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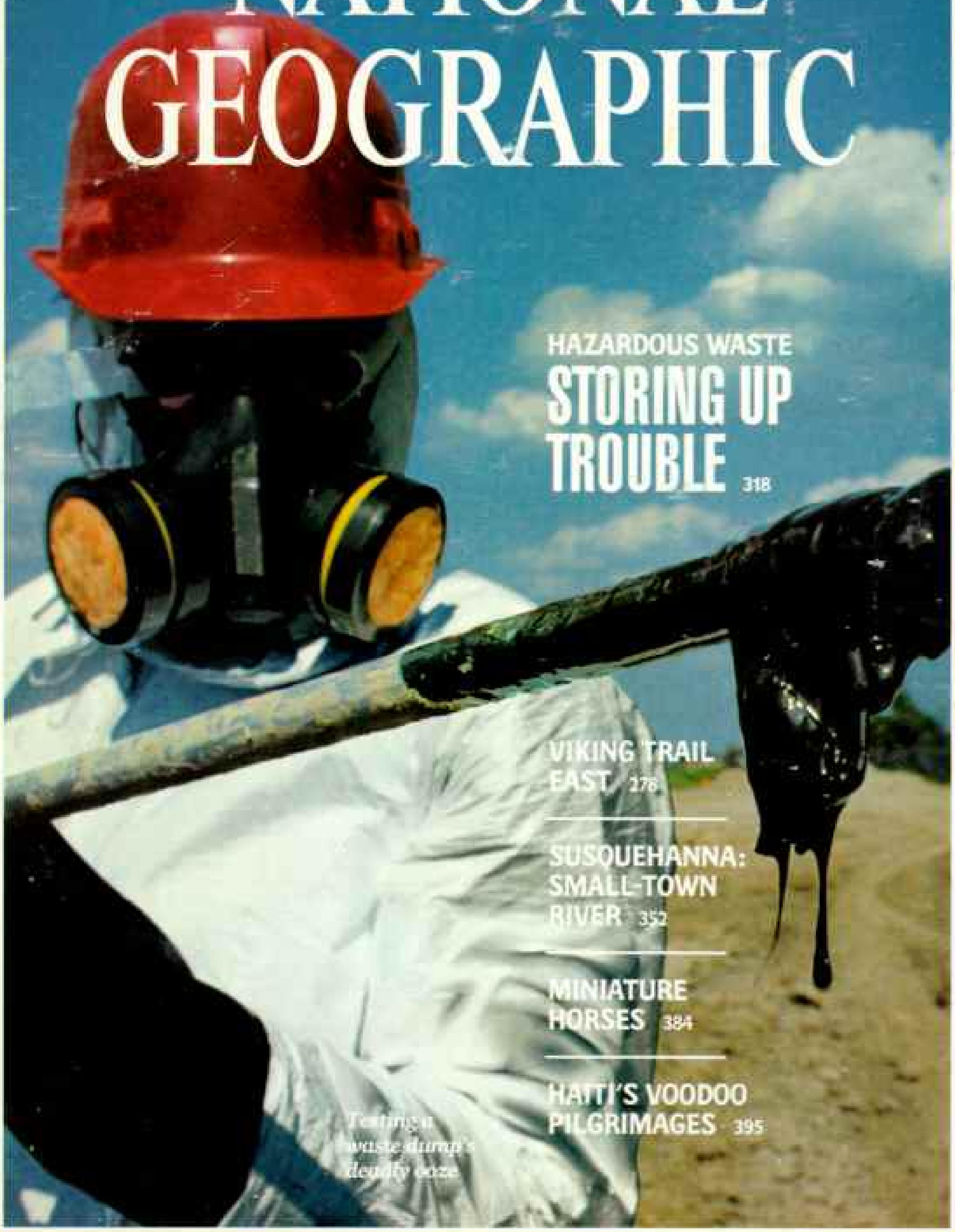

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Tenants of a waste dump's deadly ooze

SEE "BALLAD OF THE IRISH HORSE" WEDNESDAY, MARCH 6, AND
"GREAT MOMENTS WITH NATIONAL GEOGRAPHIC" MARCH 13, BOTH ON PBS TV

EVEN with someone else's war sweeping through their mountains, the Hmong people of Laos were gracious hosts to anyone who walked far enough to reach their villages. In 1973 I found an exception just east of the Mekong River. My welcome was so cool I feared I had stumbled on a village that had defected to the other side.

Nothing so simple. When the headman returned from his fields, he told me the village's opium crop—its only source of cash—had been sprayed and destroyed by Americans. "A cloud fell out the back of the plane, and all our fields died," he said.

Also, village mothers tearfully told me, within a few days so had five babies and all the young pigs and dogs. Rightly or wrongly, they blamed the spray for the deaths.

Later I learned that narcotics agents had used a heavy dose of a herbicide thought to be harmless to humans. Lurking in it was the then almost unknown chemical dioxin.

A decade later and half a world away, the United States government had to buy an entire town—Times Beach, Missouri—because it had been so polluted with dioxin it was considered uninhabitable.

Scientists say dioxin is the most poisonous chemical ever made by man. But not a single human death has yet been definitely attributed to it. Frighteningly, we still don't know how dangerous it is.

Even more sobering, we spray, eat, wash with, and generally douse our world with thousands of chemicals designed to make a better life for mankind. Are they all safe? How many, like the DDT still made and sold outside the U. S., are quietly poisoning our environment? How many are more deadly than the problems they seek to solve?

In this issue we look at one fallout from this chemical world we have created: how to deal with just the waste products we *know* are hazardous. This problem is a sobering reminder that the benefits of modern technology can carry unexpectedly high costs.

Former EPA Administrator William Ruckelshaus has said, "Living in a technological society is like riding a bucking bronco. I don't believe we can afford to get off, and I doubt that someone will magically appear who can lead it about on a leash. The question is: How do we become better bronco busters?"

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

March 1985

When the Vikings Sailed East 278

Crossing the Baltic into northern Europe's Slavic heartland, early Scandinavians raided and traded down the Dnieper and Volga Rivers. Robert Paul Jordan, photographer Jim Brandenburg, and artist Michael A. Hampshire re-create a tumultuous era.

Storing Up Trouble . . . Hazardous Waste 318

What should we do with this dangerous and inevitable by-product of industry? There are no easy answers, report Allen A. Boraiko and photographer Fred Ward.

Susquehanna: America's Small-Town River 352

From central New York State to the Chesapeake Bay, Peter Miller and William T. Douthitt follow this major yet quiet river as it meanders past the homes of farmers, steelworkers, and coal miners.

Miniature Horses 384

R. L. Blakely and photographer Thomas Nebbia capture the spirit of lovable equines that measure less than three feet tall.

Of Spirits and Saints 395

Magic and religion merge in voodoo—the folk cult of Haiti. Carole Devillers joins pilgrim festivals in which African ancestral spirits and church saints are equally celebrated.

COVER: *Deadly ooze containing PCBs is the harvest of a technician cleaning toxic chemicals from an abandoned dump in Michigan. Photograph by Fred Ward.*

THE NATIONAL GEOGRAPHIC MAGAZINE
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WHEN THE RUS INVADED RUSSIA...

Viking Trail East

By ROBERT PAUL JORDAN
SENIOR ASSISTANT EDITOR

Photographs by
JIM BRANDENBURG

Paintings by
MICHAEL A. HAMPSHIRE

VIKING ROOTS struck deep into Russian soil when Scandinavian warriors and traders, known as the Rus, created the land's first organized state—and gave their name to a future empire. The legendary Rurik of the Rus became Prince of Novgorod in A.D. 862. A thousand years later his bronze figure (right) adorns a huge monument in the kremlin square of that city. By the 11th century a Rus state centered at Kiev stretched from the Baltic to the Black Sea.

