, warm flowery notes like jasmine,

common in southern France. Japanese fragrances are delicate, fine, not blunt or obvious as they tend to be in the U. S.

Floor cleaners in Venezuela have ten times the pine fragrance of U. S. floor cleaners. A weaker fragrance wouldn't sell. Venezuelan women may wet mop their tile floors twice a day, leaving windows and doors open so the scent can be carried to the street to fortify the message: My house is clean.

Gus van Loveren, formerly IFF's perfumer for functional products—soaps, fabric softeners, you name it—told me, "For many years in Germany chlorine notes were out, because during the war they had to



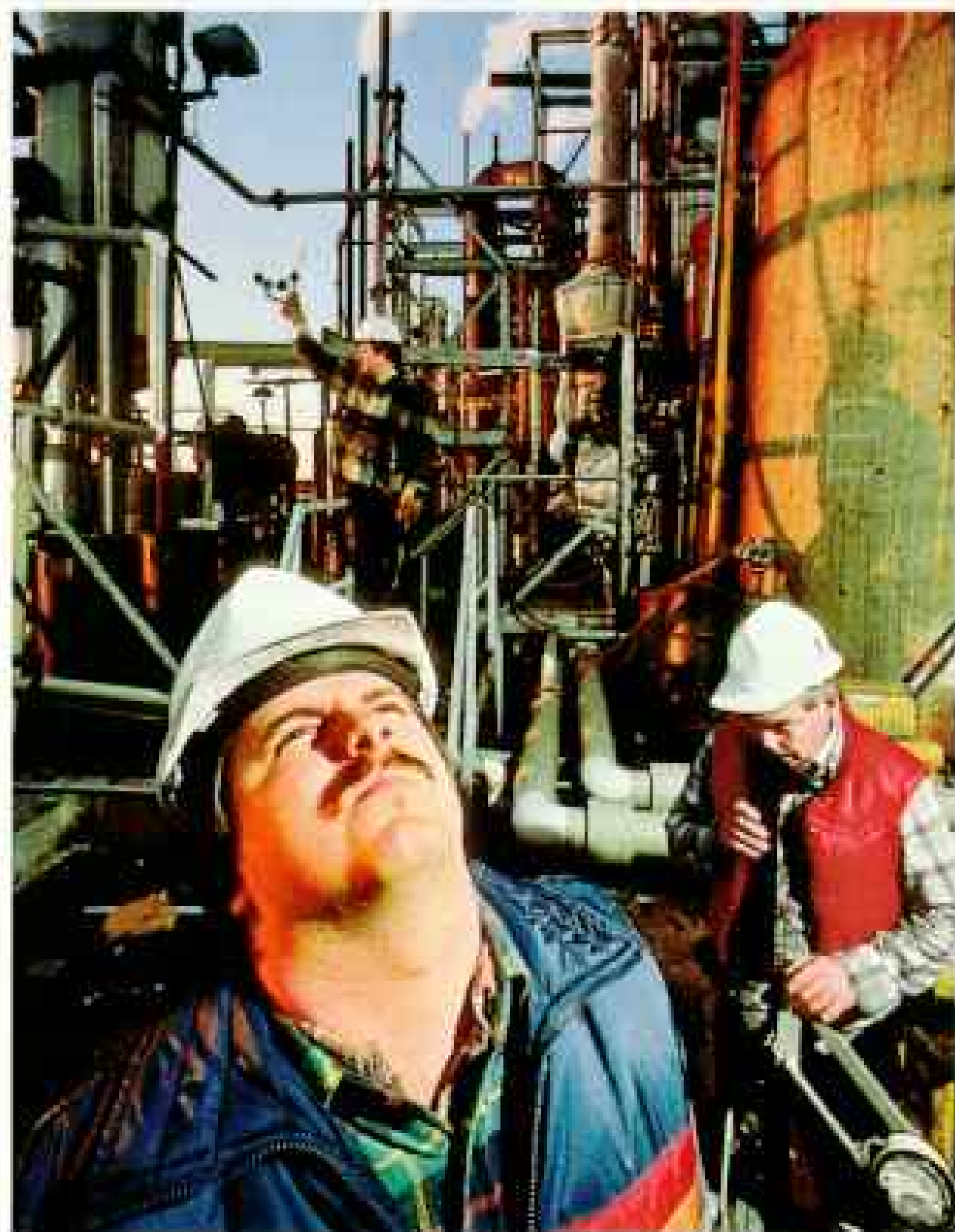
clean up the bombed-out areas with chlorine. A chlorine-bleach product would bring back memories of the war.

"I have made a lemon fragrance, probably the biggest lemon fragrance in the world. It smells more like lemon juice than the real thing. It comes from a combination of products that aren't lemon. It's like a caricature. The cartoonist puts a bigger nose on the drawing, and immediately you can see that it is de Gaulle."

On a table Gus had arrayed dozens of bars of identical soap. For the client he and his staff had tried hundreds of fragrances in the lab. An IFF "odor evaluation board" would

help narrow the selection for perfumers such as Chant and van Loveren. Board members never smell a fragrance by itself, only as it will be used by the consumer. They may sniff a washed arm (Colombian soap), clothes from a dryer (a softener for the U. S.), toy soldiers that smell of cordite. They speak in shorthand. "I'm rating it number three because of the green note." "It's more of a leathery note." "The rosy character seems to have popped out." "It's a jammy note. That's what I mean by fruity."

Gus handed me a bar of soap destined for the Indonesian market. He had gone down to a river in Bali where women were bathing



What's a stink among neighbors?

A potential lawsuit, and probably lowered property values. To be a good neighbor, a chemical company near Philadelphia developed an abatement plan after odor consultants (above) from Arthur D. Little, Inc., identified the sources of a stench. The smell of smoke can permeate a fire-damaged building for years: A deodorizing company spreads aromatic fog (left) to mask the smoke odor.



Every human body is an odor signature, according to Chicago scientist B. K. Krotaszynski (facing page), who helped develop this glass chamber for analyzing the hundreds of body-odor constituents that profile sex, race, nutrition, and illness. Dr. Lewis Goldfrank (above, at left), chief of Emergency Medicine at New York City's Bellevue Hospital, trains his staff to recognize promptly the odors of poisons and diseases that might roll in on the next stretcher—a reminder that smell can be a matter of life and death.

and made inquiries. "They are Hindus," he said. "They don't use any colognes or perfumes. They are very clean, and soap is how they perfume themselves. They like nice woody, floral fragrances. Soaps in the lower end of the European market don't smell nearly this lovely."

THE BIGGEST USERS of fragrance are companies like Procter and Gamble, Lever Brothers, and Colgate. One brand of soap uses more than two million pounds of fragrance each year. If the fragrance is bought from IFF, the formula remains locked in IFF's vault, and the fragrance rolls out in 55-gallon drums. "We put

fragrances in shampoo to make life more pleasant," Gus said. "Your hair would wash just as well without a fragrance, but with it you sing in the shower."

Soap companies first used fragrances to mask the offensive base ingredients, later to make soap smell nice. "Eventually, fragrance becomes what the product stands for," one company executive told me. "Whether you use Downy fabric softener, Final Touch, or Snuggle, if you follow directions the result will be about the same. To the housewife the final test is largely how her clothes smell. It's what says to her, 'This product is working.' Fragrance is the strongest drive in consumer soap preferences. Among all the attributes, I would probably rank performance at the bottom."

Gus and I walked to a nearby market. He is an enthusiastic smeller. He picked up a pack of toilet paper, poked a small hole in the cellophane, squeezed it, and sniffed. "'Unscented,' it says. Means it is scented. Almost everything is perfumed." He lifted a sack of cat litter to his nose. "Yessir, this has a fragrance. It smells of anise. Cats like it." A window cleaner: "Hmm, lemon-scented ammonia. That's interesting. Every marketer is trying to break that tradition of lemon oil as a cleaner." He screwed off the cap of a fabric softener. "These are beautiful fragrances. See, it's soft smelling. The marketing people know that the housewife who has to decide which one is softer will smell the softness, and we have to support them with a fragrance that smells softer."

A woman pushed a shopping cart past us. Gus turned and asked her, "Is that Ombre Rose?" She was slightly startled, but flattered to be noticed. "Why no," she said, "I don't have anything on. I just took a shower. Oh, well yes, I did put on some hand cream. What did you say it was?"

"Ombre Rose."

"No, that's not the brand."

"Yes, but it is the same type of fragrance."

Later Gus said, "She wasn't even aware she had put on a fragrance, but I'll bet that she used four or five products with a fragrance in them this morning—a soap, shampoo, makeup, hand lotion."

We headed back to Gus's office. "Just as you walk with your eyes open," he said, "you should walk with your nose open." □



Once they were many; now they are so few. Nearly three and a half million Jews lived in Poland in 1939, and their homes, synagogues, and schools throbbed with an exuberance that made Poland a center of world Jewish culture. Then came the Holocaust. . . .

In the years since, anti-Semitism has driven thousands more from Poland. Today the remaining Jews number perhaps 5,000, nearly all of them old, scattered like withered straw across the Polish plain.

Sara and Rafael Adar (right) live in Włodawa, on the Soviet border. Sara was a high-spirited young woman when the Germans marched into town; she swam the river bordering her family's farm and fled to the Soviet side. Seven years later she returned to find she had no family. Rafael too lost everyone. They met and married after the war. Now their world, once vibrant with Jewish life, is quiet. "We are making our exit," say the old Jews. "We will be gone in a minute."

Other survivors bear death-camp tattoos and grim memories. Few want anything to do with strangers. Photographer Tomasz Tomaszewski and author Małgorzata Niezabitowska, a husband-and-wife team, worked for years to build the trust implicit in the following story.

—THE EDITOR



REMNANTS:

By MAŁGORZATA NIEZABITOWSKA

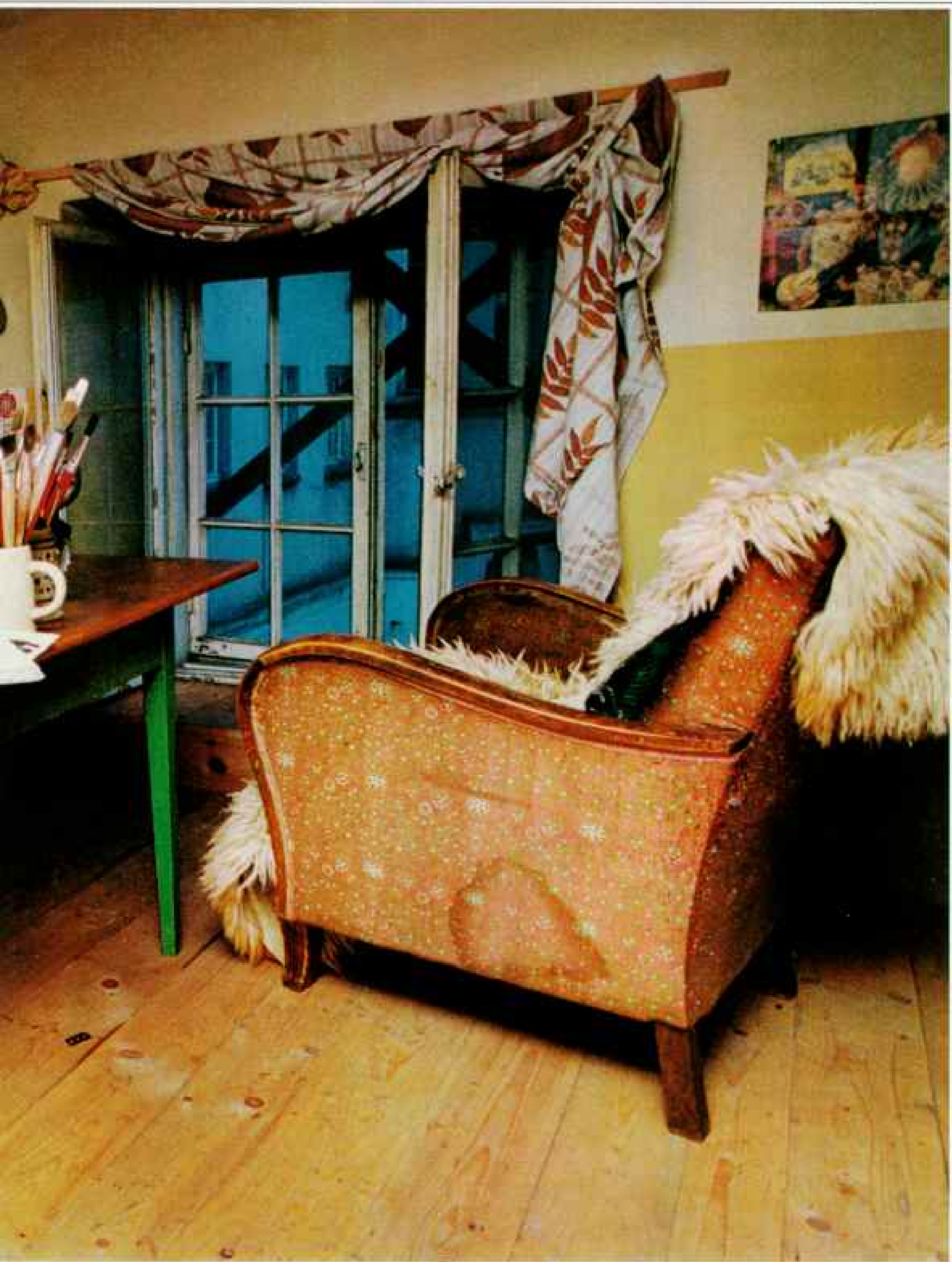


The Last Jews of Poland

Photographs by TOMASZ TOMASZEWSKI



"The seedling who has grown from a sea of nothingness," say Warsaw Jews gratefully about Mateusz Kos, who in 1985 became the first Polish boy in decades to celebrate his bar mitzvah. In



his family's apartment beforehand, Mateusz studies the Hebrew passages he is to read aloud during the ceremony. From this day on he will be a man in the eyes of Jewish law. "There are so few

Jews, and they are so old," says Mateusz, who is amazed by the excitement and attention lavished upon him by the old people. "Sometimes I think, what will it be like when I'm old, when I'm 40?"

A wealthy woman before the war, Leja Szmídt and her family owned a bread factory in the town of Góra Kalwaria that sold thousands of loaves a day. When the war came, both her family and the bread factory were destroyed by the Germans. She and her husband managed to hide with some of their wealth. They used the money to survive the war, by paying the Poles who kept them from the Germans.

Now in her 90s, Leja lives alone in this one-room apartment in the village of Baniócha outside Warsaw. Her only companion is a cat, which eats from the dish next to the stove. This picture was taken on the day a member of the Warsaw Jewish community brought her a supply of matzos for Passover. "She was very happy to get the matzos," says Tomaszewski. "She's old and powerless and the only Jew in Baniócha."







The young Jews of Warsaw celebrate Passover with a seder, the highlight of the eight-day holiday. Author Malgorzata Niezabitowska, far right, joins the festivity. Many of these



people, not raised in their religion, didn't know they were Jewish until 1968, when a wave of anti-Semitism swept Poland. Then they became painfully aware. Thousands of Jews left Poland. These few

decided to stay and embrace their Jewishness. Because there is no rabbi to instruct them in ritual, they teach themselves from American books. "We are the last, definitely," they say.

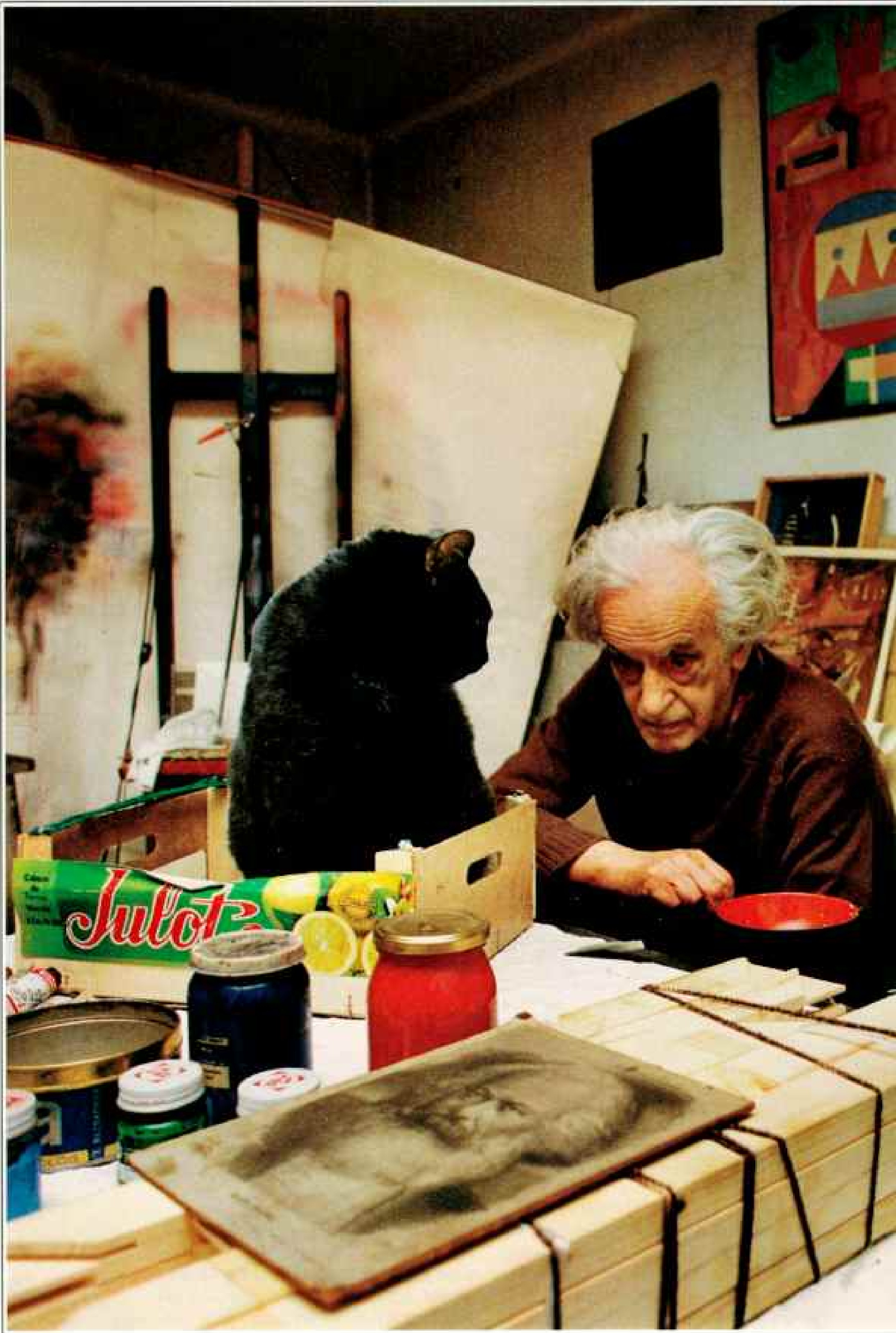


On a cold and quiet day in the Jewish cemetery in Warsaw, another of the Jews is gone—laid to rest without ritual by hired workmen in the frozen ground of a Polish November.



Hundreds of thousands of Jews lie buried here, in a place that shows the sad face of neglect or morbid cruelty: trees sprouting from unkempt graves, desecrated markers crumbling and pocked with

bullet holes. In this cemetery the Nazis ordered Jews to dig sand for the wall they were forced to build around the Warsaw ghetto. Later they filled the pit with the bodies of murdered Jews.





Jonasz Stern escaped death on July 20, 1943. It happened in the ravine at the end of Janowska Street, the site of mass executions of the Jews of the Lwów ghetto. Months earlier his wife had been shipped to Auschwitz, where she threw herself onto the electrified fence. Now it was his turn.

Miraculously, as SS bullets hit rows of people, he fell unhurt. Corpses covered him. He fainted. When he came to, the Germans had left. He lay there until the bodies around him became cold and stiff. In the night he crawled out. Smearing with the blood of strangers, he ran into the depths of the forest, then fled to Hungary. After the war he moved to Kraków and became a celebrated painter. His work, much of it abstract composition using fish skeletons and animal bones, is clearly obsessed with death. Stern comments, "A man who has lived through his own death could hardly tell the world anything else."



This man is haunted by the past. He lost a leg in the war, after being wounded and taken to a Soviet camp. There he drank a bottle of vodka and allowed his cell mates to amputate the



limb with a knife. Now he wears an artificial leg. He is also a man who loves books. They are his passion. He sells them on the streets of Legnica from a baby carriage. Because he is old and

crippled, boys often steal from him. And because he is a man who loves books, he buys them back an hour later. His spare time he spends in bed, playing chess against himself.

IN 1939 the 3.4 million Jews living in Poland formed the world's second largest Diaspora community. Today perhaps as few as 5,000 of them are left, the remnants.

Giants of literature, thinkers, reformers, scholars, and politicians grew up and worked in Poland. But later, during the Second World War, Poland became the land of the Holocaust. And even though that crime was planned and carried out by Germans, its shadow fell on the country and the people who were its witnesses and, what is worse, did not always sympathize. During the 41 years since the war, only very dramatic events like the mass emigration of 1968, in which more than 30,000 Jews left Poland after an episode of official anti-Semitism, have drawn the world's attention to Polish Jews. The rest is covered in silence.

Polish Jews, the remnants, are mostly old, lonely, ill people. Most members of the Jewish community are 70 or older. There are few children or young people, there is virtually no middle generation. The fate of the majority of these people has been unusual and astoundingly varied. But they all share the consciousness, which gives their lives a tragic dimension, that something is irrevocably coming to an end. "We are definitely the last," we heard more than once, and also from the young, who are so very few.

Lublin, a "Jewish Oxford," was famed throughout Europe for Talmudic and cabalistic learning. It was an important center of Hebrew printing. One of the first *yeshivas* in Poland was established here early in the 16th century. In 1939 some 40,000 Jews lived in Lublin. More than four decades later I have come to Lublin to find ten, a *minyan*, the number of males aged 13 and above required by Jewish law to form a quorum for prayer.

The doors of the prayerhouse are closed and secured with two padlocks. Matys Zoberman, the *shammes* (sexton) and the leader of the Lublin Jewish community, opens them with some difficulty. He is old and ailing, and these are serious padlocks, rusty and seldom used. Jews gather here for prayers on only the



most important holidays. "Rosh Hashanah, Yom Kippur, Simchas Torah, Pesach [Passover], Shavuot"—Zoberman counts them off on his fingers.

The room is vast and almost bare—an old coat rack on one wall, benches falling apart along another. It takes me a moment to pick out the small pulpit, covered with faded material, near the window. A Star of David is embroidered at the top. Nearby stands a long simple table, with shelves full of books behind it. Some have beautiful, richly imprinted



bindings, but they lie in disorder, jumbled and dusty. On the other side of the pulpit stands a plain, crooked cabinet. "That is *aron ha kodesh*, the sacred repository," Zoberman explains. "We have two Torahs."

Zoberman lives in Lubartów, 15 miles from Lublin. Before the war Lubartów was a Jewish town, but now only he is left, the last one. He has passed through many camps. He has worked in quarries, in mines, and in munitions factories. He has seen tens of thousands of Jews go to their deaths.

The army and motors are Henryk Laden's two obsessions. They brought him glory during World War II. When a Polish army began forming behind Russian lines, Laden volunteered and was soon put in charge of vehicles. He won medal after medal for bravery under German fire. After the war he settled in Siedlce. "I bought an old Volga, rebuilt it, and made it into a taxi. It was the first taxi in town . . . and has the number one painted on the door." Laden is still a proud man. He wears his decorations every day—and drives the number one taxi in town.

Survivors of the storm

Heirs of a culture that thrived in Poland for a thousand years, today's Polish Jews are the remnants of a people virtually destroyed by the Holocaust—much of which was staged on Polish soil. Of the three million who perished, most dwelt in cities or towns. In 1940 they were confined to ghettos, and later exterminated.

Although not revealed by any census, Poland's total Jewish population today is believed to be about 5,000. Most make their homes in Warsaw or Kraków.



Three years ago, after the death of the previous president, he was elected head of the Jewish community. He did not want the job. "I am a simple man," he explains with an embarrassed smile. "But they asked and insisted. 'You don't have anything else to do,' they said, 'or any family.'"

"There's no money, there's no strength, there are no people. . . ." The old man shakes his head in resignation.

"But once?" I ask.

"Ah, once. . . ." His face brightens for a moment. "Fifteen or so years back there were 20 or 30 of us for prayers. We came every Saturday. There was a kosher cafeteria, and Jews lived in the rooms across the hall. Then they left, they died. There were fewer and fewer of us, fewer. . . ."

"How many of you are there today?"

"A handful."

"But do you still have a minyan?"

"For the important holidays, everybody comes. They come from other places, from Włodawa, from Łuków, from Siedlce. And so a minyan somehow gathers."

From REMNANTS: THE LAST JEWS OF POLAND, by Małgorzata Nieszpilowska, photographed by Tomasz Tomaszewski, to be published this month by Friendly Press. Copyright © 1986 by Friendly Press, Inc. Translated from the Polish by William Brand and Hanna Dobosiewicz.

"Who belongs to your minyan?"

Zoberman, who has been pleasant, even warm until now, suddenly stiffens. For a moment the old man looks at me in silence.

Then he says harshly: "I won't tell you. You can find them on your own."

I PICK MY WAY among tubs of freshly washed linen. At the end of the corridor is a shabby door. The umbrella maker lives here, the second member of the Lublin minyan after Zoberman the shammas.

The old man has a strange face, exotic and striking despite its undeniable ugliness. Everything seems too big, too expressive—his nose, his swollen eyes, his enormous mouth. He is wearing a nylon yarmulke.

At first the man does not exactly understand why I have come, but when it sinks in, he reacts violently. "Nothing's going to come of this! I won't go for it!" His tiny, delicate wife tries to mediate, and she gets a scolding: "Quiet, mother!"

"And the fact that I say no, a completely decisive no, ought to be enough for you, miss. I'm no monkey to be put on display."

Saddened, I protest. This man with a bitter

and mocking exterior is, for me, an unexpectedly discovered character from the old Jewish world. A man with a modest occupation, simple, not wealthy, and yet respected for his wisdom and knowledge. I ask for a couple of clarifications. He renders a lengthy discourse on impure spirits, a detailed description of the celebration of Simchas Torah.

"So what do you want to write? The truth?" He is scoffing again. "But there is no truth, there are only varying degrees of lies."

"Is that how a devout Jew talks?"

My host smiles unexpectedly. "You've got me there, miss. Yes, yes, truth exists because God exists."

MARIAN ADLER, the president of the Lublin Jewish Social-Cultural Association, does not believe in God. He lost his faith as a young man, even though every one of the 4,000 Jews in his hometown of Biłgoraj was religious. Some more, some less, but everyone observed tradition.

Adler joined the Communist Party of Poland. In that region the Communists—Jews, Poles, and Ukrainians—"did their work" together. They distributed underground literature, agitated, formed trade unions, or organized cells in the existing ones. "We kept the police busy," Adler says. He was arrested for Communist activity and spent three years in prison.

"What do you think about Communism now?"

"You know, it is a beautiful idea. Noble. But it depends on who carries it out."

Years ago, when there were a lot of Jews in Lublin and they all had more strength and enthusiasm and better health, those from the Jewish Social-Cultural Association and those from the religious community were antipathetic toward each other, downright hostile. Now, when so few of them are left, and age, loneliness, and sickness affect them all, the conflicts of bygone years seem less relevant.

The second Jewish Communist in town is Edward Ungier. He has known Adler since their prewar party activism, they are still

friends, and they go to the prayerhouse together. "We don't believe," Ungier says, "but we go so that there can be ten and they can pray. They need to be supported somehow, don't they?" Edward Ungier, too, feels old, sick, and lonely. In his youth he was athletic. He threw 200-pound sacks on his back, worked all day without any fatigue. He lost his strength in the Soviet Union. "I was a wreck when I got back from there," he says. Five years of war, camps, and hunger did the job. He had scurvy and insomnia and his nerves were shot. He never really felt well again. Now he suffers from every possible infirmity: diabetes, prostate and kidney conditions, circulatory failure. But the worst torments are the moral ones.

"During the war the only thing I wondered about was whether I would ever be lucky enough to see a loaf of bread lying on the table, slice it, and eat it in peace. Oy, I thought then, I may never live to see the day. So when I survived and returned to Poland, all I wanted was peace. But that was not given to me."

"You were made to feel this?"

"Because I was a Jew. When I arrived in 1945, my comrades in the party at once took me aside and said, 'Edward, you're going to be a big shot here, a manager. We'll find you something right away.' But I didn't want it. I don't have the education, you see. So I went to work in an office. And it was good. I worked in peace until I retired. But it came out from time to time nevertheless."

"What?"

"Everybody else would win awards, but never me. They gave me a lower pension than I was entitled to. And so on. And in the end it would always come out: 'Because you're a Jew.' But the worst was with my children."

"You have a daughter and son."

"They both turned out well—educated, university graduates. Seeing that my wife is Polish, and in addition I did not practice religion, the children were brought up completely Polish. And then, in 1968, my Jewishness was thrown in their faces. My son took it so hard that he nearly became an anti-Semite."

"How is that?"



Guest of honor at a Polish wedding, Zygmunt Warszawer joins the bride and bridegroom in a barn where he hid during the war. The bridegroom is the son of the man who risked his life and family to conceal Warszawer here. For two years Warszawer slipped from farm to farm. Without the help of Polish peasants, he surely would have died. And so he attends every wedding, christening, and funeral in the area, although his home and butcher shop are miles away in Warsaw. He includes all the wedding guests when he says, "my saviors."

"Everybody was talking about Jews then, and in various ways they jabbed at him. He would come home and fret over it and ask, 'Why Dad? Am I worse than everybody else?'"

"My daughter left first, in 1978. She settled in Canada, near Vancouver, along with her husband, a Pole. My son and his wife and their six-year-old daughter finally emigrated in 1981. Now they are all living together in that little town on the Pacific. I know that I will never see them again. Even in the hour of my death I will be completely alone. And



what do I have for the rest of my life? Letters and photographs."

The daughter of Szmulewicz the tailor did not leave. She lives in Lublin, just a few blocks away, but for Szmulewicz, the fifth member of the Lublin minyan, it would be better if she were not here at all. Two years ago she married a Pole; her father cursed her and turned her out of his house.

A religious Jew, as he defines himself, Szmulewicz does not want to know anything about his daughter and does not even want to

think about her. Yet he cannot speak about anything else. Endlessly, obsessively, he returns to the same theme: How they deceived him, how they failed him, how his own wife, a Jew to boot, helped them.

"But Mr. Szmulewicz," I manage to break in, "how else could it have turned out? Just who was your daughter supposed to marry?"

"A Jew."

"But there are no young unmarried Jewish men."

"Did that give her the right to marry a goy, a Pole?"

"Why not?"

"Because all Poles hate Jews."

"All Poles hate all Jews? But Mr. Szmulewicz. . . ."

The tailor, however, will not be reconciled. As we talk, the door opens every so often. Clients walk in for fittings, and friends to chat. The shop grows crowded, so I edge toward the exit. Right in front of the door I notice a large photograph hanging over the sewing machine—several laughing people sitting around a table on a terrace.

"What's the picture?" I ask.

"That's the forester's house where I hid during the war," Szmulewicz answers.

"And who are they? Jews?"

"Jews? What Jews? Those are the foresters, the Poles who saved my life."

HENRYK LADEN, the sixth member of the Lublin minyan, lives 65 miles to the north in the town of Siedlce. Laden's everyday dress is a semi-military jacket with three rows of ribbons and miniature medals pinned on the chest. Their originals completely cover half of the dress uniform jacket that hangs in the closet, always ready to be put on. And Laden puts it on often, even if there is no holiday. His richly equipped apartment is full of mementos from World War II: pictures, photographs, military memorabilia. The army was the great love of Laden's life—a love that was not fully requited.

"I made history," he says, and he is not exaggerating much. Every Polish student learns

about the First Kościuszko Division, which was the beginning of today's army. Henryk Laden, arrested and transported to Siberia at the beginning of the war, had four years of difficult residence in the U.S.S.R. behind him. So as soon as he heard about the creation of a Polish army in the Soviet Union, he left the collective farm where he had spent the previous few months. He arrived at Seltsy on the Oka in May 1943, among the first volunteers. He became a gunner in the First Light Artillery Regiment.

The equipment they had in those days was modest at best. Things did not change until the United States sent thousands of vehicles and spare parts to Moscow as aid to its ally.

"I had been a professional driver before the war and cars were my passion," Laden says. "Later I went to the front with the Russians in those vehicles."

Laden covered the whole operational route of the First Polish Army, from the famous initial battle at Lenino to Berlin, which they took with the Soviets in May 1945. He watched as soldiers raised the Polish flag above the Brandenburg Gate—"the most beautiful moment in my life," he says today.

"Were there a lot of Jews in the First Army?" I inquire.

"Oh yes, a lot. There were five of us from my little town near Lwów: Markus Lang, Pomeranz, Targielski, Reiser, and me. A list of Jewish soldiers of the First Kościuszko Division who were killed in action was published in a Jewish Historical Institute bulletin. There is a page and a half of names and another page and a half of those who were decorated. That shows that Jews aren't so full of fear, that they can fight just as well as others, sometimes better. Unfortunately, that part of the history of Polish Jews is little known."

"Mr. Laden, 40 years have passed since the end of the war. Why do you still wear your decorations?"

"Out of sentiment. Look here—this is the Lenino Medal, this one is for taking Warsaw, for crossing the Oder, for capturing Berlin, for victory over the Germans. This is the Gallantry Cross, and beside it the Silver Cross for

Distinction in the Fields of Glory, another Silver Cross. . . ."

Laden pauses, smiles, and adds completely unexpectedly: "But you know, it's all worth as much as a sucked egg."

"THE MOST DEVOUT among us is Rafael Adar," one of the Lublin Jews confided. The Adars live in Włodawa, a small town smack on the Soviet border.

The little house stands on a quiet side street. Low, wooden, with a small veranda and a yard not much bigger than the veranda. An old gray-haired woman is sitting motionless on a bench near the door. When I ask after the Adars, she beams and grasps my hand. "That's me, child. I'm Sara Adar. Have you come especially to see us? Oy, that's good, that's good. Nobody visits old people. Come here, daughter, and let me give you a kiss."

Amazed and moved by such a reception, I bend to kiss the woman on the cheek, and she raises herself and hugs me tight. We enter the house with our arms around each other. It is divided into a room and the kitchen. Sara worries that she has nothing in the house and good-naturedly scolds me for arriving unannounced. She would have baked a cake and cooked a good dinner. After innumerable assurances on my part that I want nothing but a cup of tea, we sit down together.

"We are old Jews," she says. "The last Jews in town."

Before the war there were so many Jews in Włodawa that it would have taken you days to count them. When they walked the main street on Sunday afternoon, there was such a crowd that they poked each other with their elbows as they passed. A hubbub, but happy. Yet on the Shabbas such a sudden total silence fell. Only dogs moved around outside the houses, candles shone in every window, the singing from the many synagogues carried on the peaceful air.

The old woman tells it so colorfully and vividly that I do not even hear her husband come into the room.

"Oh, Rafael," Sara cries as she gets up and

leads her husband to me. "Look, dear, whom heaven has sent to us."

Rafael Adar is a short, slight man dressed in an old threadbare suit, with a felt hat on his head. The face beneath the hat is unusually soft, benevolent, and seems somewhat absent. We greet each other warmly, like old friends. Sara shakes her gray head, and I have no difficulty imagining how she was once young and full of energy and ran through the fields in the nearby village of Hanna and how she raced against her brothers to swim the Bug, the wide river bordering the family farm. She swam the river for the last time to escape to the Soviet side shortly after the Germans arrived. When she returned after seven years, she had no parents, no family.

Rafael has gone to the kitchen to make tea for himself. Sara watches him sadly.

"My Rafael isn't what he once was. A year ago he had a stroke, and it paralyzed him."

The old man stands in the doorway smiling gently at us.

"Rafael, sing something," Sara says, lively again. "Because you know, daughter, my Rafael is not a cantor, but when he opened his mouth to pray, you didn't want to eat anything, not even on Yom Kippur."

"What should I sing, Sara?" asks Rafael, still smiling.

"*El male rachamim.*"

The old man is silent for a moment, as if he is concentrating. Then he begins to sing. "El male rachamim—Lord, full of mercy." The melody rises sharply. It falls and comes back again, dramatic and strong. Rafael stands in the middle of the room, hands upraised. When he finishes, he sinks exhausted onto the sofa. We sit in silence for a long while.

Then Sara turns to me. "And when they brought him to me, he was so skinny, miserable, and beat up. That was not long after the war. I had no one, and he had no one. He had lost his whole family. I fed him a little, dressed him, and we went to a rabbi I knew in Legnica to get married. Oy, that was a story. I was alone in a room with the women when suddenly it hit me. No mother, no father, no sister, no brother. Strangers are going to lead me

to the canopy. What do I need such a wedding for? I don't want it! And I started to cry and scream. Nobody could calm me down. They coaxed and coaxed until they convinced me."

"But I see now that you don't regret it," I interject.

"How could I regret it?"

When I leave their home a few hours later, they walk me to the street. We say long good-byes. It is somehow hard for me to leave. At the corner I turn around. The small wooden house is still visible. On the bench by the door sit the two old people. Sara is resting her head on Rafael's shoulder. They are silent, looking straight ahead at the empty street.

THE CEMETERY in Międzyrzec Podlaski, 50 miles north of Lublin, looks impressive—at least from the outside. A high brick wall surrounds a good-size piece of land. I open the heavy iron gate. Right inside, on the grounds of the cemetery, stands the caretaker's house. At the sight of me, a powerful German shepherd almost breaks its chain. Summoned by the barking, a fat man appears from inside the house and we talk about the cemetery.

The caretaker has lived here since 1945. The Germans left the cemetery in ruins. The gravestones were smashed to pieces, broken and shattered by bullets, since the Gestapo set up a shooting range here. The walls were also partly destroyed and partly torn down. The bricks had been required for other purposes. The caretaker leads me around the cemetery. In its depths, sheep are grazing. "What I don't mow, they eat," he says, as if he wants to forestall my question.

The cemetery is old. Many of the *matzevahs* come from the 18th and 19th centuries. Some of them are cast iron, unique and beautifully ornamented monuments. Międzyrzec Podlaski was a rich town. There were beautiful synagogues here. One of them, from the 18th century and built of great stone blocks, was famous. It took the Germans more than a month to demolish it.

"How many Jews were saved and returned after the war?" I ask.



The kosher butcher shop of Zygmunt Warszawer is one of the few public places in Warsaw where Jews feel at home. Even though it is very cold in the shop, customers do not leave after making their purchases. They stand around the counter, talking and joking loudly in Yiddish. A thief came into the shop once and flashed a switchblade. Warszawer told him, "I am not afraid. You've got a knife, but I've got an ax." Warszawer has always known how to get along with people. "That's why I'm alive," he says.

"How many were saved I don't know, but very few returned. Perhaps ten."

"Do they still live here?"

"No, there are no Jews here any more. The last one died five years ago. He lies there." The caretaker points into the shadows of the cemetery.

"I know, though, that one is left for sure. He's the one I'm looking for."

The caretaker shakes his head decisively.

"He has a Polish wife, and he changed his name," I add.



"Now that's another story. Anastazy Domański. Of course, I know him. He's a brush-maker. He lives on Polna Street, number 37. Only he's sort of Jew-non-Jew."

The eighth member of the Lublin minyan has been baptized.

An hour later I am sitting with Anastazy Domański in a meadow near the forest. Here, on the tall grass, he spreads his coat. "We'll be able to have a heart-to-heart talk," he says as he sits down and takes out a pack of cheap cigarettes.

He is surprised when I tell him how I found him. "Didn't they give you my address in Lublin? They know it well enough."

"They gave it, but not the complete address," I throw in, not wanting to hurt him.

Still, Domański makes a dismissive gesture. "I know, they're a little ashamed of me, even though I often lead their prayers."

The old man lights a cigarette and unexpectedly bursts into tears.

"Something forced me to change my name, the way they killed those two . . . a young couple in the very flower of life. Sara was your age. She died in my arms. . . . I am Kagan, Natan Kagan."

He pulls a handkerchief out of his pocket and wipes his eyes.

"When was that?" I ask.

"In '46. Didn't you see their graves in the cemetery?"

"Now I remember two stones near the entrance: I didn't think they had been murdered."