Modern Soviet scholars, in a debate heavily tinged with nationalism, are negative about the role of the Vikings, known as Varangians, in the formation of the Slav state. They maintain that a confederation of Slav tribes existed three centuries before the Vikings arrived. But Western historians find that the first rulers of a state in what is now Russia, Belorussia, and the Ukraine were not Slavs but Scandinavians.

At first the realm was pagan, and its tenth-century transition to Orthodox Christianity is foreshadowed by a cross found among runic graffiti on bones discovered near Minsk (left).

To bring you this epic tale (page 290) of the Vikings who "went the other way," Robert Paul Jordan and Jim Brandenburg retraced their path from Sweden eastward and south down great rivers like the Dnieper that once drew Viking ships toward Constantinople.


ЗЕМЛЯ РОССІЙСКАЯ
ВЕЛИКОЛЕПНАЯ
ЦАРЬ

PRELUDE *to a long journey through the Russian wilderness, inhabitants of a settlement on Lake Ladoga hurry to ready a fleet of riverboats for the powerful Rus, as they called their Viking overlords. After wintering over in such towns, marauding the adjacent countryside, the Vikings would push inland in spring with their trade cargoes. Flotillas numbering at times in the hundreds would ultimately carry the greatest volume of European trade goods of the time. When the Vikings dominated trade in the region, beginning around* A.D. *800, the east shore of the Baltic was home to many different tribes, including Lithuanians, Finns, and Lætts.*

PERILOUS *passages, a series of seven rock-strewn rapids faced the Vikings between Kiev and the Black Sea. Some were negotiable by daredevil oarsmen, but others had to be portaged, presenting hazards of another kind: marauding tribes who dwelt along the Dnieper. Most fearsome of all were the Turkic Petchenegs, who in 972 slew Prince Svyatoslav of the Rus and made a drinking cup of his skull. In this depiction Vikings fight off the Petchenegs, while their Slavic slaves carry the boats and goods. Abducted by the Vikings, Slavs bear a name derived from Latin and Greek words for slave.*

FORCED *into a faith of their ruler's choosing, the people of Kiev are herded into the Dnieper as Byzantine prelates administer mass baptism into the Christian faith. Tradition holds that Vladimir, a prince of the Rus dynasty, later canonized for converting Kievan Rus to Christianity, sent emissaries shopping for a religion for his pagan kingdom. When Islam demanded abstinence, he rejected it, saying, "Drink is the joy of the Rus. We cannot exist without that pleasure." In fact, he probably chose the Greek Orthodox Church in order to strengthen his ties with the rich Byzantine Empire.*

RUDE PRESENCE *in the Golden Horn, the Vikings in their small boats are reminded by a Byzantine naval vessel that they are forbidden to carry arms in Constantinople. Though the city's fabled wealth inspired them to several attacks, they were*

ultimately appeased with lucrative trade agreements. Later, as mercenaries, they fought valiantly under the Byzantine banner from Syria to Sicily and served for generations as the emperor's personal Varangian Guard.

The Varangian Way: Viking Seedbed of the Russian State

AS THE LIGHTS *dimmed during Europe's Dark Ages, eighth-century Scandinavians penetrated most of the known world in their forays of conquest and trade. Norwegian and Danish Vikings concentrated on western Europe, but the Swedes turned toward the eastern Baltic, where they thrust deep into the lands of the Slavs. Known as Varangians and Rus, they traded with the strong, plundered the weak. They portaged to the Dnieper, where they founded the Principality of Kiev. By other portages they reached the Volga, where the entrenched Jewish Khazars and Muslim Bulgars forced them to pay tribute for a lucrative silver trade. By the 11th century the Vikings were all but assimilated by the indigenous tribes.*

White Sea

of Bothnia

0 200 km
0 200 mi

NGS CARTOGRAPHIC DIVISION
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Gulf of Finland

Lake Ladoga

Lake Onega

Staraya Ladoga
Aldeigjuborg

Helsinki

Petrokrepost

Neva

Leningrad

Volkhov

Lake Il'men

Novgorod
Holmgård

Gulf of Riga

Pskov

Staraya Russa

Lovat

Riga

Western Dvina

Velikiye Luki

Gnezdovo

Moscow

Volga

Bulgar

Vitebsk

Oka

Smolensk

Minsk

Until blocked by hostilities in the 970s, the broad Volga was the Viking conduit for Arab silver. The city of Bulgar and the Khazar port of Itil were the main trade centers.

Ural Mountains

In 882 Oleg of Novgorod seized Kiev, uniting two Varangian domains. In 907 his attack on Constantinople resulted in trade agreements that enhanced the Kievan Rus economy.

Pripet

Dnieper

Chernigov

Kiev

A gantlet of hazardous rapids, some requiring portage, could be navigated only during a few weeks of high water each year.

Volgograd

Cherkassy

Dniester

Carpathian Mountains

Berezany Island

Zaporozh'ye

Volga

Astrakhan
Itil

Odessa

Dnieper

Sea of Azov

Crimea

Reaching the Caspian Sea, the Vikings sailed to southern shores, where camel trains carried their goods to markets from Persia to China.

Reaching the mouth of the Dnieper, the Vikings rigged sails and set forth to Constantinople, coasting the Black Sea—scene of battles with the Byzantine navy.

Caucasus Mountains

Caspian Sea

Black Sea

Bosporus

Baku

Istanbul
Constantinople, Byzantium, Miklagård

A TALE OF THEN AND NOW

Viking Trail East

VIKINGS! Down the passage of a millennium their exploits still reverberate like a battle cry. For 250 and more tumultuous years, ending around the middle of the 11th century A.D., these fierce marauders voyaged forth from their dark Scandinavian fastness to scourge much of civilization.

Striking westward in fragile, shallow-draft ships, heathen freebooters terrorized and plundered a Christian Europe. People prayed for peace: "From the fury of the Northmen deliver us, O Lord." As explorers and colonists, the bearded barbarians crossed the Atlantic and settled Iceland and Greenland. Five centuries before Columbus they chanced upon a strange coast, "well-wooded and with low hills"—America.

Other Vikings, many out of Sweden, thrust across the Baltic deep into the east, where they were called the Rus. Their legacy lives on; Russia itself takes its name from these adventurer-merchants. This is their seldom-told story, a tale as astonishing as the saga of the western road.

Scandinavians were also known as Varangians; the Baltic was the Varangian Sea, their long eastern path the Varangian Way. Following the faint trail led me into ancient lands and times. It also took me through the troubled world of this day, where the old cry for peace rings out as strong as ever.

Eastern Vikings—the Varangian Rus—coursed wild rivers through the brooding taiga and windswept steppe of Finno-Ugric, Balt, and Slav tribes. Along the way they established fortified trading posts, from which they rowed in convoy down the Volga and Dnieper to the Caspian and Black Seas. The enterprising Rus carried cargoes destined for the elite of Baghdad and Byzantium—furs, amber, honey, wax, weapons, and slaves. Returning, they bore the Orient's rich brocades and silver. Even now hoards of coins minted in such places as Tashkent and Samarkand are unearthed in Sweden.