"Bandits broke into the house at night and shot them both."

Kagan's head droops, and he wipes his eyes again. After a moment he speaks.

"I would never have decided to marry her, but she saved my life. She always pampered me. That evening she gave me an excellent meal. She wouldn't let me go. 'I ask you by all the saints, Natan, don't go.' I stayed, and if I hadn't listened, I wouldn't have been alive after that night."

"And afterward you remained with that woman."

"With Domańska. Yes. I took her name. I went to church. Had to. . . ."

"And was that the end of the threats?"

"The evil times passed. Besides, she was watching out for me."

"When did you start going to the synagogue again?"

"I traveled to Lublin for the first time in 1979. They received me badly. I'm not surprised. You know, I'm a *meshummad* [apostate]. I walked in, and they said, 'You're Anastazy Domański now and no Kagan. You talk Polish real good, you talk beautifully,

grammatical. You're not one of us any more."

"They took you back."

"What could they do? They wouldn't have had a minyan."

"What's it like now?"

"They're used to me."

"For 30 years you lived far from Jews; far from their religion."

"I didn't forget. During those years I forgot nothing. You can't forget that. It's not like this grass." Kagan leans forward and pulls out a handful of grass with a violent motion. He raises it and waves it in front of my eyes. "Not grass, that I can pull up by the roots."

THE LAST TWO MEMBERS of the minyan lived on the same street in Łuków, but Herszel Golman has moved to Legnica, at the other end of Poland. On the town's main street, number 78 is a good-size apartment house. On the second floor I knock on apartment five. There is a visiting card in the door: "Pinkie and Lidia Fiksman." I knock for a long time. Silence. When I am ready to leave, thinking there is no one there, I hear a shuffling behind the door and a woman's wary voice: "Who's there?" I introduce myself.

The woman begins questioning me: Where are you from? What do you want? Who sent you? I repeat all my references to the closed door, but it has no effect. I go on explaining. At last she asks, "What is my first name?" Without pause I say something different from what is printed on the card. "Libe. Libe Fiksman." That does the trick. The door slowly opens. Behind it stands a small, corpulent woman with an expressive face. "Well, come in then," she says with a cautious smile.

The apartment is small. The kitchen contains a tile stove, and the room is divided in half by a tattered brown screen. On one side stand a chest and a round table, and on the other side a wardrobe and a bed covered with a down comforter. The woman apologizes for her behavior, but since the death of her husband, she has been afraid of attacks. These are such uncertain times, and there is nobody to protect an old woman.

"Your husband is dead?" I ask, shocked.

"He died. He died, the poor man," Libe Fiksman says. "He was 92, and his time had come." She falls silent, and then adds: "I am left alone not only in this town, but alone in the world. They are all gone, all dead." I start to say that I'm sorry, that I sympathize, but I stop myself because the words seem shallow and dry. Neither of us speaks for a long moment, and then Libe suddenly becomes animated.

"You can help me. You travel around the country and know so many Jews. Please find me somebody, I ask you."

"But who?"

"Some person—a Jewish woman. She can even be 50, she can even have a daughter. I will feed her and clothe her. That will be a lucky woman. I don't have a lot of money, but I have wealth. I have my husband's fur coat, my fur, a lot of clothes, a tea service, and a table setting for 12. When I die, she will inherit it all. The apartment too. Now it's so difficult with apartments, you have to wait so many years. It's a perfect chance, right?"

The woman looks at me anxiously. I know that I cannot say no. Libe is more and more excited.

"I have a feeling that you are going to help me. You are a good person. God might have sent you to me. Because I am very religious. In the past perhaps less. But now I read only the *siddur*, the Jewish prayerbook. Especially on Fridays. And on Saturday I lie in bed all day, and I hardly get up and I pray and pray. Because you know, I have sinned a great deal."

Libe stops speaking. She is obviously wavering: What to say next? After a moment she goes on in a hushed voice. "I have been angry at our Lord."

"How?" I ask, surprised.

The old woman nods her head.

"Oh yes. Yes. Because we are supposed to be a chosen people and—what? Blood and blood and hatred. . . . Sometimes I thought about it and . . . and I still think that way a little—it would have been better if He had not chosen us, if He had let us live like others."

ABAR MITZVAH is a joyous occasion all over the world; in Warsaw on May 18, 1985, however, the joy was exceptional. For the first time in 30 years a 13-year-old boy stood on the *bimah* in the center of the synagogue. He did not stand among his contemporaries but among old men separated from him by at least two generations—two absent generations.

All the old men had assembled for this—the sick ones, even the ones who rarely come to pray. They crowded tightly around the *bimah* on which the small, thin boy wearing a *tallis* (prayer shawl) was singing the prayers in a none-too-certain voice. “That’s the seedling,” one of them had told me earlier. “He has grown from fallow ground that we long believed to be absolutely barren.”

That day the synagogue was full. All the benches were taken, and an old woman who arrived somewhat late had to ask me to move over and make room for her. She asked me in German, but I knew her by sight and answered in Polish. She did a double take. “Aren’t you from an excursion?”

It was my turn to be surprised. “From an excursion? Why?”

“Because there are so many people here today,” she said. “So many young people, and it’s usually completely empty. I thought a tour from America had come.”

When I explained that it was a bar mitzvah, the woman at first did not want to believe me. Then she fell silent for a long while and finally said quietly, “Thank you, God, for letting me live to see such a moment.”

BERGSON HOUSE, on the right bank in Warsaw, once belonged to the Jewish community and housed both a school and a theater. Apartment 1, on the second floor, is strange, somewhat neglected, but full of charm, containing a multitude of original and amusing objects—theatrical decorations, pictures, and above all, books. They fill the walls; shelves hang even from the doors. The four of them live here: Ninel Kameraz, her husband, Bogdan Kos, and their two sons, 15-year-old Łukasz

and Mateusz, 13, the one who had the bar mitzvah—the seedling.

Ninel looks young. I am astonished when she says she is 48. “That’s right,” she confirms. “But with experience for twice that old. . . . To be a Jew, and a poor Jew at that, and furthermore from a Communist family.” She spells out her name: “N-i-n-e-l. Lenin spelled backward. Such names were fashionable among Communists. My sister is named Rema after the first letters of a Soviet slogan that was very popular in the 1920s—‘Revolution, Electrification, *Mir* [peace].’

“When the boys were four, five years old, I took them to their grandparents’ graves. I told them that I am a Jew and they are Jews after me. Later, when we were in the synagogue, one of the people who was praying asked if our sons wanted to learn Hebrew. Mateusz reacted with enthusiasm, and Łukasz also agreed. The boys started going for lessons. Łukasz soon wanted to quit. I told him, though, that he had to learn for a year. Afterward he could decide, when he knew what it was about. And so it was. He came to me and said, ‘Mama, I know I’m a Jew, but I don’t like it.’ I didn’t coax him any more.”

“With Mateusz it was different?”

“That’s right. He found something that was his and true. When his teacher suggested the bar mitzvah, he agreed with joy.”

“Of two brothers raised in the same way and almost the same age, one chose Polishness and the second chose Jewishness.”

“Łukasz is more tied to—even fascinated by—Polish culture. . . . Mateusz had a metaphysical, religious inclination since childhood. When he was little and barely knew how to walk, he was already asking about death. How is it possible? What happens afterward?”

“And you, Ninel?”

“I have a deep feeling that everything is in order,” she replies. “I am a Jew, and my ancestors arranged that with God. It has lasted a long time, and it has been difficult—it is not easy to be the people chosen by Him. But it happened. Of course, I would rather my links with Him had been more tangible, that I had



*L*ast trace of the Jews of Karczew, the huge cemetery on the outskirts of town crumbles in stark desecration. Here a stray dog leaves a bone; elsewhere cattle graze among fallen headstones and children play ball. In nearby Łaskarzew stands a huge stone monument, erected by Zygmunt Warszawer. The dedication reads, "To the Israelites of Łaskarzew and Sobolew, murdered bestially in the years of annihilation 1939-1945. Remember forever this horrible crime. Eternal fame and eternal peace to their hallowed souls."

been brought up in the religion. But it was otherwise. No, I have no doubts in this matter, and no fears."

I ask Mateusz, "What does it mean to you to be a Jew?"

Mateusz bows his head and does not speak for a long moment. Then he begins, with a slight stutter. "It's hard for me to say. . . . To me it's, well—normal. When I was little, Mama told me that I am a Jew but Daddy isn't and that the tribe is inherited from the father and the nation from the mother. Later I went



to church, to catechism, with my friends from school, but it bored me, so I stopped going. Then I asked Mama if Jews have holidays, if we could observe them. Catholics have theirs, and I wanted to have something too."

"Did you start observing them?"

"Yes. Pesach and Purim. It was certainly not all in accordance with the rules. Daddy cued us. I also read a thick book, *The History of Israel*. I took notes, and later I recited the history of Esther. Also I made raisin wine for Purim. And Lukasz led the *seder* for Pesach. I

asked and he answered. We also went to synagogue, but we couldn't tell up from down."

"On the Thursday before the bar mitzvah, when you had your examination, you fainted in the synagogue."

"Only the minyan was there. I stood a long time near the bimah. I waited and waited. I was terribly frightened, and then suddenly I felt that I couldn't do it. Then I fell. I woke up on a bench. The old men were standing over me, and each one was offering me his heart medicine. They all carry nitroglycerin."

"On Saturday it went better."

"I wasn't so nervous any more. It was a different atmosphere—a full synagogue, my friends. Once I stepped onto the bimah, it became totally quiet. Behind my back I could feel that they were all listening. It was funny—as soon as I started reading, all those old gentlemen began prompting me. Every one of them! When I walked off the bimah, they all hugged and kissed me, even though I didn't know a lot of them."

"How do you get along with your brother? Doesn't it bother you that one of you wants above all to be a Pole and the other one above all a Jew?"

"I don't see anything bad about that. It all comes down to choice. He doesn't want to depend on a religion. He says he wants to be free."

"And you?"

"My religion doesn't hinder me in any way."

"For thousands of years being a Jew has involved persecution, suffering, even death."

"Yes, I know something about that."

"How do you understand the bar mitzvah? What does it oblige you to do?"

"Not to renounce it."

"Not to renounce what?"

"Jewishness."

"So now how would you answer the question, 'What does it mean to be a Jew?'"

"It seems simple at first. And then the more you know, the harder and harder it becomes being a Jew. Especially in Poland."

"But I see that you're not turning back."

"No. I'll take the risks." □



METEORITES

Invaders From

By **KENNETH F. WEAVER**
FORMER SENIOR ASSISTANT EDITOR

Photographs by **JONATHAN BLAIR**



15-MINUTE TIME EXPOSURE TAKEN FROM INSIDE ARIZONA'S METEOR CRATER

Space

Blazing across the night sky, a shooting star from the Geminid meteor shower cuts across star trails. Each year thousands of tons of extraterrestrial material, most of it undetected, breaches the atmospheric shield, usually to self-destruct before impact.

ONE DAY some 50,000 years ago, along Cañon Diablo in northern Arizona, antelope grazed on a sagebrush flat near a juniper woodland. Save for an occasional saber-toothed tiger and mammoth, no danger threatened. Man had not yet appeared on the continent.

Far to the southeast a dazzling glow suddenly lit the sky. It approached with unearthly speed, becoming brighter than the sun and leaving a luminous trail. Every animal lifted its head in alarm.

Without a warning sound the terrible brilliance was upon them. The very earth exploded. Millions of tons of rock jetted upward in a great conical sheet. A monstrous shock wave leveled trees for miles in every direction. Wildfires burst out spontaneously, blazing from land already seared by the giant fireball.

Darkness settled over the area, for pulverized rock, dust, and soot, thrown far into the stratosphere, blocked the sun. Then, as wind and rain dispersed the veil, the first feeble light revealed a landscape of desolation. Where the fireball had ended its deadly flight, a high rim encircled a wound in the earth 4,000 feet across and 750 feet deep.

Thus was born Meteor Crater.

An imaginary scenario? Not at all. Scientists in recent years have vastly increased their understanding of the extraterrestrial visitors we call meteorites and the craters they can make. We know that the fireball thousands of years ago was caused by a giant chunk of iron and nickel, the Cañon Diablo meteorite. Air in front of this intruder from space became shock-compressed and highly incandescent. That in turn heated a thin outer layer of the iron body to incandescence, and molten material streamed

Scar from a cosmic bomb, Arizona's Meteor Crater is earth's most studied impact structure. Nearly a mile across and originally 750 feet deep, the crater—here crusted by snow—is attributed to a 300,000-ton meteorite some 50,000 years ago. Meteorites of this size, which can unleash the explosive energy of nuclear weapons, probably fall less than once every thousand years. Apparent crater at left is a bulldozed livestock pond.





off during its swift passage. On impact it disintegrated, melted, and partly vaporized. Remnants by the ton have been found within a six-mile radius of the crater.

Eugene Shoemaker of the U. S. Geological Survey at Flagstaff, Arizona, authority on Cañon Diablo and its crater, estimates that the bolide (a fireball-producing object) measured 135 feet across, with a mass of 300,000 tons. It traveled at some 12 miles a second. Its destructive energy equaled 15 megaton bombs, twice that of the Mount St. Helens explosion, and a thousand times that of the Hiroshima bomb.

Fortunately, objects of this size fall only rarely, perhaps once every 1,300 years or so on the average. However, truly huge objects may come our way over geologic intervals. Shoemaker estimates that a meteorite six to seven miles in diameter will hit about once every 65 to 100 million years. Such an impact would leave a crater more than a hundred miles across. As we shall see, its effects would be disastrous to much of life on earth.



Only fruit of a ten-year vigil, sections of a meteorite are seen against a photograph of its fall near Lost City, Oklahoma, in 1970. Testimony to the frustrations of meteorite tracking, this was the sole find for a group of scientists whose cameras monitored the skies for a decade.

Interested in earth-threatening cosmic bodies, Eugene and Carolyn Shoemaker (facing page) have discovered eight comets and nine stray asteroids at California's Palomar Observatory. Gene calculates that an impact large enough to cause global catastrophe occurs every 65 to 100 million years.

While the odds of a giant impact in your lifetime are so vanishingly small that there is no cause for concern, it may surprise you to learn that earth is subject to constant bombardment from space. At least 20,000 tons of meteoritic material annually penetrates our atmosphere—more than 50 tons a day. Most of this is small, the size of dust particles or sand grains. Larger objects—from a few ounces to a ton or more—account on the average for perhaps a hundred tons a year.

Despite the volume of material falling on our globe, only one person is known to have been struck by a meteorite. In 1954 a woman in Sylacauga, Alabama, suffered a severe hip bruise when an 8.5-pound stone crashed through the roof of her house (page 413). Contrary to one story, the song "Stars Fell on Alabama" was not inspired by this event; the music was copyrighted 20 years earlier.

By amazing coincidence, two separate meteorites—one in 1971 and the other in 1982—broke through the roofs of houses in Wethersfield, Connecticut. No one was injured in either case.

THE NAME Meteor Crater is really a misnomer.* A *meteor* is a shooting star, a streak of light across the sky. The object causing that display is a *meteoroid*. And if the object does not burn up in the atmosphere but lands on earth, it is a *meteorite*.

Meteorites are not easy to find, as can be attested to by the few men like the late Dr. Harvey H. Nininger who have spent a lifetime looking for them. Aside from the large numbers found in Antarctica in recent years, the annual list of new meteorites recovered on land is probably no more than 10 to 20, although some of these may have broken into numerous fragments.

Contrary to the common perception that most meteorites are basically iron, like the Cañon Diablo bolide, more than 90 percent of those recovered from observed falls are composed of stone or mixtures of stone and iron. On the other hand, irons are by far the easiest to find, because they can more readily be distinguished from ordinary rocks.

*It is also called Barringer Crater after the engineer who claimed the huge hole in 1903, hoping, in vain, to find a valuable lode of nickel-iron. Daniel M. Barringer was one of the first to argue that the crater was of meteoritic origin.



Moreover, irons are more likely to get through the enormous drag of the atmosphere without breaking up, and they resist weathering far better than stones.

A prime example is the Hoba iron, world's largest single meteorite, still lying where it fell near the northern Namibian town of Grootfontein, in the southwest corner of Africa. To reach it I drove along the Otavi Valley, with yellow-flowered *geelbos* and thick thornbush lining the way.

On the Hoba farm, where Jan Engelbrecht raises cattle and maize, a simple dirt road leads to the meteorite, resting in

unpretentious solitude amid acacias and small bushes. A dark, rusty-looking, rather squarish mound, it is only half-buried below the surface. Its measurements of something more than nine by nine by three feet belie its huge mass, estimated at 66 tons. Along corners and edges a few glittering patches reveal where samples of the iron-nickel body have been sawed off for laboratory study.

The Hoba meteorite was found in 1920. No one knows when it struck earth, but a thick rind of rust suggests that it must have fallen in prehistoric times.

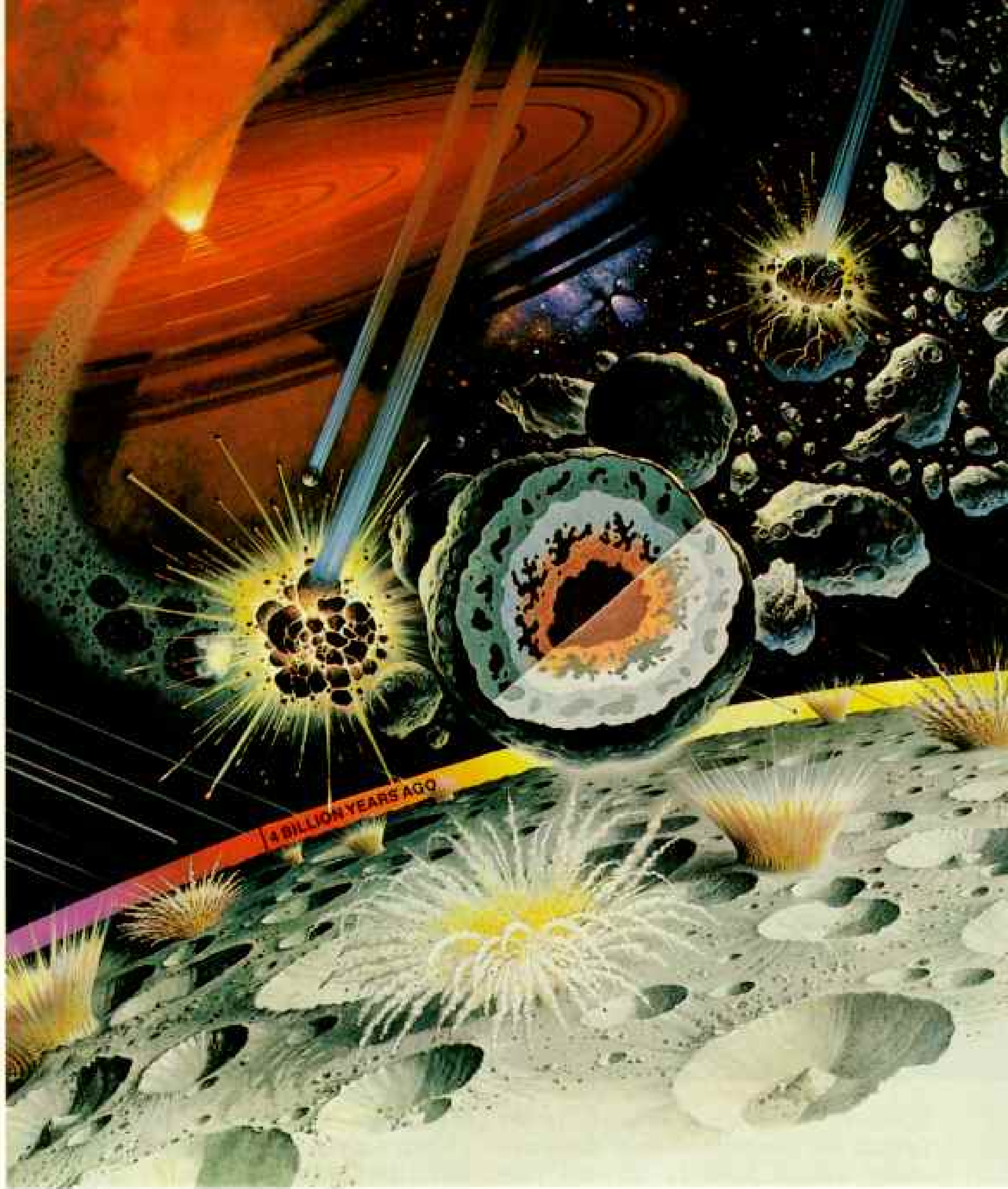
Why did Hoba not break up on entry into the atmosphere? Scientists point out that a stony meteorite this size would undoubtedly have fragmented, but irons are far stronger.