Viking chieftains became rulers of Slav cities like Novgorod and Kiev, founding a dynasty and marrying into Europe's royal houses. Several times Viking fleets sailed the Black Sea to attack mighty Byzantium. The Greeks, impressed by the "ax-bearing barbarians," hired them as mercenaries. Giving their name to the famed Varangian Guard, they guarded the most Christian emperor in Constantinople and fought for him in the field. In the tenth century Prince Vladimir, Viking-descended ruler of Kievan Rus, brought Christianity up the Dnieper, forcing his subjects into its waters for baptism.

I BEGAN MY JOURNEY into this stormy past late on a June evening beside the old Viking road where it rolls, hard-surfaced, two-lane, through fields of peas and rye up to Stockholm. The midnight sun was dying hard, and a fillip of arctic sea air quickened the blood. "Green winter," the Swedes call it.

An occasional car and motorcycle roared by; a smiling bicyclist waved a bouquet of wildflowers. "For my wife," he said. Half a mile distant a pair of swans pounded powerful wings through the rosy twilight. I had a feeling of unreality, even though the tidy dwellings of Täby parish and a modern shopping center lay just over the horizon.

Rune stones dictated the mood, thousand-year-old sentinels looming along the road, memorials to good works, far-flung sea wolves, life and death. This was the Täby district in those days too, and a local magnate wanted to be remembered. He placed about 20 stones. I stopped beside one near a causeway. The inscription read: "Jarlabanke had these stones raised in memory of himself while he still lived. And he built this bridge for his soul. And alone he owned the whole of Täby. God help his soul."

No one knows how many rune stone inscriptions exist. Sweden has far more than Norway and Denmark—some 3,000. Many have been incorporated into venerable buildings and churches. Some stand alone where they always have.

All afford glimpses of the Viking age and its people. Jarlabanke tells us proudly how he saw himself: man of achievement,

landowner, bridge builder, aspirant to heaven. Other stones nearby convey other messages; witness Estrid in her simple testimonial to her pilgrim husband, Östen: "He visited Jerusalem and died in Greece."

Archaeology and written accounts provide additional avenues into the shrouded Viking era. Sweden remains a storehouse of archaeological wealth—the surface has barely been scratched. At the present rate, 2,000 years of digging await.

Oddly, the Baltic island of Gotland is scarcely mentioned in writings from Viking times, and its market towns are largely unexcavated, yet more Viking artifacts and buried treasure have been turned up there than in all the rest of Sweden. Raiders and traders funneled through strategically located Gotland; the island served as an international entrepôt. Pirates infested the Baltic. Gotland's merchants hid their silver. Around 120,000 coins have been found, 50,000 of Arabic origin, the rest mostly English or German.

On the old Viking road *in Sweden's Täby district, 11th-century rune stones tell of kinsmen who "died in Greece," the foreign land most often mentioned in Sweden's 3,000 or so runic inscriptions. Using a 16-character alphabet, designed for easy carving, rune masters limited messages to bare facts and terse verse.*

Farmers who plow up caches must turn them over to the Central Office of National Antiquities; they receive the silver's current value, plus an eighth, plus an additional bonus. "I'm the only legal treasure hunter in Sweden," remarked Majvor Östergren, a dedicated young archaeologist with the central office, as we hiked through a forest one morning (page 293). She carried a metal detector on her shoulder like a rifle. "When the snow is falling and it is windy and cold, it is no fun. But it can be exciting. Yesterday I found, in a house, a belt mount made of bronze, and also 40 coins."

We halted in a grassy, boulder-strewn glade: no houses here. Majvor smiled. "On this site silver is spread all over. This was a marketplace. The harbor was over there. Wattle-and-daub houses rested on the boulders. There is a lot of settlement clay, earth darkened by years of human occupation. People hand-worked iron and bronze and made glass and amber beads. I've also uncovered grinding stones and weights and balances. Earlier it was believed that most hoards had been found in open country, beneath a tree or rock or in a field, but now we know that we find them in the ancient house sites."

She swept the detector slowly back and forth. Suddenly it emitted a beep, then a steady tone. "Perhaps something for the *byse*," Majvor told me, "the elf who guards the houses and meadow. 'Beware of the byse,' parents still warn their children."

Whatever this find might be, it would wait. She was impatient to be away. "Well," she said, looking toward a spring that the villagers used in the tenth century, "what can he be doing?" Photographer Jim Brandenburg knelt there, camera clicking. "Shooting flowers," I said.

"Ah, yes—flowers," Majvor declared, thoughts of hidden Viking wealth vanishing. "If only soldiers could shoot flowers."

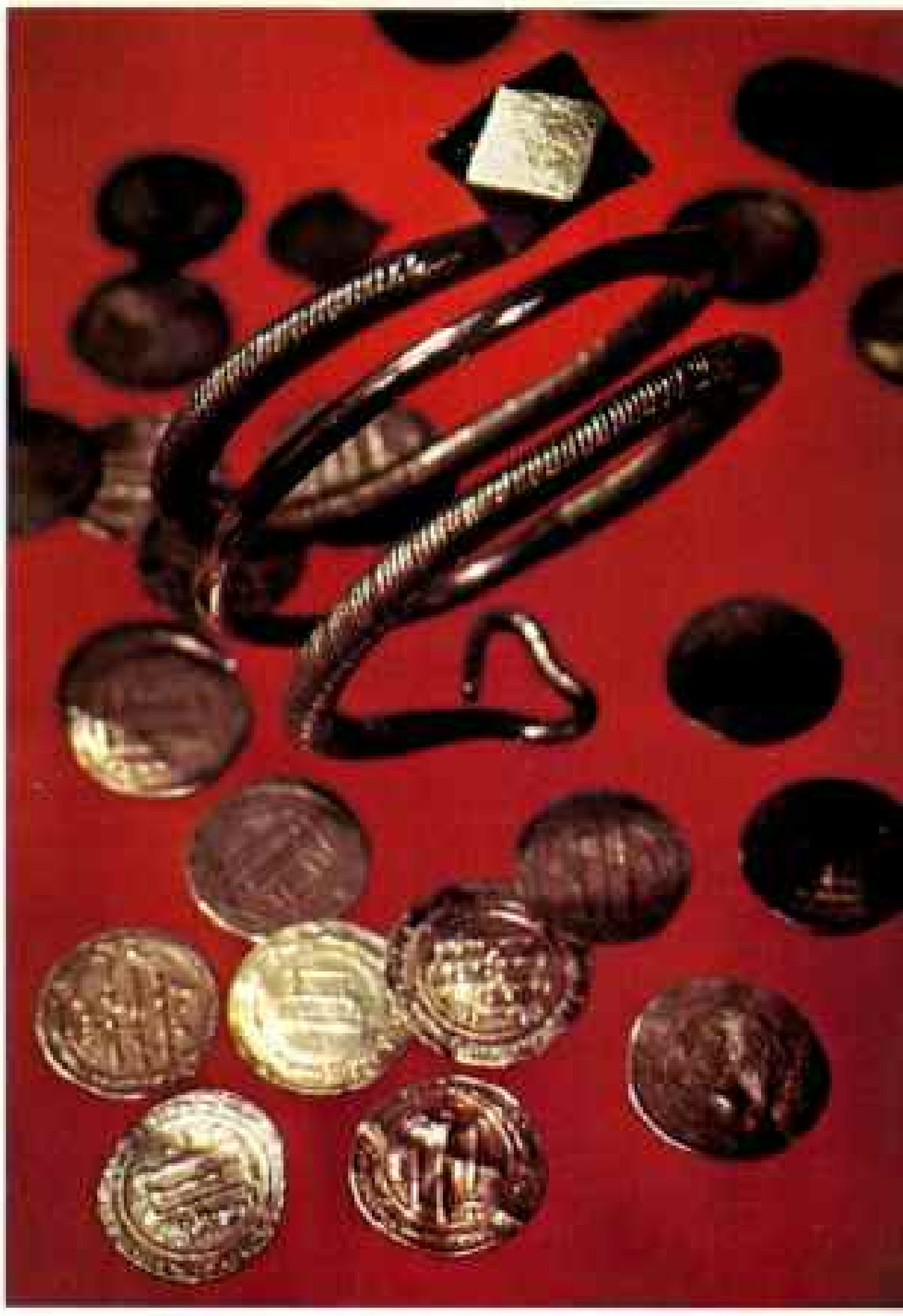
A DAY LATER I traveled to the small island of Björkö, site of Sweden's oldest town, Birka. I was welcomed by several soldiers who would agree with Majvor: conscientious objectors, serving their term performing maintenance duties.

I stood with them on someone's grave—Viking burial mounds billow by the thousands on Björkö—while they scythed the lush grass. "Eleven of us are stationed here. We're the other side of the coin," observed a tall, blond 20-year-old named Olof Michélsen. "We refuse to bear weapons. Well, there were peaceful Vikings in the old times. They used the scythe, they worked with their hands. We're working as they did then. Evolution—it makes you wonder."

Birka itself is a wonderment, a time capsule of the Viking age. Founded about A.D. 800, it had vanished by the 970s. In its prime, this was a great center of domestic and international commerce, a palisaded market town with several harbors protected by a hill fort and garrison.

Beneath the fort lay the teeming settlement, today still largely unexcavated and marked by its black earth of human detritus. Self-governing under an officer of the king, Birka had connections that reached to the ends of the known world.

The elements and centuries have reduced all this to a slumbering emptiness of meadowland, edged with birch and juniper and dominated by the crumbled fort. Björn



Symbolic death ship, *a pattern of stones outlines a Viking grave site near Stockholm* ***(above)****. The author (left) learns that warriors who died fighting were dispatched to mythical Valhalla, conducted there by the Valkyries, handmaidens of the Nordic god Odin. A modern-day Valkyrie, state archaeologist Majvor Östergren* ***(top right)*** *uses a metal detector to raise Viking spirits of a different sort on Gotland. A great trade and piracy center in the Viking era, the island is a burial ground for hoards of Arabic silver like these coins and bracelet* ***(right)*** *that the Vikings obtained through trade in the heart of the present-day Soviet Union.*

Ambrosiani, head of the museum department of the Museum of National Antiquities in Stockholm, guided me about. One of Birka's most recent excavators, he has unearthed a jetty, now inland, pinpointing the location of an old harbor within the town defenses.

The archaeologist believes that the settlement had two kinds of residents: the permanent citizens and merchants from abroad. The locals were cremated and buried outside the town; their mounded graves contain mostly Scandinavian goods. The merchants were given unburned burials inside the town; these graves yield treasures from abroad.

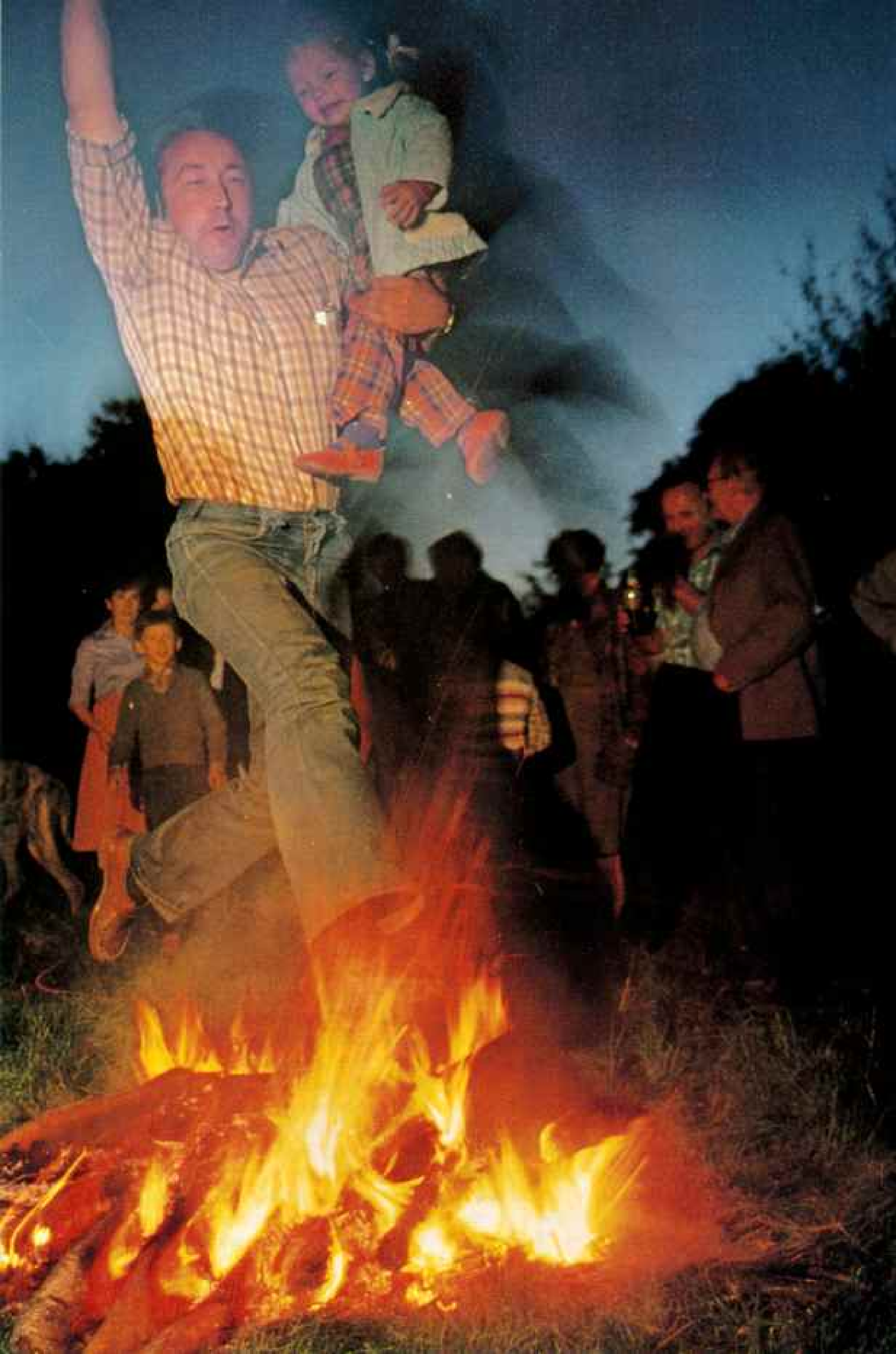
There are more than 3,000 graves. Some 1,100 were excavated as the 19th century ended. "They are mostly graves of adults," said my guide. "A number are double burials—a man whose wife or slave joined him in death. Very few children have been found."

Birka's grave goods attest a prosperity and an appreciation of luxury usually not associated with the bloodthirsty Viking period. The museum's display in Stockholm dazzles the eye: Chinese and Byzantine silks, silver from Araby, pottery and glass from the Rhineland, English and Irish weapons and ornaments, furs, amber, gold, earrings, clasps. . . .

"TO GO VIKING" meant a voyage of pillage and piracy. But the Vikings who slew monks and melted their silver into ingots on the spot do not rivet the attention of experts like Dr. Ambrosiani. "Archaeologists do not see that side of it," he said, "the wild thing, so much as they see colonizers, the starting of towns, traders—the peaceful side."