And why is there no crater? Scientists can only speculate that the bolide approached at a very low angle so that atmospheric drag slowed it down much more than usual.

THE SECOND largest single meteorite ever found—Ahnighito, or the Tent—was known

to Eskimos in west Greenland as long ago as 1818. It was part of the Cape York iron from which the Eskimos laboriously pounded pieces for harpoon tips and knives. In the late 1890s Arctic explorer Robert E. Peary managed to move the 34-ton monster 300 feet to his ship and transport it to the United States. Today it is the centerpiece of the extensive Arthur Ross Hall of Meteorites in the American Museum of Natural History in New York City.

For most of the lifetime of mankind, meteorites were an intriguing mystery. The idea that stones could fall from the sky was

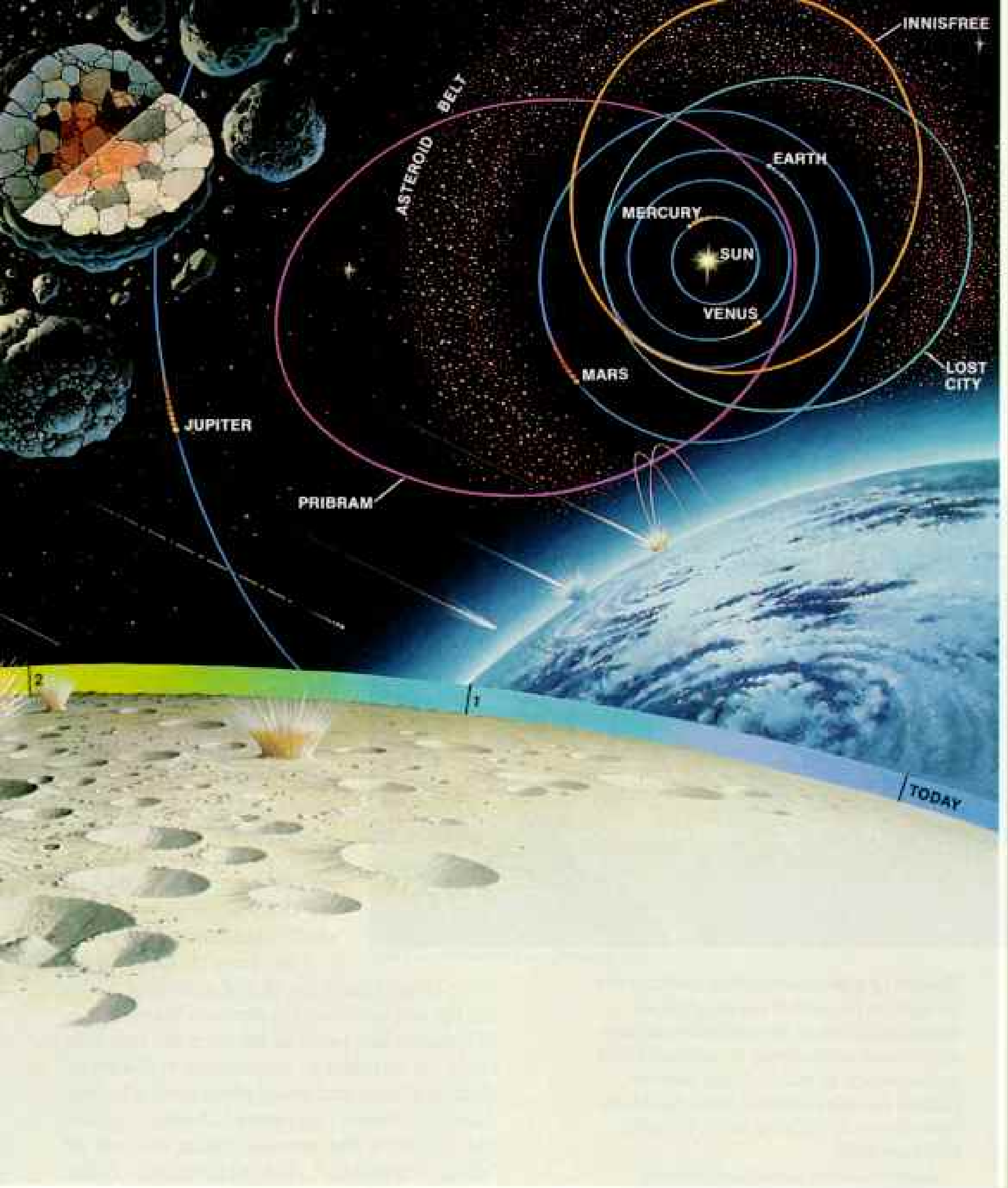


Evolution of a meteorite

Meteorites in museum cases today originated some 4.6 billion years ago in the maelstrom of the infant solar system. Dust grains in the solar nebula (top left) gradually accreted into ever larger bodies called planetesimals. Eventually some of these differentiated as heavy elements

like iron sank to the core, while lighter materials, like silicates, rose to the surface (cutaway left center).

Planetesimals were continually colliding, breaking apart, and reaccreting, resulting in bodies with irregular structure, some of them predominantly iron, others of



PAINTING BY DAVID MELLER

stone (cutaway top center). The forming planets swept up most planetesimals, except in a zone between Mars and Jupiter that became the asteroid belt. From here some fragments are nudged into earth-crossing orbits by gravitational tugs from Jupiter. The skewed orbits of three—Lost City, Innisfree, and

Pribram—are shown intersecting the orbits of inner planets (upper right) before falling to earth. After journeying through space, a meteoroid creates a meteor as it streaks through earth's atmosphere (center). On impact, it is called a meteorite. Fragments of earth thrown into space by the impact

sometimes fall back to earth as small glassy objects called tektites.

As depicted below the colored time line, meteorites were bombarding the planets and moons with far greater frequency during the first 700 million years of the solar system. Since then, meteorite activity has slowed dramatically.

mentioned even in ancient Chinese, Greek, Roman, and biblical writings, but it was often viewed with deep skepticism. (Thomas Jefferson, however, almost certainly did *not* make the statement attributed to him that "I would rather believe that two Yankee professors would lie than that stones fall from heaven.") Some people thought that these strange "thunderstones" had been struck by lightning.

Only in the late 18th century did scientists begin to recognize that meteorites were extraterrestrial matter. Confirmation came in 1803, when a member of the French Academy investigated the fall near L'Aigle, France, of a shower of 2,000 to 3,000 stones.

The largest weighed about 20 pounds.

Today we know that most meteorites are extremely primitive remnants of the formation of the solar system 4.6 billion years ago. They provide a valuable record of that event. Moreover, small white mineral inclusions in a meteorite known as Allende have strange isotopic anomalies: That is, the proportions of different isotopes, or species, of certain elements, such as oxygen, are strikingly unlike those on earth. This proves that they contain traces of presolar matter—debris from explosions of dying stars. These bits of mineral help give insight into the nature of the presolar universe and the formation of the solar system.

As Professor Gerald J. Wasserburg of the California Institute of Technology puts it, "With Allende we may be looking into the heart of the stellar factory."

IT IS ONE THING to realize that meteorites are extraterrestrial and that their parent bodies were formed near the beginning of the solar system. That, however, does not answer the question of where they have been during the 4.6 billion years of earth's existence.

The answer may lie in two places. One is the belt of asteroids orbiting the sun between Jupiter and Mars, much of it more than twice as far from the sun as is earth. It consists of uncounted millions of chunks of rock and small planetoids left over after the planets had formed. Another possible source is the comets, those billions of "dirty snowballs" that periodically come from far out beyond the realm of Pluto, swing around the sun, and then vanish again into the unknown.

The asteroids, many in overlapping orbits, often find themselves colliding with their fellows. The grinding, shattering effects of these constant collisions over the eons have produced an immense amount of rubble. The gravitational tugs of Jupiter's huge mass sometimes perturb the orbits of the objects so radically as to throw them



THESE BRIMBORG (ABOVE AND FACING PAGE, BELOW)

Spawn of giant meteorites, tektites are thought to be melted ejecta of major impacts, launched by explosive collision on ballistic trajectories across hundreds or thousands of miles. These button-shaped samples (above) from Australia show typically ablated front, at right, and rear sides.

Meteorites are classified in three groups: stones, irons, and stony irons. Of the two irons illustrated (facing page), one comes from meteorite-rich Antarctica. Carbonaceous chondrites, a subgroup of stones, are very rare. A large one that scattered near Pueblito de Allende, Mexico, in 1969, has proved a bonanza for scientists like Gerald Wasserburg (facing page) of Caltech. He and others found evidence of matter within white inclusions in the stone that predates the solar system.



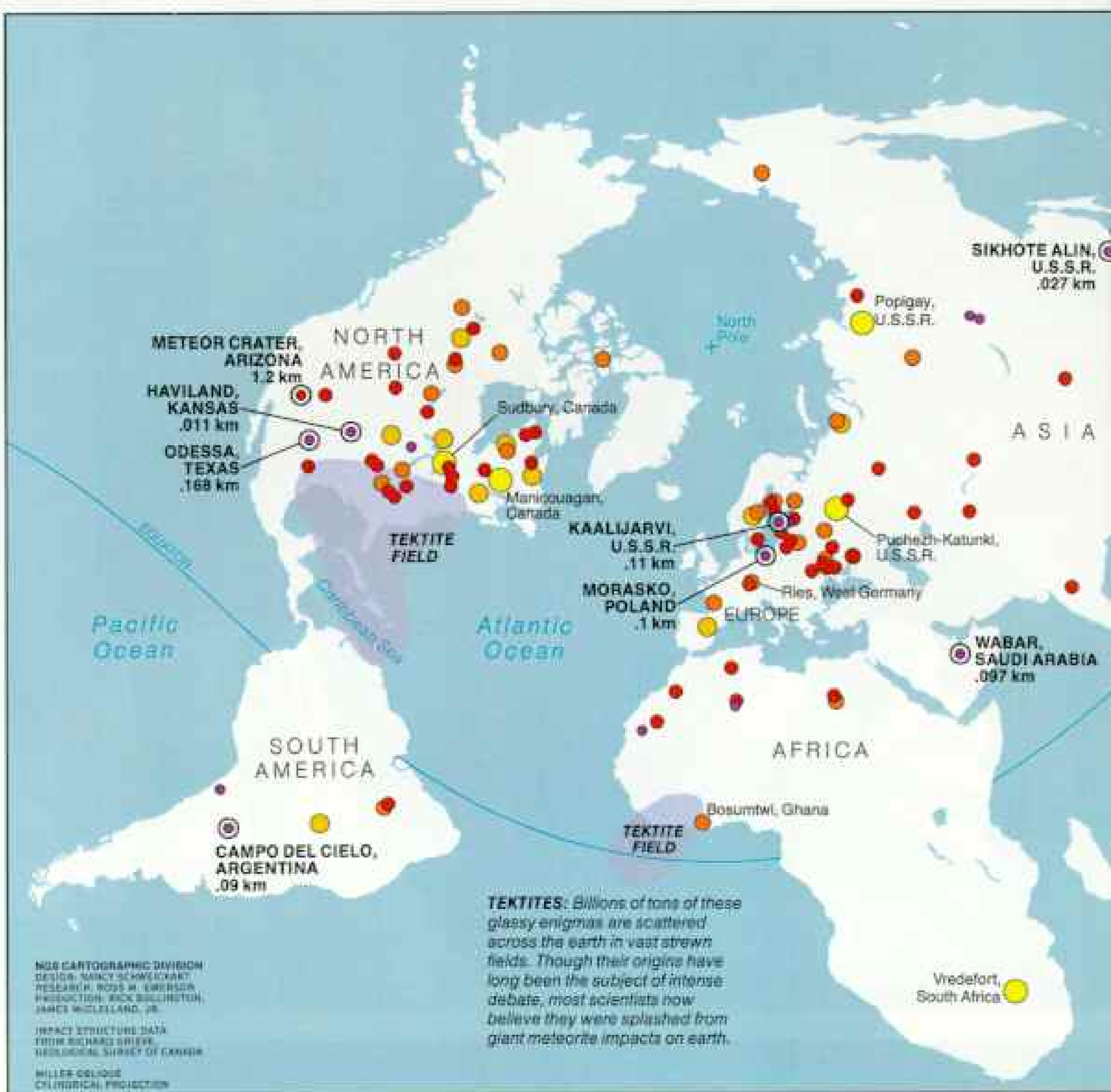
**Stony Iron:
Imilac, Chile**

Iron: Alvord, Iowa

**Stone: Farmville,
North Carolina**

Iron: Derrick Peak, Antarctica

**Carbonaceous chondrite:
Allende, Mexico**



close to earth. In some cases the fragments become what are known as earth crossers.

Just as two highways meet at a crossroads, so do the orbits of earth and of these displaced asteroids intersect from time to time. Nothing may happen for several hundred thousand or even several million years, but sooner or later earth and asteroidal fragment meet at the crossroads. A collision is inevitable, and another meteorite comes to ground.

The first earth crosser was identified in 1932 by Karl Reinmuth, an astronomer at Heidelberg Observatory. While studying his photographic plates, he realized that he was seeing a fast-moving object that would

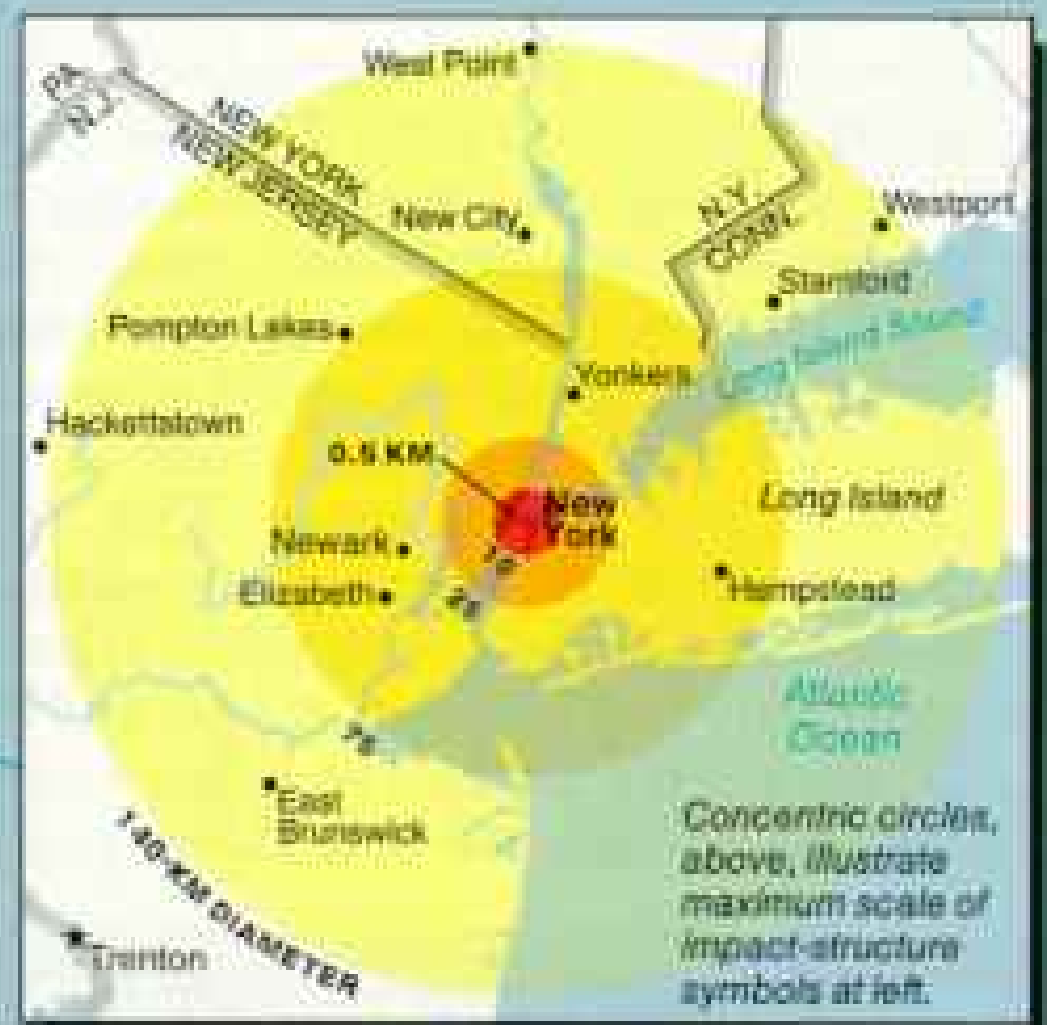
get as close to the sun as Venus, well inside earth's orbit. The object was named Apollo after the Greek sun god because it came closer to the sun than any other asteroid known at that time. The name has since been applied to other objects with similar orbits.

Today some 40 Apollo earth crossers have been identified. Astronomers believe there may be as many as 1,000 Apollos greater than a kilometer (3,300 feet) in diameter. Calculations suggest that several objects this size will collide with earth every million years.

Not all earth crossers, however, are asteroids. A number are now thought by

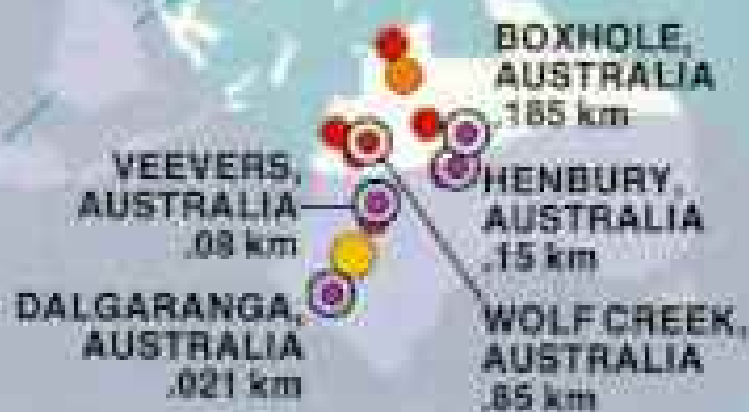
Meteorite impact structures

Known	Probable	Diameter
		0 km-3 km
		.6 km-10 km
		11 km-25 km
		26 km-75 km
		76 km-140 km



Earth's pockmarked face

Of the 116 impact sites depicted here, 13 have been unequivocally associated with meteorites. Though meteoritic material has not been found near the remaining 103, the presence of chemical and mineralogical fingerprints identify them as probable impact structures. They are thought to have been caused by hypervelocity impacts of large meteorites whose pre-atmospheric speed was little affected by atmospheric drag. The craters can be as much as 30 times larger in diameter than the bodies that created them, which melt and almost entirely vaporize on impact. Early in earth's development the planet would have been as heavily cratered as the moon. Erosion and plate tectonics, however, continue to erase the record of impacts.



TEKTITE FIELD

Indian Ocean

ANTARCTICA: Japanese and American expeditions have discovered some 7,500 meteorite fragments here, many of them well preserved, thanks to their long encasement in ice.