Trader-settlers steered their boats into the east along many paths (map, pages 288-9).

Leaping into summer, *an exuberant Latvian hurdles a midnight bonfire near Riga, celebrating the long "white night" of summer solstice—an ancient respite from spring planting observed by all Baltic peoples. Viking river traders would have witnessed such fires as they sailed inland from the Gulf of Riga.*



Remnant of Holy Russia, *the medieval Pechory Monastery near Pskov is still home to some 80 Orthodox monks, most of them well past 60. By order of Rus Prince Vladimir, Vikings christianized the Kievan Rus only a few years before their Swedish homeland began to shed paganism around A.D. 1000.*

The most traveled route traversed the Gulf of Finland and coursed the River Neva and other waterways to connect either with the Volga, leading to Arab merchants dealing in Asia's fabulous wares, or with the Dnieper and Byzantium's riches. Difficult portages were necessary. On the Neva, the dragon ships sailed past the future site of one of the world's great cities, Leningrad.

ANOTHER WAY penetrated the Gulf of Riga, proceeded along the Western Dvina and into other watercourses flowing to the Volga or Dnieper. In Riga, Latvia's capital, Jim Brandenburg and I found only indirect reminders of the Northmen. The polished fossil resin they prized so highly still casts its magic warmth and beauty. Latvians like to call their country Amberland, its shores the Amber Coast.

"On the seashore after a storm," said Voldemar Amols, "you find small pieces of amber. You would think they were just rocks. For me they are an everyday love affair." Voldemar, 54, is a master amber worker. His basement workshop is filled with hand tools and grinding wheels, vise, buffer.

"I got started in 1966," he said. "I was a ship's electrician, and my wife told me to return to shore. It is a very good living. Once a month I go into Riga, and the amber enterprise gives me the raw stones. You must be inspired when you are making the jewel. I can work 12 hours a day if I'm inspired, but some days only three or four. If you do a beautiful jewel, you are proud. People will enjoy just seeing it."

Upstairs he brought out a bottle of Hungarian Tokay. His mother-in-law, Emilia Helde, a short, white-haired lady of 81, joined us. She too is an artist with amber, an artist of passion. "It is the stone of the sun," she said, "the tears of the tree, the best and most beautiful treasure." Mrs. Helde was wearing a pin she had created. I admired it. "Are you married?" she asked. Off came the pin—"A present for your wife."

To me Riga at first appeared the usual Eastern European medieval-modern city—spires and red-tile roofs and glassy high rises. Other aspects soon turned up. After dinner at the Hotel Latvia I watched the nightclub's floor show. Its scantily clad chorines and flashy routines were worthy of Paris or Las Vegas. On another occasion I helped celebrate the annual ritual of St. John's Eve, at summer's beginning. During this bacchanal, no respite is permitted until dawn. Should your name be Janis (John),

you must cheerfully provide all callers their fill of beer and cheese. I made a night of it with Janis and his friends: arm-in-arm toasts to peace, and endless song, including "Tipperary," "My Bonnie Lies Over the Ocean," and "Auld Lang Syne."

Thus in the mainstream, I was prepared for Youth Day. By the thousands, young people assembled downtown to parade raggedly through the streets for a couple of hours. Banners held high proclaimed "No to War, Yes to Peace" and "No to the Arms Race." Finally the throng filed into the Park of Culture and Rest, past a sign reading "Youth of Riga Are Against NATO Rockets!" and entered a large amphitheater.

"This is happening today all over the Soviet Union," said Elita Erdmane, a student at the University of Latvia. "This is our demonstration against the rockets to be situated in Western Europe. People in Latvia are afraid of war. We want to be friends. Why do you threaten us with your missiles? All countries should disarm."

Someone loosed a flock of doves. They rose above the multitude, circled, and soared to freedom. The demonstration was over. "People in the West are afraid of *your* missiles too," I said. "Nobody wants war." But she was moving away.

NOT FAR BEYOND LENINGRAD the Vikings nosed their prows from the River Neva into Lake Ladoga. A few miles south of the lake they occupied a fortified town, Staraya (Old) Ladoga, which they called Aldeigjuborg, and made it a trading post and staging area. At such settlements they unloaded their biggest seagoing ships, too large for narrow inland waterways, switching to smaller craft. These were carved by local residents from tree trunks, six or so meters long, two or three wide. Moving on, they bore southward via the River Volkhov; ahead of them lay the stronghold of Novgorod, known to the Vikings as Holmgård ("island town").

At Staraya Ladoga, Soviet archaeologists have uncovered evidence of Scandinavian habitation, in addition to proof that Finns and Slavs dwelled here side by side with the Vikings. Their conclusion: The Vikings gradually were assimilated.

This brings us to a centuries-old controversy that continues unabated. How important were these Scandinavians to the creation of the Russian state? Vital, say most

Western scholars: By dominating the land and ruling the cities in the ninth and tenth centuries, the Vikings founded the Slavic Rus nation. The realm of the Kievan Rus became Europe's biggest dominion; eventually it spread from Lake Onega in the far north to the lower Dnieper River in the south, and from the Carpathian Mountains on the west to the mouth of the Volga.

The counter argument maintains that 300 years before Northmen arrived, Slav tribes had formed their own confederation. Scandinavians had little effect on Slav culture,

How sweet it is, *after an interminable Leningrad winter, to embrace the sun in a local park* ***(left)*** *or match wits with an unpredictable trick fountain* ***(above)*** *at the Summer Palace of Peter the Great, who founded the city in 1703. Frozen for nearly half the year, the Neva River delta, upon which the city is built, was the major entry point of the Vikings into Russia. As St. Petersburg it would serve for two centuries as imperial Russia's capital, after Peter forged the nation into a major European power.*

say Soviet authorities. When the Rus were integrated at Staraya Ladoga, it was merely part of the overall pattern of assimilation in the East, as it also was in the West.

Jim and I were denied access to Staraya Ladoga for reasons undisclosed. Several Viking sites in fact were off-limits to us, just as Soviet journalists meet restrictions in the United States. Yet authorities did open Petrokrepost, a closed city. We were the first U. S. citizens, they said, to visit this shipbuilding and repair center, located where the Neva flows out of Lake Ladoga.

A small contingent greeted us. We toured the city, looked in on the Palace of Culture, studied the museum's exhibits, and enjoyed a luncheon that included caviar, vodka, and Pepsi-Cola.