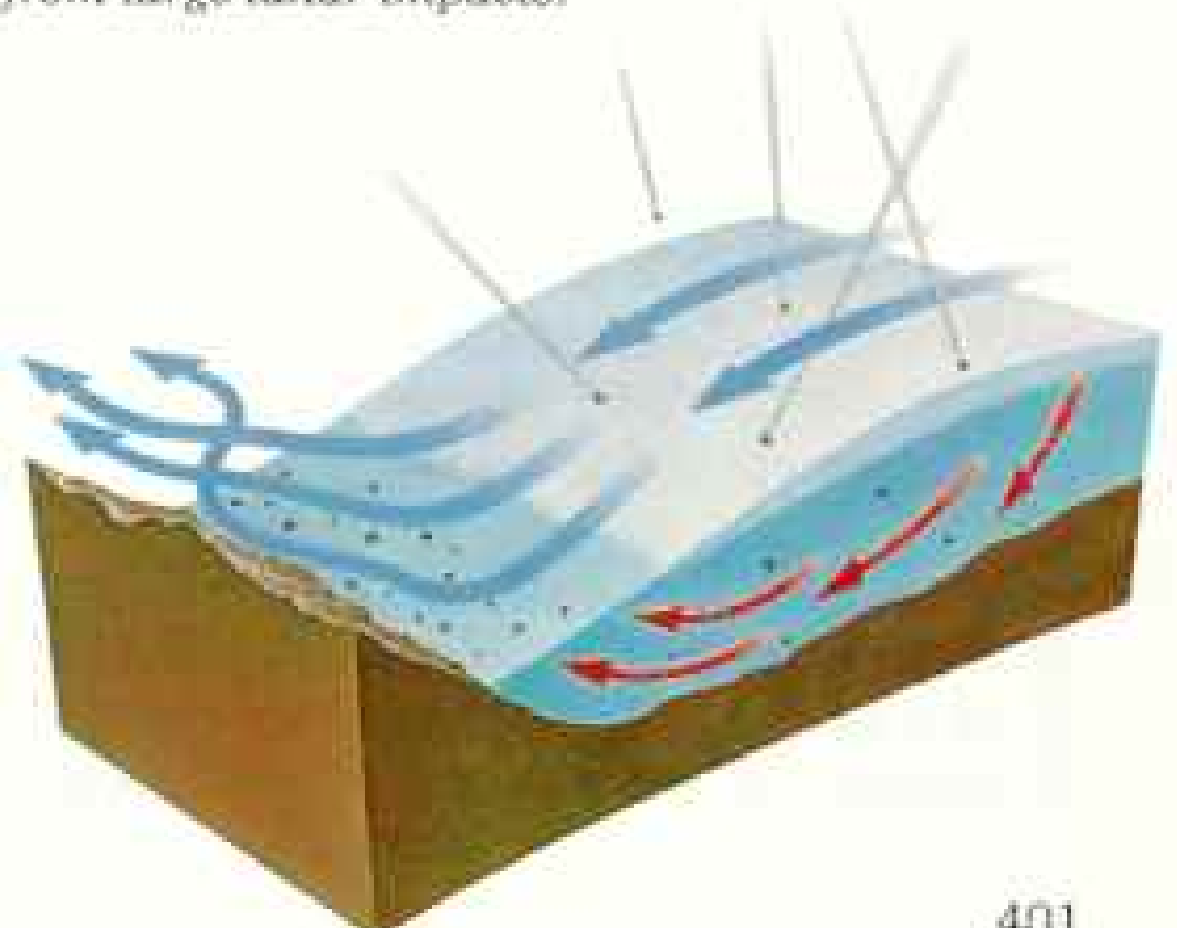
ANTARCTICA

South Pole+

Conveyor belt of extraterrestrial riches, the Antarctic ice sheet moves upward against mountains (diagram, below right) causing long-buried stones to surface as the ice is removed by wind erosion (blue arrows). A specimen (below left) is one of four whose composition closely resembles material found on the moon, indicating they may be ejecta from large lunar impacts.



IAN WHILLANS; DIAGRAM BY DAVID MELTZER



some scientists to be “burned-out” comet nuclei or fragments from them. As comets leave the deep freeze of space and approach the sun in their hairpin-like orbits, ices of water, carbon dioxide, ammonia, and methane that make up perhaps half the comet nucleus will begin to sublime—that is, turn directly from solid to vapor. This action tends to unbind the earthy, rocky portion of the comet, sometimes explosively, releasing small particles. Together, the gas and dust stream out for millions of miles, forming the kind of filmy tail that Halley’s comet

for hundreds of miles exploded in the atmosphere some six miles above the headwaters of the Tunguska River. The cataclysmic detonations were heard at least 600 miles away. The air shock wave circled the earth. Twenty-five miles from the site it threw a group of nomads from their tents; ten miles farther at a trading post one person was knocked to the ground unconscious. During the “white night” that followed throughout western Europe, newspapers could easily be read, and Siberian nights remained abnormally bright for the next two months from light-reflecting dust high in the atmosphere.

Because the Tunguska site was almost inaccessible, and perhaps because of a lack of information and interest, Russian scientists did not mount an investigation into the phenomenon for nearly two decades. When they did make their way into the swampy region, they found trees laid down in parallel lines for 20 miles

and more. But mystery of mysteries, there was no crater. Nor were there any telltale meteoritic fragments, although peat deposits have given up tiny cosmic spherules that probably melted from the bolide.

What caused the Tunguska event? Speculations have included an alien spaceship, an annihilating collision of matter and antimatter, and a vagrant black hole—explanations as unacceptable as they are imaginative. It is now generally recognized that Tunguska, like Cañon Diablo, was a meteoritic event. But because the bolide exploded so far above ground, the shock wave did not blast out a crater.

Scientists calculate that the Tunguska object had the destructive energy of a ten-megaton bomb. But the experts are divided over whether it was a piece of asteroidal material or a fragment of a comet nucleus. One type of meteorite, known as carbonaceous chondrite, is structurally weak and easily crushed. Comet nuclei are believed to be similar, for the material is probably porous.

Moreover, calculations of the orbit of the Tunguska object show that it could have been a fragment of Encke’s comet, a



COURTESY HOUGHTON LIBRARY, HARVARD UNIVERSITY

Divine intervention was how the German King Maximilian interpreted the 280-pound meteorite that landed near the Alsatian town of Ensisheim (above, depicted in a contemporary woodcut) in 1492; Maximilian decreed that the stone be preserved as a sign of God’s wrath toward his enemies. In the same year Columbus reported “a marvellous branch of fire” that fell into the sea as he crossed the Atlantic. On display in Ensisheim’s town hall, a surviving 120-pound remnant of the Alsatian stone is toasted by an association of local “guardians” (facing page).

watchers have observed in recent months.

After repeated passages about the sun, a comet may be left as a small, dark husk, perhaps no more than a mile or so in diameter. Just as gravitational perturbations may force asteroids into more eccentric orbits, so may comet nuclei find themselves captives in near-earth orbits, where they too could become parent bodies for meteorites.

IN THE EARLY MORNING of June 30, 1908, a spectacular event in the remote forests of Siberia astonished and mystified the inhabitants. A blinding fireball visible



cannot be ruled out as the source for the Tunguska bolide. Until more evidence is at hand, Tunguska—the largest such event in the historic record—will continue to be in part a mystery.

SHOOTING STARS, or meteors, are common enough sights for regular watchers of the skies. Only occasionally, however, does one see a meteoroid fall to earth. And even more rarely is the meteorite located after the fall is observed.

Scientists treasure such falls because the meteorites are fresh and likely to be uncontaminated by earthly materials. And there is always hope that each new meteorite will offer something different, which might unlock additional secrets of the solar system.

A spectacular example of such a fall is the Allende carbonaceous chondrite, a rare type, that fell in the Mexican state of Chihuahua shortly after 1 a.m. on February 8, 1969. Its awesome sonic booms were heard for great distances, and the blazing bolide was seen over much of the U. S. Southwest.

frequent visitor that returns to earth every 3.3 years. Encke's tail material, strung out along its orbit, is the source for the Taurid meteor showers seen in the skies of late October and November each year.

In fact, most annual meteor showers, of which there are more than two dozen, can be traced to comets. The Geminids of December derive from an Apollo asteroid (and that one may be a dead comet).

Spectrophotometry of the asteroids shows that some of these planetoids seem to fit the appearance and chemical makeup of carbonaceous chondrites. Thus an asteroid

fragmented into thousands of pieces totaling an estimated four tons. One chunk barely missed the post office at Pueblito de Allende, which gave the meteorite its name. The fragments came to ground in an elliptical pattern, or strewn field, covering more than 100 square miles. Almost all large stony meteorites break up and fall in showers like this.

Within hours representatives from numerous museums, laboratories, and universities rushed to the area to get samples. Together with schoolchildren, cabdrivers, and others, they collected two tons. Allende



turned out to be an unusual type of meteorite, of which only seven other examples were known, and it was available in lavish amounts.

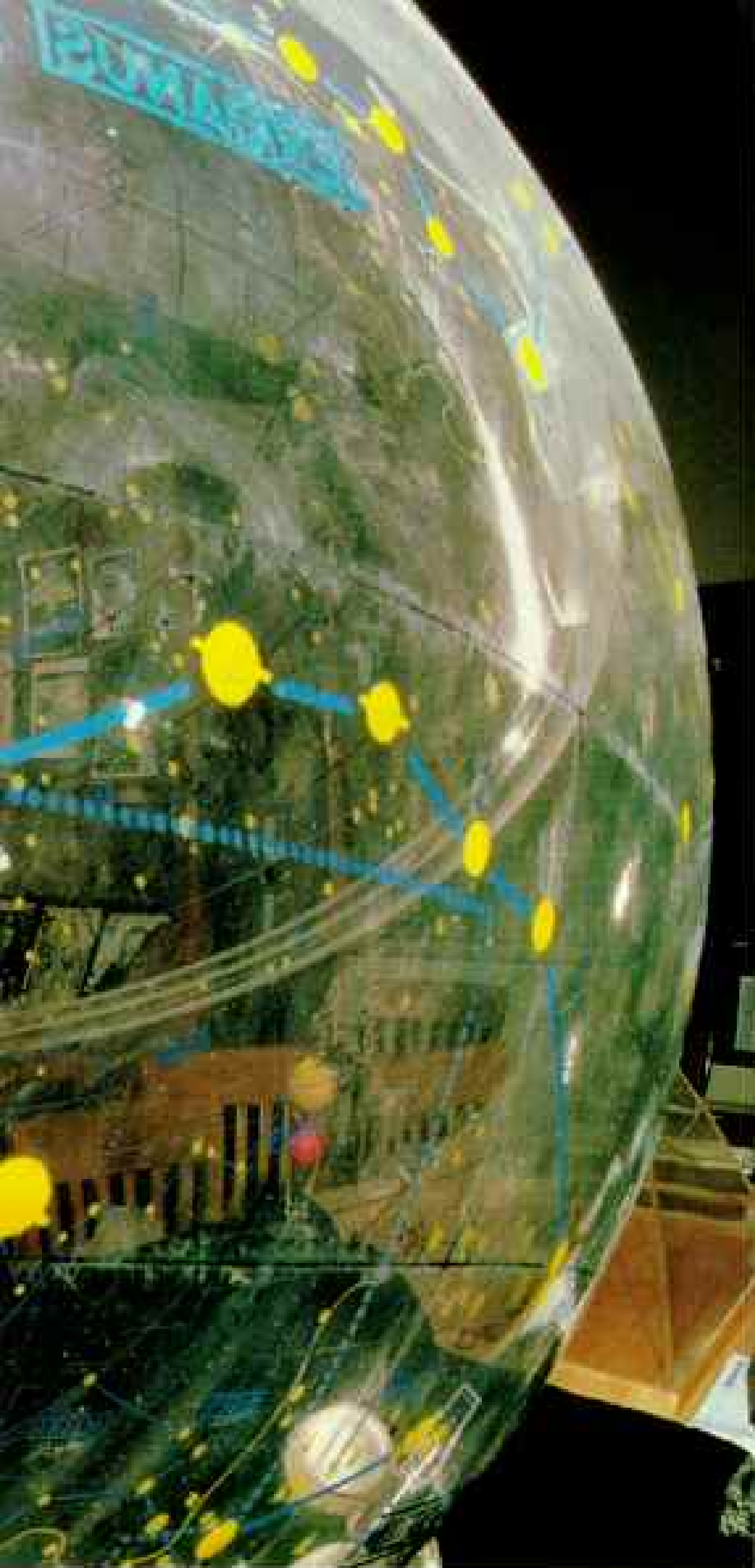
One of the scientists who went to Allende was Elbert King, then curator of the Lunar Receiving Laboratory at NASA's Johnson Space Center at Houston, Texas. He welcomed the chance to use material from space to calibrate the gamma-ray spectrometer that would be used to examine lunar material. Within 104 hours after the fall, King's spectrometer was counting gamma-ray emissions from Allende samples.

Just five months later the Apollo 11 astronauts brought back the first lunar rocks and

soil. The tremendous interest in lunar material, and the remarkable scientific machinery mobilized to examine it, brought a revolution in the study of meteorites.

Allende proved easy to collect because it fell in such large amounts in open desert country. But smaller meteorites, even when they are seen to fall, may be difficult to find.

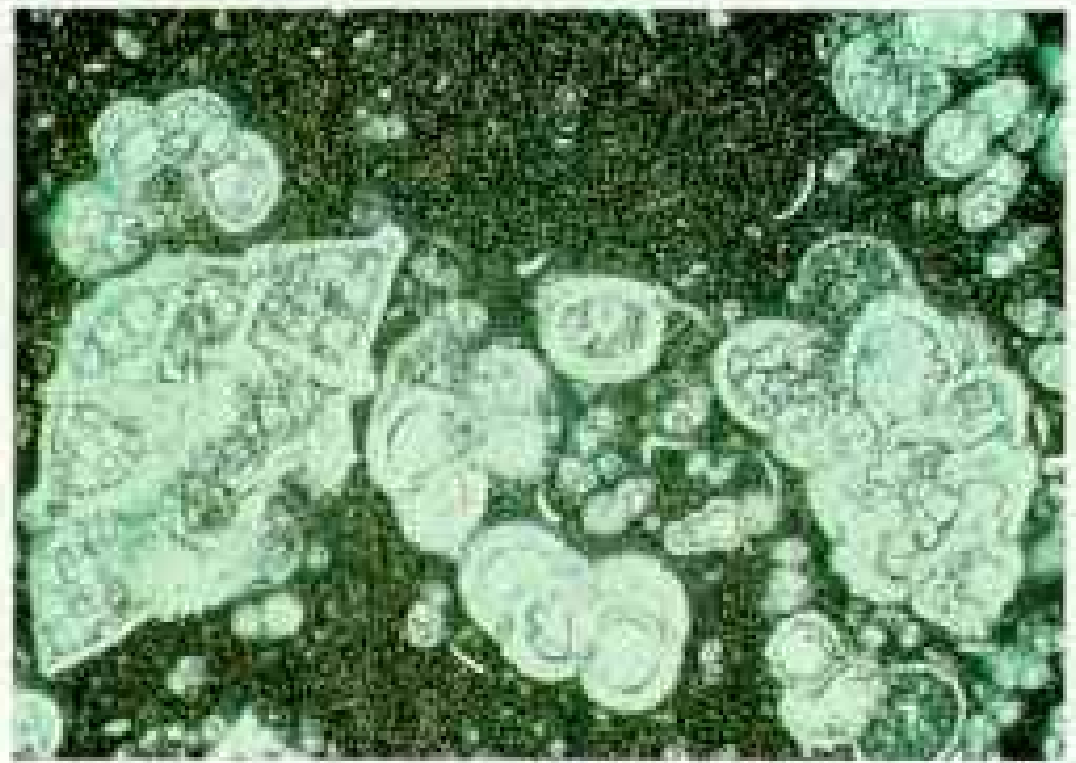
Harvey Nininger, former biology professor at McPherson College in Kansas, who died last March at the age of 99, developed the most successful method of tracking such falls. He would travel the countryside, especially in the midwestern plains, seeking out anyone who had seen a bolide on its fiery path. By correlating the estimates of



ROGER BESSMEYER, STARLIGHT PHOTO AGENCY

A mass extinction some 65 million years ago had long perplexed scientists when the father-and-son team of Luis and Walter Alvarez and their colleagues in 1980 proposed a bold theory involving a gigantic meteorite impact. Seen behind a star globe in their Berkeley lab (above), the Alvarazes discovered that a thin layer of globally distributed clay (right) between strata of the Cretaceous and Tertiary periods was rich in the rare element iridium. They believe the iridium and other elements are fallout from a life-extinguishing impact by a comet or huge asteroid. A section of limestone from the Cretaceous (right center) is embedded with fossils of many microplankton species, while the Tertiary sample (top) contains far fewer.

Meteorites—Invaders From Space



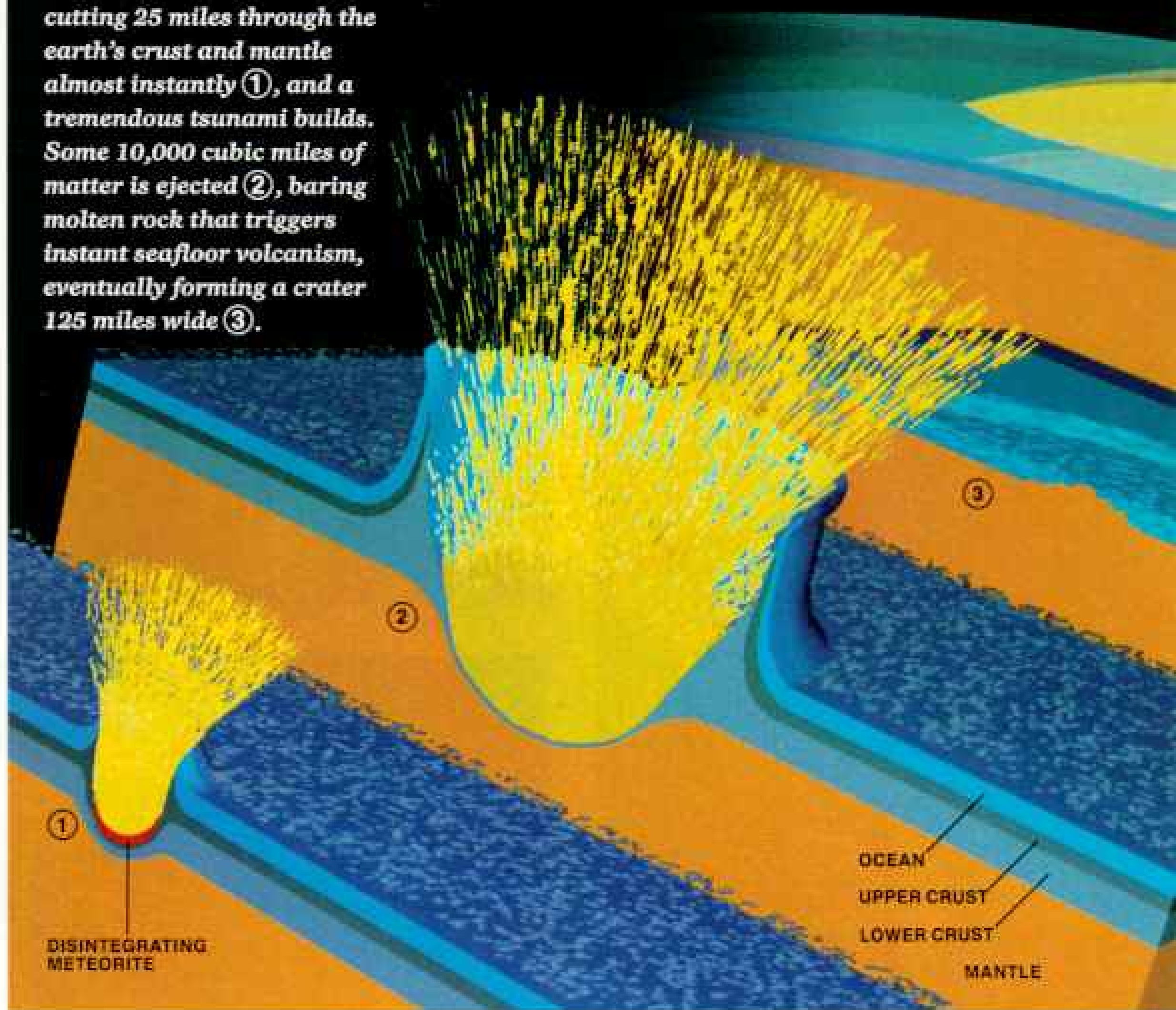
ALESSANDRO MONTANARI (TOP AND ABOVE)



GIANNI TORTOCI

Model of a cataclysm

A meteorite six miles in diameter, like that which may have devastated the planet 65 million years ago, hits the ocean at 12 miles a second, cutting 25 miles through the earth's crust and mantle almost instantly ①, and a tremendous tsunami builds. Some 10,000 cubic miles of matter is ejected ②, baring molten rock that triggers instant seafloor volcanism, eventually forming a crater 125 miles wide ③.



COMPUTER SCENARIO BY HELVIN PRIGENT, LOS ALAMOS NATIONAL LABORATORY, NEW MEXICO. FROM DATA CONTRIBUTED BY STERLING COLGATE, LOS ALAMOS; DAVID HODDY,

direction from each of the informants, he would gradually narrow down the field of search and sometimes find the quarry.

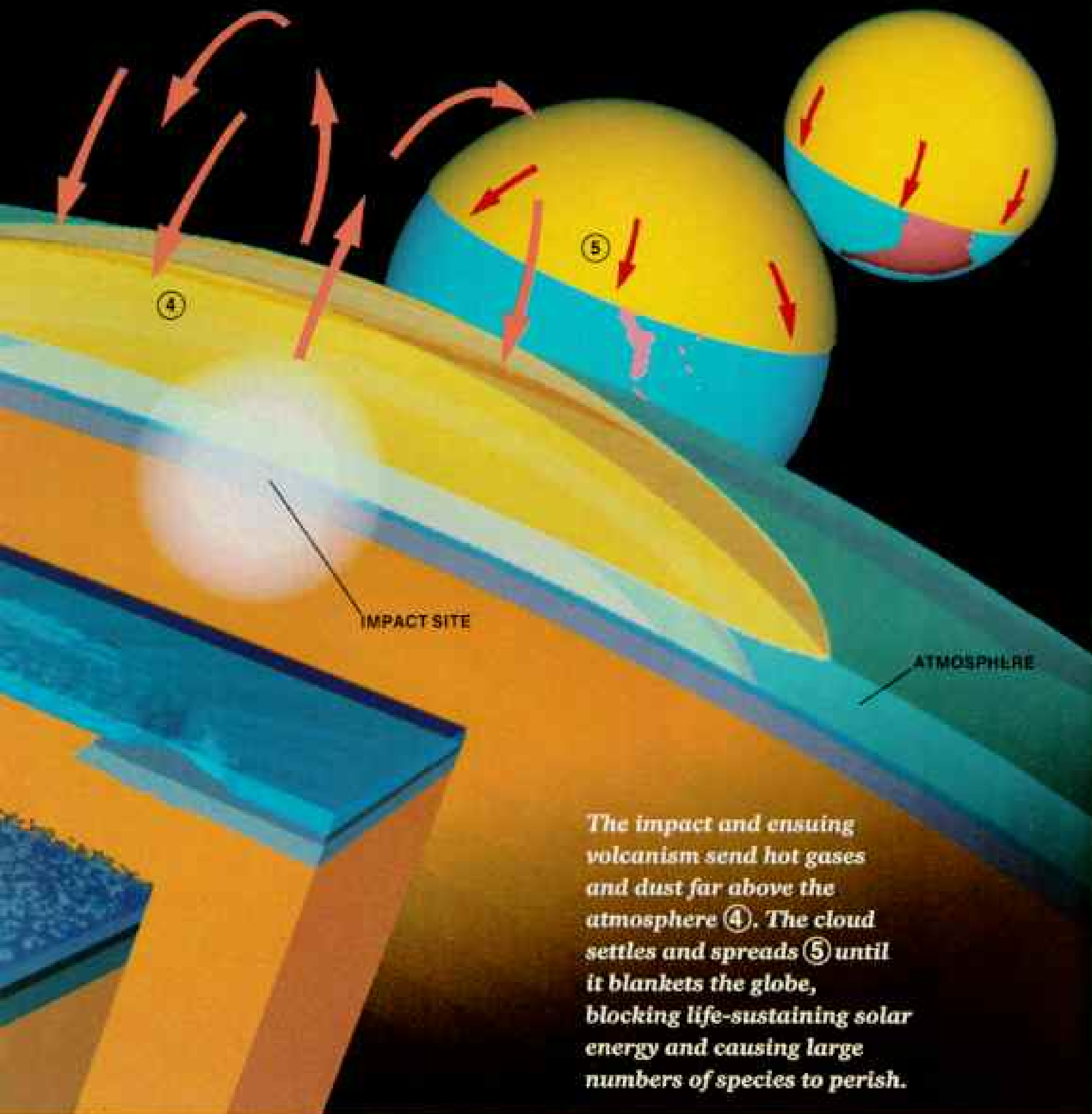
At Grange meetings, church suppers, and other gatherings, Nininger would give talks about meteorites and show samples. Then he would ask if anyone in the audience had seen anything such as he had described. A farmer might remember something his plow had turned up, since rocks are relatively rare in the prairie fields of the Midwest.

Nininger would examine the object. Irons could often be identified by their appearance and density. Stony meteorites would usually have a thin black fusion crust—evidence that the surface of the rock had heated to

incandescence and melted during the brief atmospheric flight. (The interior stays cold, however.)

In this manner, and by judicious trading over a period of 50 years, Nininger made the largest private collection ever assembled—6,000 fragments representing 690 meteorites. A portion today is in the British Museum of Natural History in London, and the rest is at Arizona State University in Tempe.

Synchronized camera networks in several countries have attempted to photograph meteoroids in flight with the aim of recovering them. In the United States the Prairie Network operated nightly for ten years with only one fall recovered—four stony



The impact and ensuing volcanism send hot gases and dust far above the atmosphere ④. The cloud settles and spreads ⑤ until it blankets the globe, blocking life-sustaining solar energy and causing large numbers of species to perish.

L. BIOLOGICAL SURVEY, FLAGSTAFF, ARIZONA, AND SHELL SCHUSTER, LISA GRANT, AND KEV BAEYENHAGEN, CALIFORNIA RESEARCH AND TECHNOLOGY, CHATEWORTH, CALIFORNIA

fragments that came down near Lost City, Oklahoma, on January 3, 1970.

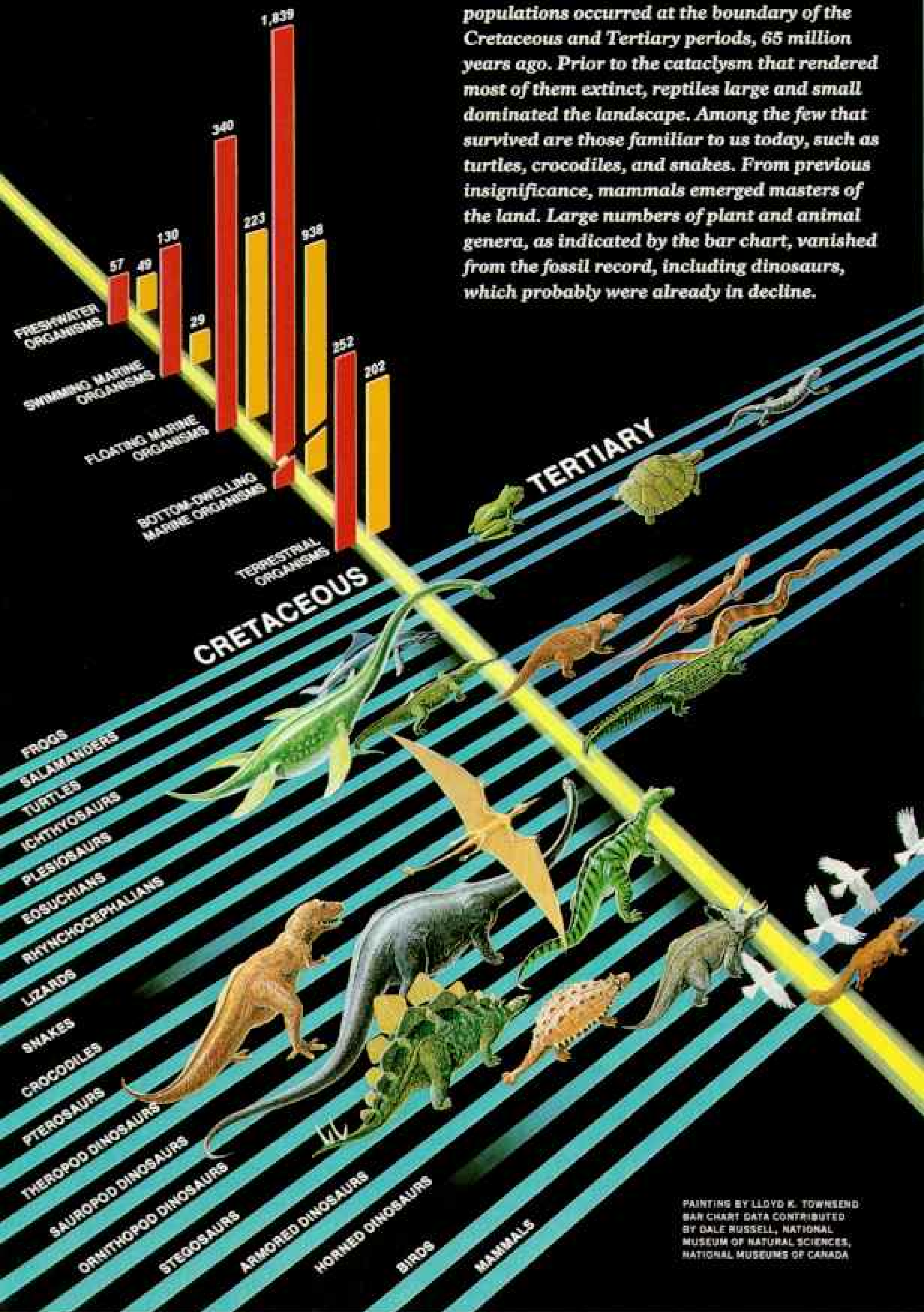
Similar techniques recovered the Innisfree stone in Canada and four pieces of the Pribram stone in Czechoslovakia. Rotating shutter-action broke up the meteor trail into a series of dashes on the film. Analysis of these produced the trajectory and calculated orbit of the meteoroids. All three orbits resemble those of Apollo earth crossers.

The greatest cache of meteorites ever uncovered is, of all places, in Antarctica. In 1969 a Japanese expedition near the Yamato Mountains happened to find a number of meteorites, one of which was a rare type. Expeditions since then, both Japanese and

American, have mounted searches. They have collected some 7,500 specimens, greatly increasing the amount of meteoritic material available to scientists.

Seaward-moving ice in Antarctica sometimes becomes blocked and pushed up against mountains largely hidden below the surface. Because of low temperatures the blocked ice cannot melt, but, scoured by high winds, it sublimates, escaping as vapor. Meteorites trapped in the icy conveyor belt are thus exposed on the surface, and gradually they accumulate. There is astonishingly little snowfall on the continent, so with diligent searching, the black objects from space may be spotted against the pale blue ice.

An abrupt change in both land and marine populations occurred at the boundary of the Cretaceous and Tertiary periods, 65 million years ago. Prior to the cataclysm that rendered most of them extinct, reptiles large and small dominated the landscape. Among the few that survived are those familiar to us today, such as turtles, crocodiles, and snakes. From previous insignificance, mammals emerged masters of the land. Large numbers of plant and animal genera, as indicated by the bar chart, vanished from the fossil record, including dinosaurs, which probably were already in decline.



PAINTINGS BY LLOYD E. TOWNSEND
 BAR CHART DATA CONTRIBUTED
 BY DALE RUSSELL, NATIONAL
 MUSEUM OF NATURAL SCIENCES,
 NATIONAL MUSEUMS OF CANADA

Many of these icebound meteorites fell hundreds of thousands of years ago, and some are heavily weathered. Some are well preserved because of the low temperatures and relatively clean conditions. The scientists take great pains to see that they are not contaminated. Protected by clean Teflon bags, the stones are kept frozen until they reach Houston, where they are opened in processing cabinets originally designed for lunar samples.

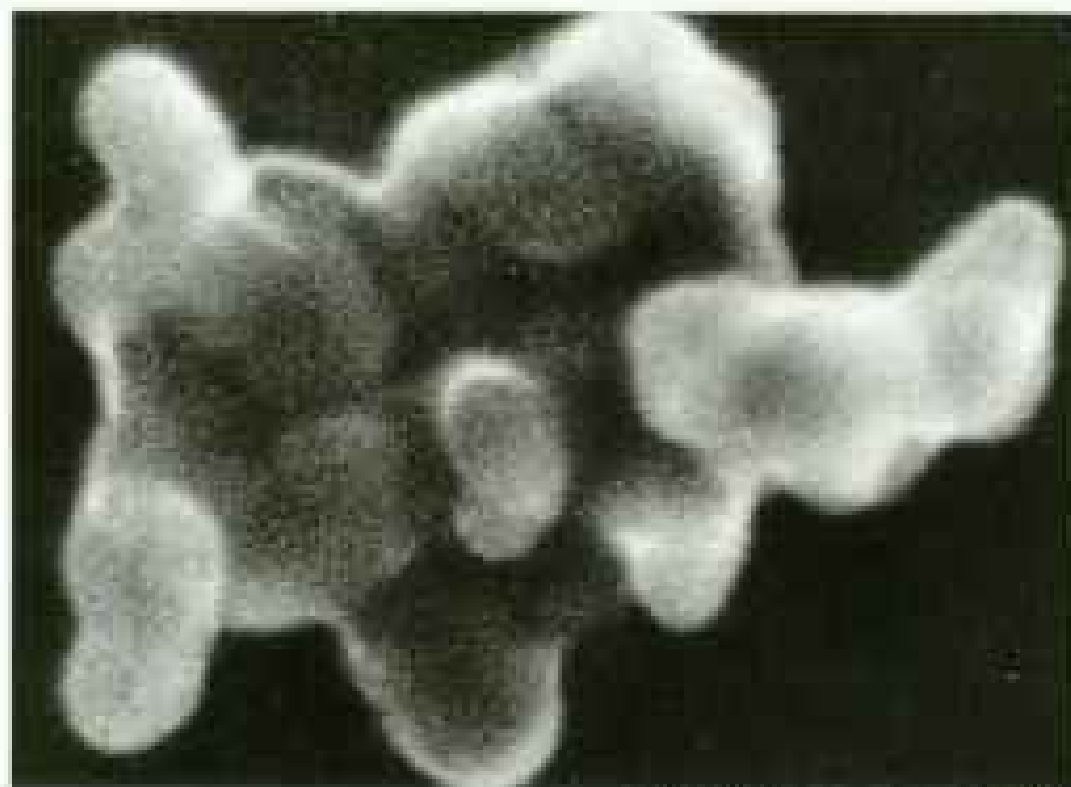
Surprisingly, four of the Antarctic finds are believed to have come from the moon—rocks hurled into space by lunar impacts. Their chemical and mineralogical makeup closely resembles that of samples collected on the moon and is unlike that of other meteorites. At least one Antarctic meteorite and several in other parts of the world are now believed to have come from Mars.

SCIENTISTS classify meteorites in three broad groups: irons, stony irons, and stones, based on their proportions of metal and stony, or silicate, material. The largest group by far are stones, and the most common of these are termed chondrites. They are so called because they contain large numbers of spherical bits of silicate known as chondrules, which never originate on earth. Some may be as large as a pea, but most are millimeter size or smaller (a millimeter is about as wide as two of the periods on this page).

Chondrites are of special importance because they represent material existing when the solar system accreted, and they escaped melting within planetary bodies. Analysis of the chondrites reveals significant information about those primordial conditions.

Carbonaceous chondrites, such as the famous Allende meteorite, contain a great deal of fine-grained earthy material as well as chondrules. Two rare types, known as C1 and C2, offer a treasure trove of organic molecules. Australia's Murchison stone, for example, contains several amino acids. Such molecules are not biogenic (produced by living things), but they could be the direct chemical precursors of organic evolution.

The largest of all meteoritic stones fell near Jilin (formerly Kirin), China, in 1976. A fireball and several explosions preceded a shower of chondrites with a total mass of



UNIVERSITY OF CHICAGO (TOP)

More fuel for the impact theory: Traces of ancient soot (above) in the clay of the Cretaceous-Tertiary boundary could be residue from a global conflagration following the event, proposes cosmochemist Edward Anders (top), standing before a stylized sculpture of Mount Fuji at the University of Chicago. "The fire and the worldwide soot cloud blocking the sun would have been an ancient analog to 'nuclear winter'—a serious worry of our age," Anders says.



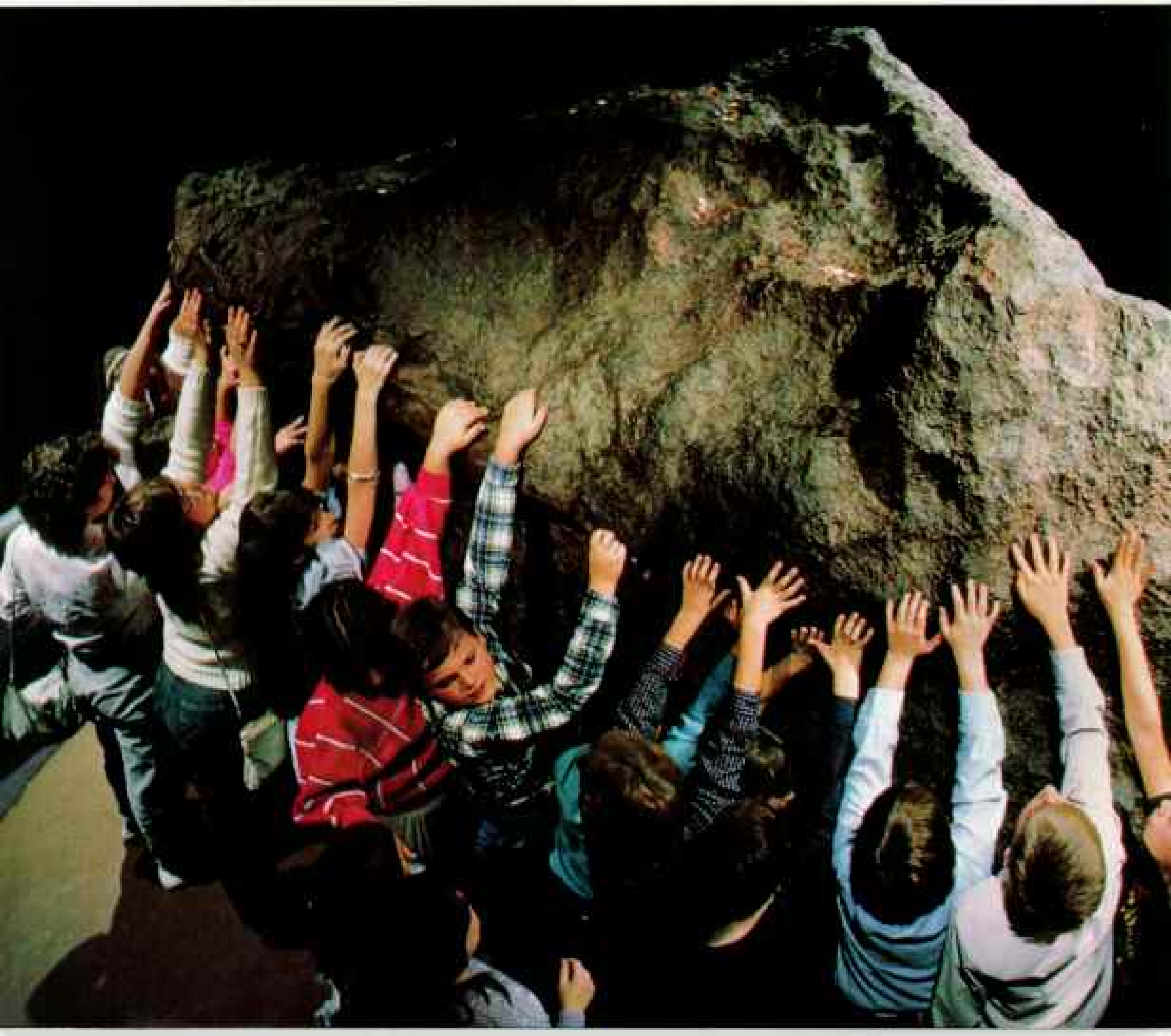
AMERICAN MUSEUM OF NATURAL HISTORY

Anvil chorus of young admirers pays tribute to the great Ahnighito, the world's second largest single meteorite, on display in the American Museum of Natural History in New York City (below). For untold generations the Eskimos of Cape York, Greenland, revered the 34-ton iron meteorite, which is thought to have fallen 10,000 years ago. They once fashioned harpoon blades

from lesser fragments of the Cape York iron. Explorer Robert E. Peary persuaded them to reveal the meteorite's location, and three summers later he and his crew finally managed to load the behemoth onto their ship (left). Navigating through ice and gales, and with a compass rendered useless by the presence of the meteorite, he brought Ahnighito to New York in 1897.

Twice the weight of Ahnighito, the 66-ton Hoba meteorite is the world's largest. It still lies where it fell, half-buried, in northern Namibia (right). The absence of a crater could be explained by a low-angle entry through the atmosphere.