"There was great danger along the river here," said a historian. "The land was

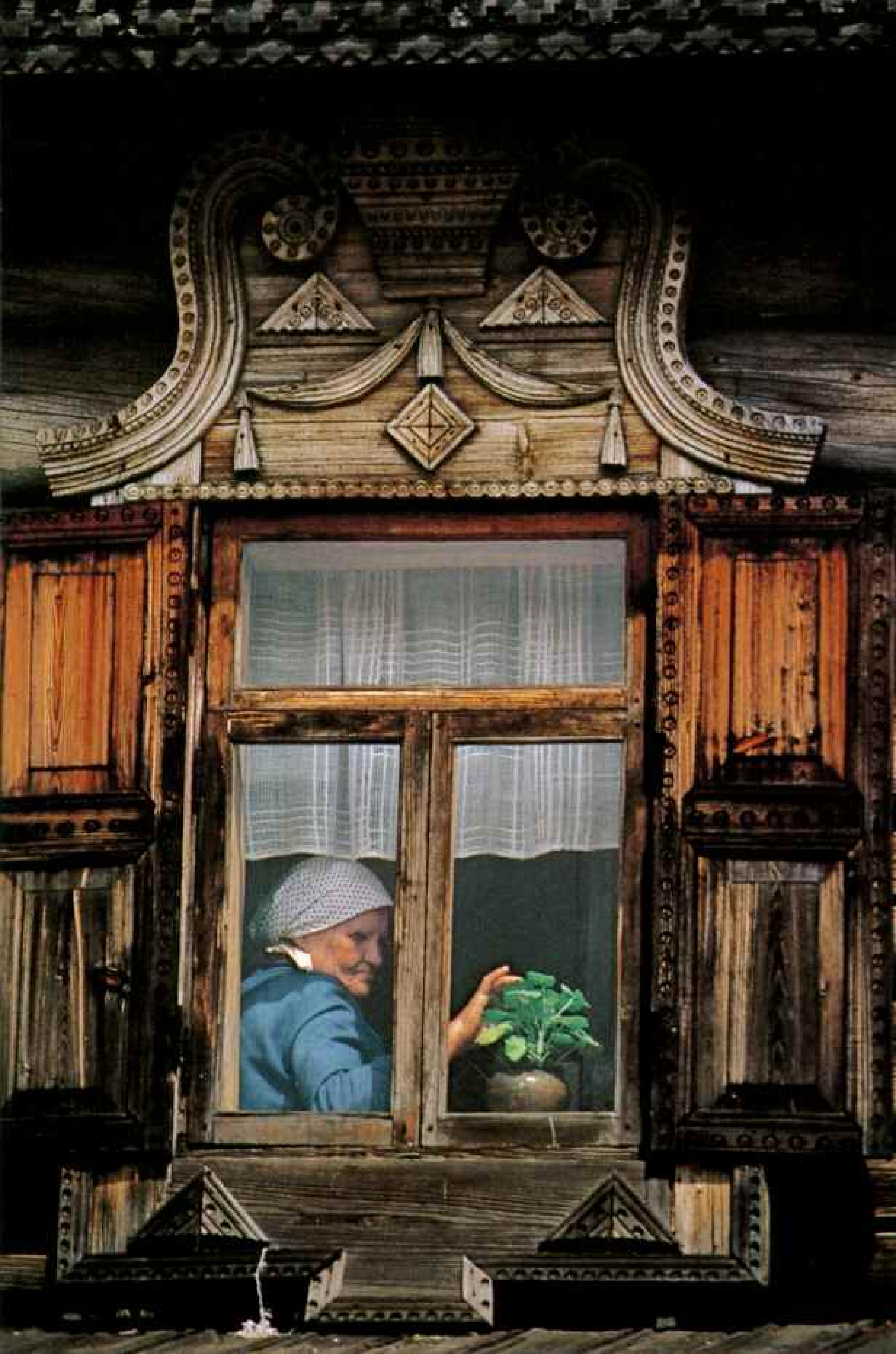
Amber and furs, *both a bounty of the primeval Baltic forests, were key items of Viking trade. Acquired from local tribes, they were bartered for Arab silver and Byzantine gold.*

Fossilized resin, amber is still abundant around the Baltic, where the world's best amber artists fashion ornaments like this piece in Latvia (**above**). *Belorussia's great forests and swamps still yield bounties of furs, like the Amur raccoon dog skins modeled by young White Russians from Vitebsk* (**right**).

covered with dark forests. Robbers attacked the traders. Our children learn about this in school; they are taught about the route of the Varangians to the Greeks."

A newspaper editor, economics his specialty, turned us back to today. "A lot of difficulties," he declared, "are created by the arms race. We are not very rich. If we could just compete with the United States in peaceful ways, believe me we would provide for all the needs of our people much sooner than your country. It is against our will, but we must spend a lot of money on defense." As we parted, he extended a hand. His voice was firm with conviction. "It would be a good idea if one million Americans would come here, and one million Russians would go to Washington."

Next day we came to Gospodin Velikiy Novgorod—Lord Novgorod the Great,



as its chroniclers saluted it. Established around A. D. 860, it is one of old Russia's oldest cities and once was the Vikings' main northern trading post.

Arab and Byzantine writers of the time often were taken with the Rus. The Arab geographer Ibn Rustah trenchantly portrayed them at what may have been tenth-century Novgorod:

"As for the Rus, they live on an island . . . that takes three days to walk round and is covered with thick undergrowth and forests; it is most unhealthy. . . . They harry the Slavs, using ships to reach them; they carry them off as slaves and . . . sell them. They have no fields but simply live on what they get from the Slavs' lands. . . . When a son is born, the father will go up to the newborn baby, sword in hand; throwing it down, he says, 'I shall not leave you with any property: You have only what you can provide with this weapon.'"

And what about the appearance of these hardy creatures? Encountering them somewhere on the Volga, the Arab diplomat Ibn Fadlan recorded this impression:

"Never had I seen people of more perfect physique; they are tall as date palms, blond and ruddy. They wear neither coat nor mantle, but each man carries a cape which covers one half of his body, leaving one hand free. Their swords are Frankish in pattern, broad, flat, and fluted."

ACCORDING to the much disputed 11th- and 12th-century Primary Chronicle, warring Slavic tribes invited three Viking princes to rule over them and bring order. On came the legendary Rurik, his two younger brothers, and Rus warriors. Whatever the truth of the matter, the Rurik dynasty seems to have begun in Novgorod in the 860s, and only ended in the 16th century with the son of Tsar Ivan the Terrible.

Christianity's civilizing influence arrived late in the tenth century. In time an onion-domed church stood on every street. "Oh, the churches," said Nadia, the peppery Intourist guide assigned to us. "Many were destroyed by the Nazis, who held Novgorod for two and a half years. There are 47 now. Only one is an active church, the rest are state monuments—museums. About 215,000 people live here. A million and a half visitors come every year from all over the Soviet Union, and 50,000 foreigners."

She ushered us into the medieval Church of Our Savior of the Transfiguration. "Of course," she said, "this was not heated in the winter, none of them were. But"—an arch smile—"if you believed in God, it was warm."

She pointed to a sorrowful Christ looking down from a central dome. From on high, wherever we stood, He seemed to be watching us. "His eyes!" Nadia exclaimed. "When they were restoring the mural, they could work only ten minutes at a time—His eyes were so fierce."

It happened to be Sunday. We drove to the working church. Nadia, a nonbeliever, entered with us and left abruptly a minute later. Smoke from flickering tapers suffused an aura of sadness. Worn old women wearing babushkas crowded the narthex and nave; a scattering of elderly men and young people stood among them. Somewhere a baby cried. Voices rose and fell, chanting, as the priest offered Communion. Crossing themselves, the somber communicants turned and slowly departed, arms folded over chests.

Outside, I asked the guide why she had not stayed. Nadia shrugged: "Who can understand what they do in there?"

Below Novgorod, Viking trade routes broke off southeastward to the Volga and Caspian; south to the Dnieper, Black Sea, and Constantinople; westward to the Baltic. Jim and I followed the southern way, calling at several river towns that had known the Rus and finding little trace of them.

But we found no lack of hardworking people, and always, underneath, we heard

A Russian Williamsburg, *the early Viking stronghold of Novgorod draws hordes of tourists to its open-air museum of historic wooden buildings. The independent city-state flourished during the 12th and 13th centuries but gradually succumbed to the rising power of Moscow. Ivan the Terrible, whose son was the last of the Rus dynasty, virtually wiped the city off the map in 1570 when he massacred many thousands.*

Sifting every ounce *for artifacts has produced a deep pit at Novgorod, where 28 levels of log-paved streets (upper right, with another street at left) date back to the early tenth century, when the fortress city was a Viking stronghold. A wealth of evidence attests to a significant Viking presence in Russia. According to a story questioned by scholars, the Slavic tribes of this region were so torn with internal strife that in 860 they petitioned the Vikings for strong leaders—a call answered by Rurik and his two brothers.*

the anxious murmur of a land tormented by the fear of nuclear holocaust.

Near the small city of Staraya Russa, past which Viking traders once coursed, collective farmers and fishermen spoke of their lives and problems, and of what they tersely called "the echo of war." On the same day two weeks earlier, playing separately, two boys, 11 and 13, had unearthed World War II artillery shells that exploded and took their lives.

At Velikiye Luki, honored as a "warrior city," our hosts invited us to place flowers beside an eternal flame where more than 6,000 World War II dead lie. "The entire city was destroyed by the Nazis," said the man next to me. "The population was 40,000 in 1941. But only 1,100 were left when Velikiye Luki was liberated in

January of 1943. We shall never forget."

Stark evidence of the Vikings, and the Slavs and Balts with whom they intermingled, awaited us near Smolensk, at Gnezdovo on the Dnieper. Here spread the remains of a fortified settlement with around 3,000 grave mounds. Burials were of two kinds, as at Birka and other market towns. Excavation of 500 mounds by Professor Daniel Avdusin of Moscow University, an eminent Soviet archaeologist, showed most to be cremation burials, the rest inhumation.

"We're in the tenth century," Professor Avdusin told me. "The settlement is at its peak. Ramparts of earth protect it. Ships are repaired here, food and supplies delivered, goods purchased. Artisans and craftsmen work in shops—blacksmith, jewel maker, carver of bone combs."

The archaeologist conducted me through Gnezdovo's vast field of death. At one excavated cremation, I picked up a curious sliver of bleached wood. "*Nyet,*" said my guide. "Not wood. That's human bone."

We halted in a pine forest beside Burial Mound No. 13. Before excavation it had been about 15 meters wide, one and a half meters high, with a flat top. Such a top usually marks a chieftain's tomb, rich in goods. So it proved to be. This cremation was a boat grave. It contained weapons, Arabic coins, iron rivets (perhaps from the boat), beads of crystal and amber, and semiprecious stones.

Burial Mound No. 13 disclosed proof of something else. It was a double grave. "The warrior was burned with a woman," said the archaeologist. "I think she was probably

a slave girl. What we have found here reminds us very much of what the Arab Ibn Fadlan wrote."

In 922, along the Volga, Ibn Fadlan attended the ship burial of a Rus chieftain: "They gather his wealth and divide it into three parts—one part for his family, one part to provide clothes for him, and a third part for *nabidh* [a fermented drink], which they drink on the day that the slave woman is killed and burned with her master. . . ."

A girl slave volunteered to be burned with her master, Ibn Fadlan relates. His ship was hauled onto land and wood placed beneath. A tent was raised on deck and a brocaded mattress set on it. The richly clothed corpse was seated on the mattress. Beside him the Rus laid out food, nabidh, and weapons. They "brought in a dog, which they cut in two and put in the ship." They also sliced up two horses with a sword and put them into the ship. Two cows received the same fate.

On the day of the burial, the writer continues, the slave girl said, "Lo, I see my lord and master . . . he calls to me. Let me go to him." Aboard the ship waited the old woman called the Angel of Death, who would kill her. The girl drank from a cup of nabidh and sang a long song. She grew fearful and

Latter-day Viking, *a youth takes to the water in Minsk, the home of several Olympic-class rowers for the U.S.S.R. By oar or sail, Viking vessels ruled northern waterways for some three centuries.*

hesitant. At once the old woman grasped her head and led her into the tent.

Inside the tent the girl died beside her master by stabbing and strangling. Then the ship was fired. "Soon it was burning brightly—first the boat, then the tent and the man and the maiden and everything in the boat."

IRONICALLY, THE MAN who eventually ended such savagery in the East, Prince Vladimir of Kievan Rus, himself had been an idol worshiper and a libertine of Solomon's stature. If the Primary Chronicle is to be believed, Vladimir had 800 concubines—"He was insatiable in vice."

Perhaps to further ties with Byzantium, Vladimir chose the Orthodox Church to minister the Christian faith to his people.* His reign saw adoption of Slavonic for the liturgy in place of Greek, a step that helped preserve his independence from Byzantium. On a day in 988 his subjects walked into the Dnieper and submitted to mass baptism—it was that or risk his certain displeasure (painting, pages 284-5). Today's Kievans know the road they took. It is Kreshchatic, Christening Street, the main thoroughfare.

And Kiev, where the far-reaching steppe begins, has become the Soviet Union's third largest city, capital of the bountiful Ukraine. It is a stately city of hills and undulating avenues arched with poplars and chestnuts. In summer, from the bluff upon which the oldest section rests, one watches swift hydrofoils and leisurely passenger ships cleave the broad, slate-blue Dnieper. Sunseekers clutter a beach on the far bank. Over all this soar church domes resplendent in gold leaf. Here rose the important monastery and cultural center called Pecheryskaia Lavra, now a state museum (page 312).

And beneath this splendor lies a fearful nether world of labyrinthine catacombs. "There is a legend," said museum director Yuri Kibalnik, "that the Varangians hid cargoes and foodstuffs in the caves. For hundreds of years monks lived here in underground cells. People were attracted by the eerie sound of the monks singing beneath their feet. Most of the caves are man-made. We are still finding new passages."

Down the centuries a cult of holy relics developed as religious hermits lived out their lives in the chill labyrinths. Hunching my way cautiously through small, dank tunnels, I wondered how many eremites had contributed their bones to this charnel house. Thousands, judging from the evidence on all sides.

*See "Byzantine Empire, Rome of the East," by Merle Severy, in the December 1983 GEOGRAPHIC.

The remains of some, believed by the faithful to have supernatural powers, have been placed in sepulchers for veneration. A plaque identifies Nestor, putative compiler of the Primary Chronicle. He rests in dignity. Wrapped in a white shroud, face covered, his mummy occupies a wooden sepulcher with a top of glass.

PRINCE VLADIMIR'S SON, Yaroslav the Wise, guided Kievan Rus to its highest peak in the 11th century. Commerce flourished with Byzantium, learning and literature advanced under his patronage. He built on his ancestral ties to the West, taking to wife a Swedish princess, Ingigerd. One of his daughters, Elizabeth, married Harald Hardraada, who became King of Norway. His daughter Anna became Queen of France, and daughter Anastasia, Queen of Hungary. Royal marriages also were arranged for four of his sons.

Of Yaroslav's works, one wonder abides. The Cathedral of St. Sophia, gold domes blazing on the heights of the city, still summons a sense of the glory that was Kievan Rus. Today it is a state museum, and tourists flock to its pageantry from across the U.S.S.R. and abroad. Yaroslav built the church in the 11th century and lies there in a marble sarcophagus. "We *know* it is Yaroslav," said a guide. "He walked with a limp. When the tomb was opened many years ago, his remains disclosed a malformed leg."

I stood long before a faded mural depicting Yaroslav's great-grandmother Princess Olga, the first of the Rus royalty to be baptized, on a visit to Constantinople in 957. Just as her courageous act had filled Yaroslav with pride, so her regal person captivated me. But there was something else about her, something sublime. That quality caused Nestor to rhapsodize: "Olga was the precursor of the Christian land, even as the day-spring precedes the sun and as the dawn precedes the day. For she shone like the moon by night, and she was radiant among the infidels like a pearl in the mire. . . ."