Iron meteorites—such as the three-ton Old Woman (bottom right), discovered in California's Old Woman Mountains in 1976—break apart in the atmosphere less often than their stony cousins. Believed to be the fragmented cores of asteroids, they are far less common than stones, though easier to distinguish from terrestrial rocks.





DAVID BRILL (TOP); ALBERT MOLDOVTZ (ABOVE)



EGGS FROM SOAFOTO (TOP LEFT); OTIS IMBOGEN, NBS PHOTOGRAPHER

Skyborne cataclysm, a 1908 explosion over Siberia sent a shock wave around the globe. Because it occurred above ground, no crater was formed, but trees were flattened for 770 square miles near the Tunguska River (above). Many think that the nucleus of a comet exploded; others blame an asteroid. Cosmic spherules from the site (left) indicate that it was a meteoritic event.

The only known victim of a meteorite, Mrs. Hewlett Hodges (facing page, bottom) escaped with bruises in 1954, when a stone crashed through her roof in Sylacauga, Alabama. Nobody was hurt as meteorites on two occasions plunged through roofs of the same town—Wethersfield, Connecticut. On November 8, 1982, 11 years after the first event, a fire inspector examines the damage of the second meteorite (facing page, top).

about four tons. One stone alone weighed almost two tons.

AT THE OPPOSITE EXTREME from such large falls are the micrometeorites. These are dust grains, many of them much thinner than a human hair. They result from total breakup of the more fragile stony meteoroids, including comet nuclei.

Donald Brownlee of the University of Washington has collected more than 100,000 of these tiny specks. He gets some from the stratosphere using a sticky surface, somewhat like flypaper, carried aloft to 60,000 feet by U-2 planes. He gets a hundred times more by dragging a 600-pound magnetic rake more than three miles down at the bottom of the Pacific Ocean. About half of the micrometeorites contain metallic iron, or magnetite, so they readily stick to the magnet.

Particles the size of sand grains are responsible for many shooting stars in the night sky. They melt, forming cosmic spherules. Smaller particles tend to lose their velocity very high in the atmosphere before they can melt; they float to earth unchanged.

"If you had lettuce for lunch," says Professor Brownlee, "you probably ate a few of these dust particles. They are very primitive carbon-rich chondritic material, probably from comets at least as old as the solar system. Some represent the outer fringes of the planetary system when it formed; some may be interstellar grains, formed elsewhere in the galaxy, that existed before the sun and planets formed. That is why they are so important to study."

Extremely tiny glassy balls called microtektites are found in deep-sea cores. Unlike Brownlee's dust they are not extraterrestrial; they are simply miniature versions of larger glass objects called tektites, found only in certain areas of the globe. These objects were once thought by some to come from the moon, but their chemistry is terrestrial, not lunar. Almost all scientists now believe tektites to be once molten droplets thrown up by giant impacts on earth. Some show strong ablation, or melting, effects from speeding through the atmosphere.

One group of tektites, known as moldavites, are found in Czechoslovakia. They



DAN HARR, HARTFORD COURANT (TOP); JIM LESTER

To find a fallen star, Robert Haag will travel to the ends of the earth. Seen here close to home in Tucson, Arizona (**below**), he has followed his metal detector through South America, Canada, and Egypt, driven by a collector's zeal. The crown jewels of his extensive collection are polished sections of the Imilac pallasite, a rare stony iron he acquired in trade from a Chilean collector. Backlighting sets fire to amber inclusions of olivine in one section (**right**).

When biology professor Harvey Nininger began collecting meteorites in the 1920s, they were commonly valued at a dollar a pound. A pioneer in meteoritics, the science of meteorites, he is seen (**facing page, top**) with a cast of a meteorite in Colorado, four months before his death last March at the age of 99. He found about half of all meteorites discovered in the 1930s, largely with the help of thousands of rural Americans. One of his ingenious methods was a trailer with electromagnets, seen at Meteor Crater in a 1939 photograph (**bottom**) of Harvey and his son, Robert.



are about 15 million years old and are thought to have been thrown out from the 24-kilometer (15-mile) Ries Crater in Germany. Another group, called Ivory Coast tektites, about a million years old, probably came from the 10.5-kilometer Bosumtwi Crater in Ghana, the sacred lake of the Ashanti tribe. Others, whose origin is more uncertain, are found in Australia, Southeast Asia, North America, and the Soviet Union.

METEOR CRATER, with which we began our story, is the freshest and youngest of the important impact craters on earth. It is one of 13 impact sites that are unequivocally associated with meteorites. They include the Odessa, Texas, and Hviland, Kansas, craters, and others in Australia, the U.S.S.R., Argentina, Poland, and Saudi Arabia.

More than a hundred other sites lack actual meteorites but are nevertheless regarded as impact structures because they contain certain deformation features and diagnostic minerals. One is coesite, a crystalline form of silica created from quartz under pressures 20,000 times that of the atmosphere. Another high-pressure form of silica is called stishovite. Neither mineral was known before 1960, but today they are recognized as the fingerprints of meteorite impacts.

Shatter cones offer further diagnostic evidence of intense shock. These cone-shaped striated fractures may be tiny, or they may reach as much as 40 feet in length. At a giant impact site partially underlying Chicago's O'Hare International Airport, shatter cones were recently found beneath a hundred feet of glacial sediments.

In addition to the more than a hundred structures of demonstrable impact origin, more than 50 others may be meteoritic rather than volcanic, although they lack any of the diagnostic criteria. Many of these are faint outlines of huge craters long since eroded away. They sometimes show up in photographs from space.

If one looks at the moon, one sees a multitude of enormous overlapping craters that testify to massive bombardment in eons past. Earth too experienced such bombardment, especially in the first 700 million years of its existence, when the planets were still sweeping up the planetesimals left over from



AMERICAN METEORITE LABORATORY (ABOVE)

A big one that got away, a meteorite of perhaps a thousand tons was deflected from its course on August 10, 1972, by earth's atmosphere. Seen here in a fortuitous amateur photograph at Jackson Lake, Wyoming, leaving a trail over the Tetons, the fireball was visible from Utah to Alberta, Canada. The combination of its oblique angle of approach and its velocity caused it to skip off the atmosphere like a stone on water. If it had struck, it could have caused an explosion comparable to a small atomic bomb.

the accretion of the solar system. Convulsions of the earth and erosion by wind and water have long since erased most evidence of these monstrous impacts.

CATASTROPHE overwhelmed the earth about 65 million years ago. The fossil record shows that large numbers of living things became extinct rather suddenly, on a geologic time scale; as many as half of all genera disappeared.

This massive extinction, seen in the disappearance of fossils above a thin clay layer in the geologic strata, is used by scientists to define the boundary between two great geologic periods—the Cretaceous, dominated by the reptiles, and the Tertiary, which saw the tremendous expansion of the mammals. The extinction was real, but the causes for it are uncertain and have long been a subject for vigorous debate.

In 1980 four scientists at the University of California at Berkeley—Luis and Walter Alvarez, Frank Asaro, and Helen Michel—proposed an extraterrestrial cause—a giant asteroid impact. According to their calculations, the meteorite would have been some ten kilometers (six miles) in diameter, and would have produced a crater at least 10 to 15 times that size.

Evidence lies not in a huge crater but in chemical and mineralogical clues in the narrow clay layer—less than an inch thick—laid down around the world by the fallout from the impact. In Italy, in Denmark, in New Zealand, and in a number of other places, this layer has been found by the Berkeley group to contain surprising amounts of noble metals such as iridium, platinum, and osmium. This enrichment of





JAMES M. BAKER

"An interesting experiment," says knife maker William Moran, of Middletown, Maryland, of the blade he made from an iron meteorite. "I had to fold and weld the metal ten times to get the impurities out." Actually Moran used the technology of ancient peoples who exploited iron from the sky for weapons and tools. Today meteorites are more valued than ever, but as sources of information on earth's cosmic setting.



SIGGE BRIMBERG

the noble metals is many times over the abundance found in the earth's crust. The iridium and other metals are extraterrestrial; they represent part of the vaporized debris of the huge impacting body itself. Shocked quartz offers further evidence of the impact.

The Alvarez theory proposed that enormous amounts of dust thrown into the atmosphere would have blocked sunlight, stopped photosynthesis, and disrupted food chains long enough to cause the extinction. More recent work by Edward Anders and his associates at the University of Chicago suggests that the impact also ignited raging flash fires worldwide that added great volumes of soot to the light-stopping dust.

Most scientists accept the evidence of impact, but many differ as to the environmental results. Some see extreme cooling

because of blocked sunlight, similar to the so-called nuclear winter. Others see heating of the earth as a consequence of a greenhouse effect from water vapor thrown up from the ocean.

"If the cold and dark don't get you first, you may die from overheating later," says Gene Shoemaker.

Much has been made of the idea that the Cretaceous-Tertiary impact caused the extinction of the dinosaurs. The fossil record, however, suggests that the giant reptiles were well on their way out by the time of the impact. In any case their demise may not have occurred at quite the same time as that of the marine plankton that suffered so extensively at the end of the Cretaceous.

No crater has been found to support the Alvarez proposal. On land, only three impact structures a hundred kilometers or larger are known, and none is of the right age. The two largest, Sudbury in Canada and Vredefort in South Africa, are Precambrian—that is, more than 570 million years old. The other, Popigay in Siberia, is dated at about 40 million years and is too young. No craters have ever been confirmed on the bottom of the ocean, although about two-thirds of the impacts must occur in the ocean. In any event a 65-million-year-old crater might well have been subducted by plate tectonics over such a long period.

CAN THE EARTH BE SAVED from such cataclysms in the future? Gene Shoemaker thinks maybe it can, although the hazard for mankind is remote. His scheme involves careful observation of the earth crossers to determine when one is on collision course with earth. Then spacecraft sent under international auspices to rendezvous with the asteroid would attach a future propulsion system called a mass driver—just adequate to nudge the object into a non-threatening orbit.

It's something to think about the next time you see a bolide trace its fiery path across the heavens. □

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Over two-thirds of the world's surface are covered by oceans. One-fifth of the remaining land is desert. These figures are of special interest to Dr. Farouk El-Baz, whose native Egypt is 96 per cent desert.

Dr. El-Baz attempts to redress our limited knowledge of deserts – of their origins, their expansion, their possible reclamation. His task is enormous, for even a single desert cannot be covered in one researcher's lifetime.

But Dr. El-Baz, a geologist who emphasises the global picture, has aerospace technology on his side.

Indeed, it was photographs of the wind-swept surface

of Mars that first prompted Dr. El-Baz to say, "It looks like the desert of my childhood in Egypt." Poring over Sahara pictures taken from space, he found subtleties that the geological maps cannot show: three distinct bands of colour splitting the desert into different zones. One



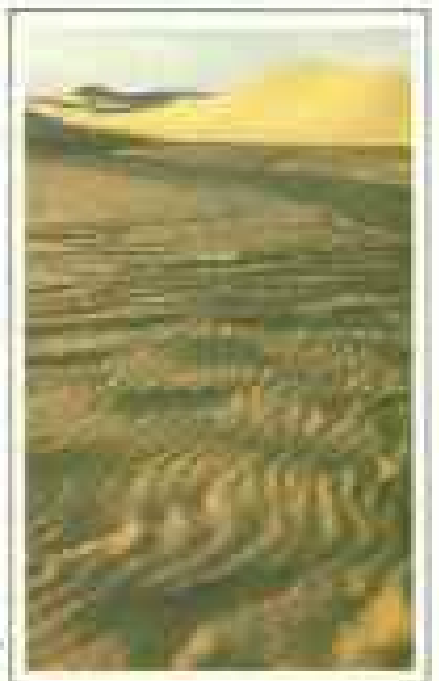
of these, an earthy-yellow zone, was good, fertile soil, ripe for reclamation – and undetected throughout 7,000 years of Egypt's history.

Again, comparing space pictures that were taken at ten-year intervals, Dr. El-Baz saw that sand dunes, like glaciers, have predictable movements – vital knowledge for siting often buried desert roads.

Analysis of global weather

To investigate Earth's deserts, Dr. Farouk El-Baz began on Mars.

patterns and regional topography has led him to state, quite simply, "Deserts are not caused by goats eating the shrubbery. It's lack of rain coupled with wind erosion that we should be blaming. It's scientifically evident that desertification is more affected by solar cycles than by man."

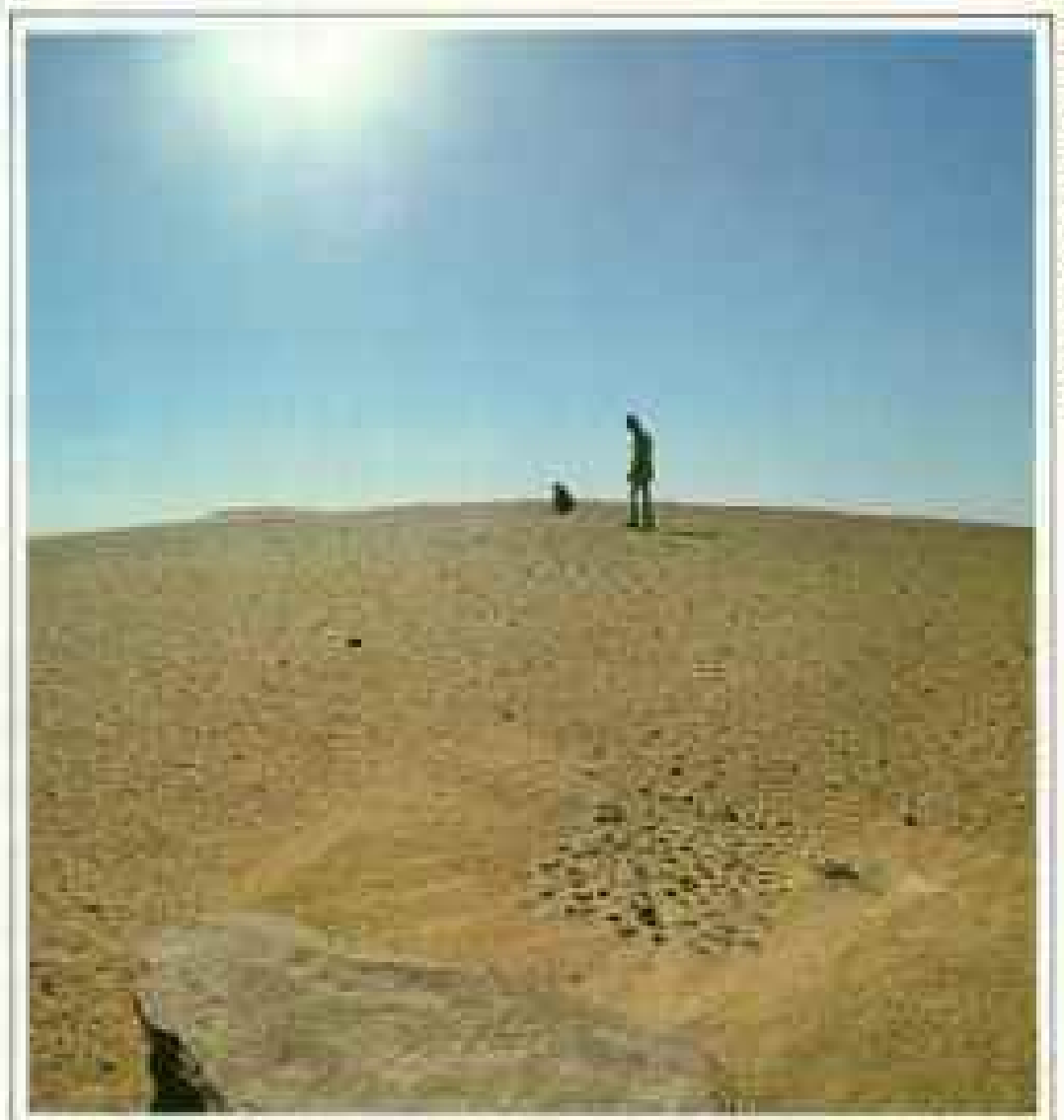


After many expeditions his understanding is growing. Aerospace technology is helping him uncover the mysteries of the past. As for the present, he depends on the precise technology of Rolex.

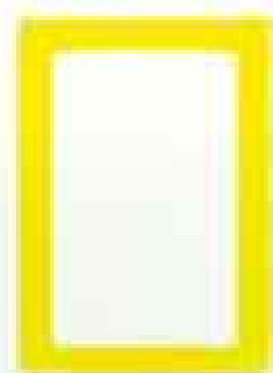
In the searing heat and the dust storms of earth's most desolate regions, Dr. Farouk El-Baz has found his Rolex – like the desert – to be predictable. And enduring.



ROLEX
of Geneva



PHOTOGRAPH BY JACQUES GUILLET



Tools for students: six million free maps

IF YOU WANT to learn a new language, you begin with words and grammar. Only when you acquire enough vocabulary, and can string words together into meaningful sentences and paragraphs, can you communicate effectively. If you want to teach geography, you hand your student a map. Maps are the basic, essential tools of a knowledge of geography—so vital to regional, national, and world understanding.

Since we at the Society strive to help teach the language of geography, we have taken an unprecedented step. We have provided—at no charge whatever—a new map for secondary-school students across the United States. Some six million of these specially prepared maps will soon arrive at public and private schools all over the country.

Actually, what we have provided is more than a map: It is a short, illustrated course on the basic principles of geography, in the format of a double-sided poster almost two by three feet in size. The heart of the poster is a highly detailed relief map under the headline “Maps, the Landscape, and Fundamental Themes in Geography.”

The map shows not only the chief physical features of the United States, but eight vegetation types as well. Blocks of text explain several central themes of geography and relate these to the map: the principle of *location* and its various meanings; the significance of *relationships and interactions* between human societies and natural environments; an understanding of the special character of *regions*; and, by combining people, places, and landscapes, the *unifying nature of geography* in a dynamic, ever changing world. Color photographs illustrate the themes, which are expanded upon on the reverse side.



JULIE YORNBURG ADKINS, EDITOR, AND DOUGLAS STERN, COMPUTER GRAPHICS ARTIST, CONSULT ON MAP DESIGN. PHOTOGRAPH BY PATT LARCA FIELD

Taken as a whole, the poster is a comprehensive tool for building geographic knowledge, and thus better understanding of the world. It is a commitment to principles of geography as developed by the Society and other organizations that compose the Geographic Education National Implementation Project (GENIP). Most of all it is a commitment to our schools, teachers, and students.

May they use these building blocks of knowledge well. How well they learn will in large measure determine how successful their generation will be in coping with the environment, preserving our natural resources, formulating national policy, and shaping global understanding—just to name a few compelling reasons to study geography.

Silbert A. Brown

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY

“You really know how to make a guy happy.”

This is an authentic passenger statement.



Lufthansa

Members Forum

Serengeti

Your article on the Serengeti (May 1986) was timely and well done. However, I was disconcerted to read about "sullen" hunting dogs, vultures with "filthy habits," and hyenas like "hideous teddy bears." Such insights belong to the 19th century. Each species has a beauty and perfection of its own, an image forged and tested by evolution. We should neither denigrate nor exalt animals; we should not find in them what we seek.

George B. Schaller
Roxbury, Connecticut

These are some of the finest in-the-field wildlife photographs I have ever seen in NATIONAL GEOGRAPHIC or any other magazine. Superb!

Wade Byars, Agence France-Presse
Los Angeles, California

The feature on the Serengeti was exceptional. The image that has remained in my mind is that of slaughtered elephants, killed for their ivory. I saw tons of ivory products for sale in Hong Kong, Singapore, and China. The blame lies not only on the poacher, the importer, and the retailer, but on the buyer as well. I saw thousands of tourists buying ivory as if it were wood. Don't people realize?

Paul Morrison
Ottawa, Ontario

In Tanzania you can buy ivory artifacts, cheetah- and leopard-skin purses, lion teeth, and lion claws in any shop. The shopkeeper gives an official export form for the items. In Kenya the wildlife protection laws are very strict. Nobody can buy or sell any wild-animal products. Laws like Kenya's are required in Tanzania.

Raj Rasania
Chicago, Illinois

Several rhinos had been poached just days prior to our recent stay in Ngorongoro Crater, reducing the total remaining to fewer than 30.

Doug Lamb
Silvis, Illinois

The article on the Serengeti should have been renamed "The Glory of Death," considering the photographs included. Am I to allow my young son to view this display of the grotesque and horrific?

Craig H. Coon
Spencerport, New York

The senseless slaughter of these magnificent elephants, although not pretty to see, should be shown to all GEOGRAPHIC readers. I can only hope that the government of Tanzania will be more determined to stop poaching.

Pat Bryant
Shreveport, Louisiana

Newfoundland

It's about time someone shed light on Canada's most misunderstood province (May 1986). Newfoundland's police do not carry firearms, and we have the lowest crime rate in Canada. Thank you for a lovely tribute.

Judy C. Murphy
Placentia Bay, Newfoundland

On page 682 you have Nellie Carter making a plea for help, or SOS, although she does not seem to know it. The Union Jack she is holding is upside down, a distress signal. I hope she got the help she needed.

Ed J. Brogden
Sarnia, Ontario

One thing should be mentioned in any article on Newfoundland: the work of Sir Wilfred T. Grenfell in establishing the medical missions that have so well served the European fishermen on the Grand Banks and the residents of Newfoundland. Thousands of nurses and technicians have been trained there.

Richard E. Horton
Orange, Virginia

I missed seeing the positive aspects of Newfoundland. What I saw was more of the typical Canadian cold, ugly, north image—an all too common misconception. How about including art, culture, and beauty in the next one?

Jane Gray
Dwight, Ontario

You failed to mention that "Newfies" are probably the kindest, nicest, most fun-loving people on earth. Although poor people, they have a zest for life that Americans couldn't understand.

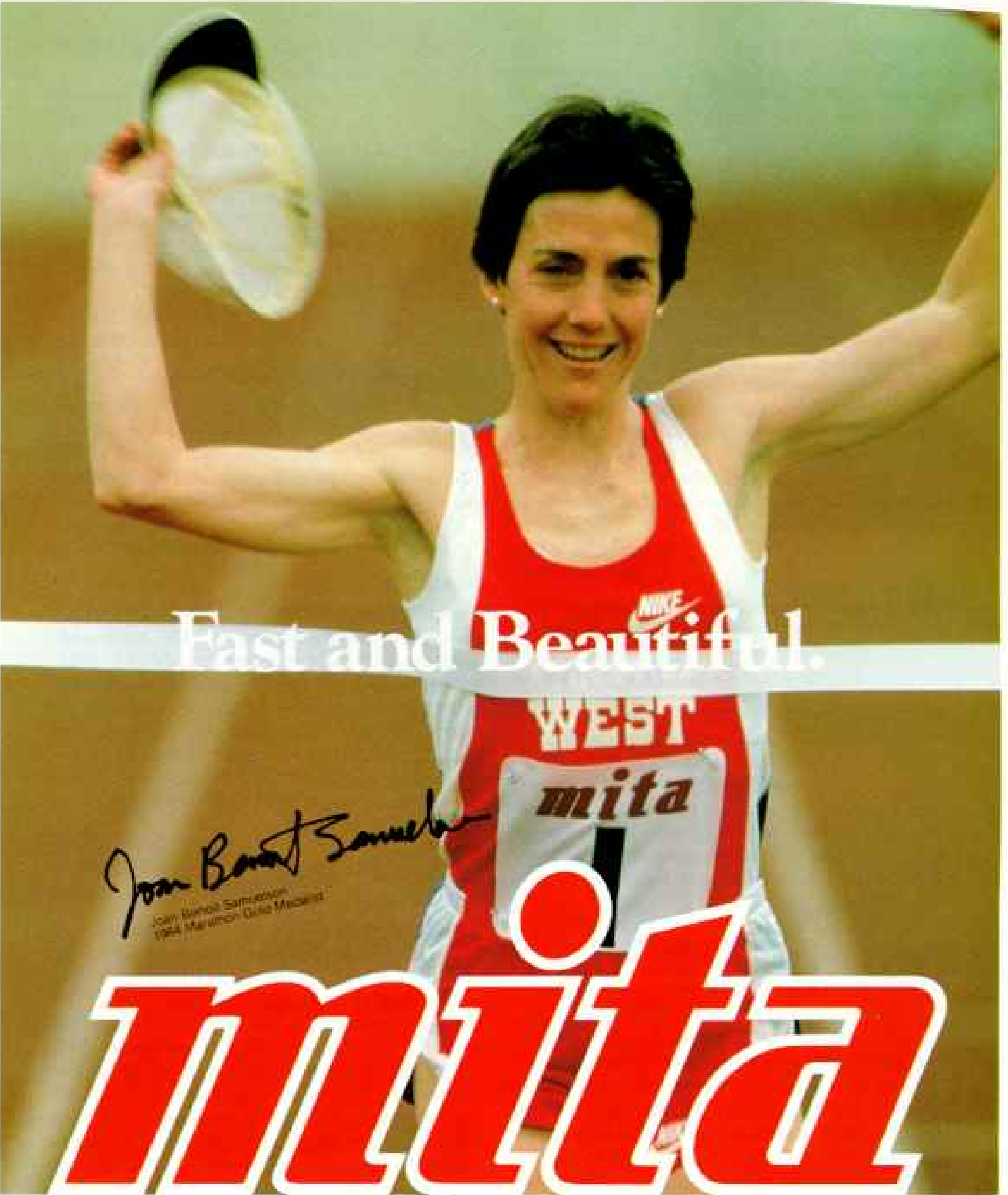
Charles L. Owen
Las Vegas, Nevada

Tennessee

Priit J. Vesilind's article (May 1986) has precipitated a flurry of applause. The only flaw was the erroneously inverted state flag on page 613. The GEOGRAPHIC is in good company. The U. S. Postal Service made the same mistake a few years ago in their state flag issue.

C. Tracey Parks
Lebanon, Tennessee

Lainey Marty's wheelchair and communication device were a modern miracle one year ago, but the prototype pictured is obsolete and must be



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MITA official copier of Athletics World Championships 25/8-6/9 1987, Rome

replaced with commercial equipment now available. Hopefully Lainey will have a new system for her 1986-87 senior year at Shrine School. Lainey will attend Vanderbilt University. The special-education services and facilities of Memphis city schools are among the best in the world and have a national reputation for excellence.

J. E. McCandless
Principal, Shrine School
Memphis, Tennessee

Conspicuous by its absence was any reference to Meharry Medical College in Nashville. Meharry has, for more than a hundred years, trained gifted minority students to be physicians, dentists, and research scientists. And to attribute the demise of Memphis to the assassination of Dr. Martin Luther King, Jr., is, in my opinion, a misinterpretation. As heinous as the crime was, the assassination brought about a determination of its people to rebuild the city on the premise of equality and justice for all.

Donald N. White
Bronx, New York

Why was there no mention of the people to whom that state first belonged—the Cherokee nation?

Patricia L. Grile
Muncie, Indiana

"Loess soil [in west Tennessee], windblown from the Great Plains," is incorrect. The loess was derived largely from the Mississippi River floodplain. During the Pleistocene when the river, laden with glacial silt from upper parts of its basin, overflowed and receded, the sediment dried and then blew into Tennessee. Similar material is still blown in from plowed fields of eastern Arkansas.

Melvin Marcher
Oklahoma City, Oklahoma

Earthquake in Mexico

Your excellent articles about earthquakes and mudflows (May 1986) reminded us how restless our earth really is. The more important lesson is that many natural events can be predicted. In western Canada, for example, despite the warnings of many scientists, the threat of a major earthquake is not taken seriously. When it eventually hits, we too will experience a disaster because of our unwillingness to accept and plan for the inevitable.

Frank W. Baumann
Squamish, British Columbia

Lisbon was destroyed in 1755 by one of the strongest earthquakes of historic times. Our capital was rebuilt using a new building process invented by Manuel de Maia, a Portuguese engineer, similar to the one on pages 664-5. The structure was also tested on a stand, with levers pulled by horses to simulate the seismic movements. It

seemed interesting to find the same type of structure reinvented in modern buildings.

Miguel Ramalho
Cascais, Portugal

I am so disappointed by the last part of your article. As if Mexico's earthquake and consequent sufferings were a godsend to show people in the U. S. more about quakes! The only possible godsend was that Mexicans showed the world their willingness to help each other at the risk of their own lives. Let that be a lesson to us all.

Katie Cosgrove Villaseñor
Guadalajara, Mexico

Eruption in Colombia

I heard about the tragedy in Colombia, but until reading your article (May 1986), I never realized that so many people were injured and killed. Photographer Steve Raymer did an excellent job. The pictures are an eye-opener.

Lisa Gagnon
Kansasville, Wisconsin

Members Forum

I must refute John Burton (May 1986) on his statements about Nicaragua. My cattle-and-sorghum farm was confiscated on March 1, 1983, without compensation. I could not even go back to pay my employees. I had paid taxes for 27 years, and our farmlands were a long way from being idle. Today, with much farmland expropriated, most without any compensation, farm production has dropped, and Nicaragua has to import basic foodstuffs.

Gaye Llanes
Miami, Florida

Ndebele

As engineers in South Africa's Department of Water Affairs, we have been involved in a major project in KwaNdebele, conspicuous by its absence from your article (February 1986). The project consists of a major dam, purification works, reservoirs, and distribution system. Water as yet may not be delivered to individual houses, but it is being supplied to community centers, and it is pure—by no means a norm in Africa. The expropriation of land is an unavoidable part of many public works for the benefit of the majority. Much is wrong in South Africa, but much is being done. NATIONAL GEOGRAPHIC should give due consideration to both aspects.

Jan M. Jordaan and Frank Hollingworth
Pretoria, South Africa

.....
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Malayan Tapir Genus: *Tapirus* Species: *indicus*

Adult size: Length of head and body, 220-250cm; tail, 5-10cm; shoulder height, 90-105cm

Adult weight: 250-300kg **Habitat:** Dense rain forests in Burma and Thailand, south to Malaya and Sumatra **Surviving number:** Unknown **Photographed by** Wardene Weisser

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An excellent swimmer, the Malayan tapir spends much of its time in the water, feeding, cooling off, or ridding itself of insects. The distinct black-and-white coloration serves to camouflage the tapir among the shadows in the forest, helping it to elude predators such as tigers and leopards.

The Malayan tapir does not adapt well to changes in its habitat. As a result, this shy creature has declined dramatically throughout its range and currently survives only in isolated and undisturbed areas. The tapir faces a bleak future without further protection of its vital habitat. Invaluable in conservation efforts, photography helps to promote a deeper understanding of this unique denizen of tropical rain forests.

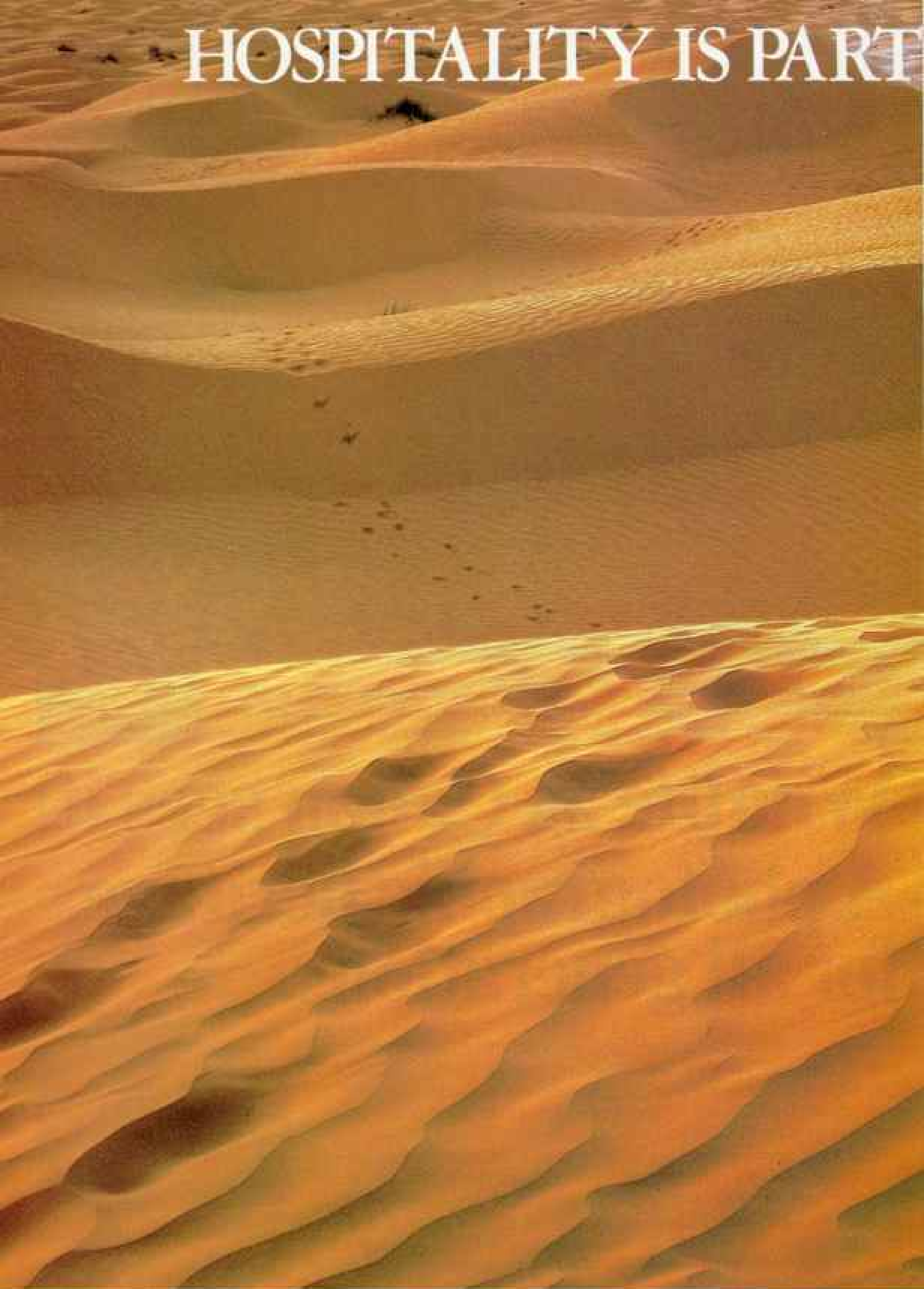
And understanding is perhaps the single most important factor in saving the Malayan tapir and all of wildlife.



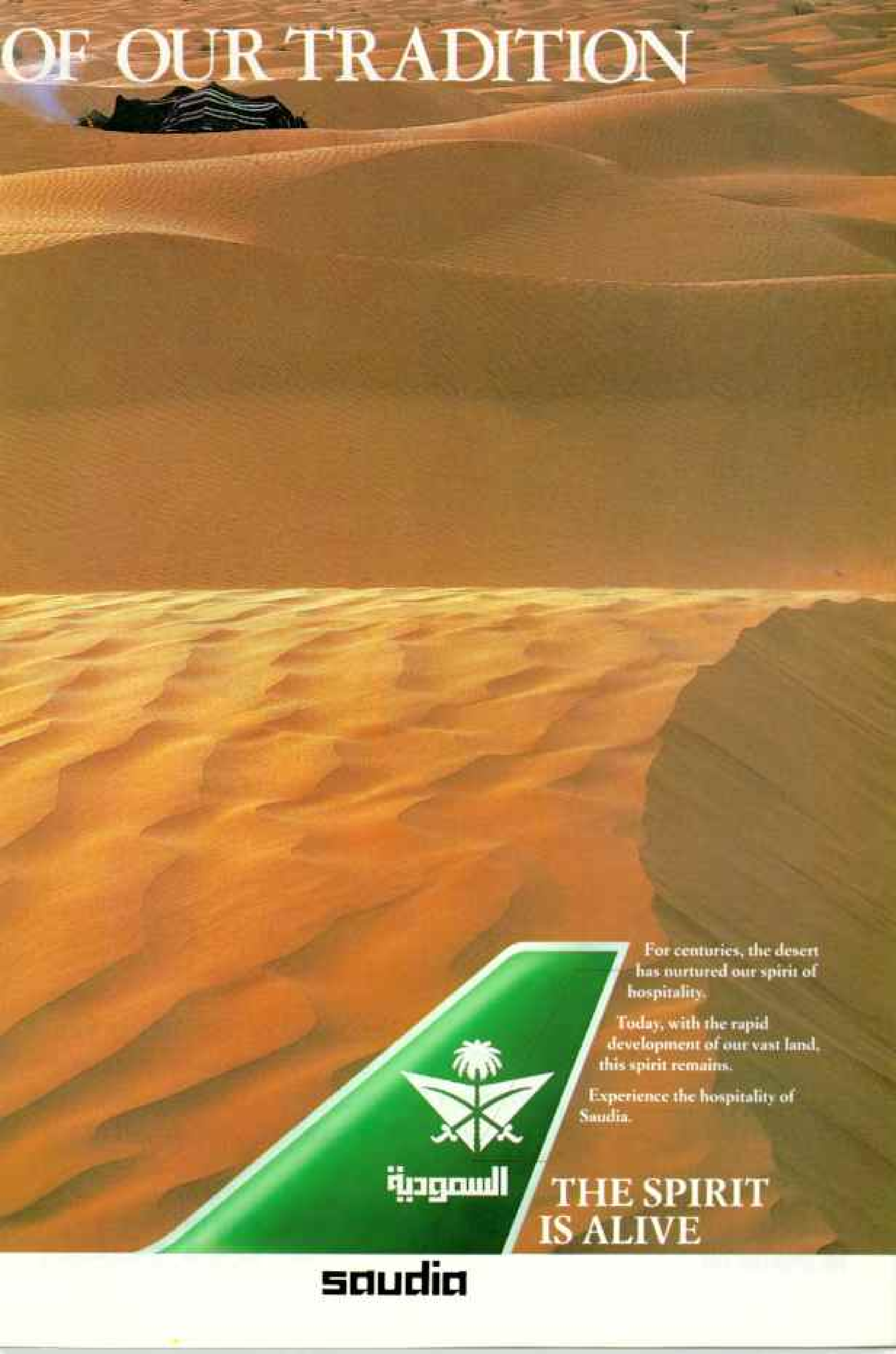
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A dramatic sunset over the Sydney Opera House. The sky is filled with vibrant orange, red, and purple clouds. A prominent, thick, red, glowing streak curves across the upper half of the image. The Opera House is silhouetted against the bright light of the setting sun. The water in the foreground is dark with shimmering reflections of the sunset colors.

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On Assignment

AS EVERYONE KNOWS, a good hug works wonders. In the case of author Małgorzata Niezabitowska (*right*, at right) and her friend Sara Adar an embrace helped bridge the vast difference between a young Polish writer born after the Holocaust and a Polish Jew who survived it.

It was not always this easy for Małgorzata and her husband, award-winning photographer Tomasz Tomaszewski, to get close to the last Jews in Poland for the article in this issue. Most of them are lonely old people, haunted by wartime memories and anti-Semitism, who shun attention—especially from journalists.

"I never dreamed how difficult it would be," says the author, who holds degrees in law and journalism from the University of Warsaw. "It meant overcoming mistrust and gaining acceptance in the closed circles where a goy is always an outsider and every Pole is an anti-Semite."

The idea for the project had its roots in Małgorzata's childhood. Raised by her grandmother, she grew up hearing tales about "the good old times" before the war and about the family's Jewish neighbors: "the grain merchant Bergson, almost a member of the family; Zylberstein, in whose shop one could buy all the confections of the East; Dr. Lewicki, who saved my father from a violent childhood attack of whooping cough." Her grandmother also spoke of a Jewish family who had been concealed during the war in a special closet in the family home. "When I wanted to know more, she would say, 'I will tell you someday. These are tragic matters.' I never learned of their fate. And when I grew up and looked around, I realized there were no more Jews."

Thus the couple set out on a five-year search for the few remaining Jews in Poland. "The first two years we spent just

being with them," says Tomasz. "I didn't take a picture; Małgorzata didn't make a note." They eventually traveled some 50,000 miles back and forth across Poland, interviewing more than a thousand people. Their ultimate success, Tomasz says, was a



TOMASZ TOMASZEWSKI

matter of patience and professional teamwork, refined by nine years of marriage.

This fall Małgorzata and Tomasz will take a break from their respective positions in Warsaw as a writer and editor and as a photographer and vice president of the Polish Art Photographers Union. They will come with their eight-year-old daughter, Maryna, to Harvard University, where Małgorzata has accepted a yearlong Nieman Fellowship to pursue advanced studies.

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