With the workaday Rus of Olga's time, the infidels, life revolved around the seasons. In November they left Kiev to spend the winter collecting tribute from Slav tribes. Returning in April when the ice had melted, they fitted out their tree-trunk boats. In June, after spring floods had receded, the Rus moved down the Dnieper. Dangerous rapids and the threat of ambush from hostile tribes faced them. With luck, a six-week voyage would bring them to the Black Sea. Across it lay opulent Constantinople—to them, Miklagård, the Big City—with its marble palaces and exotic marts.

On a rainy morning in late July I boarded a hydrofoil of the smallest class, a Rocketa, in Kiev. Several days and hydrofoils later, a weary veteran of one of Europe's longest rivers, I docked in Odessa on the Black Sea. To the Vikings their old highway would seem as strange as the planing, pounding craft that carry today's commuters at speeds up to 70 kilometers an hour (45 miles an hour).

ENGINEERS have conquered the mighty Dnieper with six dams and locks. Huge reservoirs—people call them seas—have backed up, wider in places than the eye can encompass. Where savage nomads once lurked, fishermen occupy the shores. Small boats bob in the chop, lines payed out. On every island vacationers loll in the sun, tenting it. Passengers captive for hours in crowded hydrofoils look on them with envy.

Almost ten million Russians, Belorussians, and Ukrainians live on the Dnieper's banks. None respects the river more than Capt. Ivan Kornienko, of Cherkassy, whose ship in summer delivers passengers, food, oil, and fuel to passing traffic. In winter the ship becomes an icebreaker.

"No," he told me, "this is not the river of long ago, because of the dams. I have been on the Dnieper more than 20 years, and my father before me. It has been a good friend. But it is very treacherous. Where I made

***Blessed and cursed** by its position on the upper Dnieper, the ancient city of Smolensk has survived centuries of bloodletting, as Russians fought Lithuanians and Poles for the portage stronghold developed by the Vikings in the ninth century. More recently the city was destroyed by Napoleon and again by the Nazis. Today millions depend on the river for transport, electricity, and water.*

The Gnezdovo Hoard

SHADES of the long-ago Rus haunt the forest at Gnezdovo, site of a tenth-century settlement near Smolensk. Here a wealth of artifacts indicates that Vikings once ruled the Smolensk area.

BOTH BY NATIONAL GEOGRAPHIC PHOTOGRAPHER VICTOR R. BOSWELL

Decorative and functional, *items recovered from Gnezdovo's rich burial mounds and other archaeological sites bear the unmistakable mark of Viking art at its liveliest. They include many striking silver pendants, some strictly Scandinavian in style* ***(left)****, and some crescents, demonstrating Slavic influences* ***(far left)****.*

Bronze *ornaments from the hoard include an oblong scabbard clip* ***(left)*** *and a circular cloak fastener* ***(right)****.*

Mother of Rus cities, *Kiev graces the blue Dnieper nearly 600 miles north of its mouth on the Black Sea (**right**). In contrast to the Ukrainian capital's sprawling urban development on the east bank, gold-leafed domes on the near shore mark one of the city's oldest sites—the Monastery of the Caves. Here, in a labyrinth of man-made catacombs, generations of medieval monks lived and died. A Ukrainian archaeologist (**below**) shows a side cave filled with skulls that he discovered in 1981. In these caves, according to legend, Vikings hoarded food and trading supplies after the city became the capital of Kievan Rus. Kiev would flourish in the 11th century as a commercial, cultural, and spiritual center.*

safe passage yesterday can be dangerous today. Sandbanks shift with the currents. Sudden winds out of the northwest make waves like the ocean: A river ship must decide the right course, or it can break in two."

From the balcony of their pleasant sixth-floor flat, Captain Kornienko, 42, and his wife and 12-year-old daughter surveyed the Dnieper's sweep, here about 15 kilometers. He turned to me, choosing his words thoughtfully. "You are the first foreigner on the territory of this flat. For the first time in my life I am seeing an American. Welcome.

"You ask me about the river. It has provided well for us. I relax off duty by doing nothing, or I watch television, read. I help my daughter with her schoolwork. Sometimes we get in the car and go to the country to pick mushrooms or berries. People who work on the water—it is almost impossible for them to change their way of life. I will continue to the end, retiring at 60."

Proud of their heroic role *in the "Great Patriotic War" that cost their country some 20 million lives, World War II veterans don their medals at every opportunity—as have these old soldiers on a visit to Kiev. Dubbed a "Hero City" for its valor in the face of the Nazis, who destroyed 40 percent of it, Kiev has repeatedly risen from the ashes of war since its Viking days.*

FOR THE VIKINGS, the Dnieper posed deadlier perils than anything today's tamed river may offer. Byzantine Emperor Constantine Porphyrogenitus, in a manual written about 950, eloquently described fearful cataracts the Rus had to negotiate. He listed seven by name. One vignette: "At the fourth great rapid, which in Rus is called Aifor [Ever fierce] . . . everyone brings their ship to land and those

who are to stand watch disembark. These sentinels are necessary because of the Petchenegs who lie constantly in ambush. The rest take their belongings out of the dugouts and lead the slaves, fettered in chains, across the land for six miles, until they are past the rapids. After that they transport their vessels, sometimes by hauling them, sometimes by carrying them on their shoulders, past the rapids."

Ambushers and cataracts claimed many a Viking on the Kiev-Constantinople trade route. The lucky ones paused at St. Gregory's Island to offer thanks, sacrificing birds, bread, and meat. Today the industrial city of Zaporozh'ye ("the town beyond the rapids") overlooks the island, and a great dam just above it straddles the Dnieper. Backed-up waters have deeply submerged the gigantic rocks. A museum of history

Profane memorial *to Viking vainglory, a runic graffito scars a balustrade in Istanbul's Hagia Sophia. Only the name "Halvdan" remains legible—a Varangian Guardsman perhaps or one of the host of Viking questers, whose exploits left an indelible mark on history.*

was rising on the island when I stopped by.

Finally the Rus came to the river mouth. There, on the island of Berezany, the only rune stone ever found in the U.S.S.R. was discovered in 1905. I tracked it down to a dusty storeroom in Odessa's archaeological museum. It is simply a memorial raised by a Gotlander named Grani to the memory of Karl, his comrade.

Few ordinary mortals will make a mark that lingers a thousand years. Even more extraordinary, Grani's modest tribute to Karl survives while almost nothing remains of the Viking presence in the imperial metropolis they knew as Miklagård. Christian Byzantium perished 500 years ago. Constantinople was rechristened Istanbul in 1930; mosques and minarets and the recorded call of the muezzin proclaim Allah's supremacy. Where Europe meets Asia at the Bosporus, the Turks' main city thrusts with incredible human vitality in all directions.

Seeking the Viking past in Istanbul, I saw a distressing modern counterpart at every hand. Soldiers armed with AK-47 assault rifles stood guard at banks, post offices, hotels—any place where terrorists might seize money to finance their operations. "We are glad the soldiers are there," declared an American friend, long a resident. "The terrorism has stopped."

Out of the Dnieper's mouth and over the Black Sea the Rus sailed several times to attack and savage Miklagård. Never did they conquer. Treaties were worked out. "We of the Rus nation, Karl, Ingjald, Farulf, Vermund, Hrollaf, Gunnar, Harald, Karni, Frithleif, Hroarr, Angantyr, Throand, Leithulf, Fast, and Steinvith, are sent by Oleg, Great Prince of the Rus . . . for the maintenance and proclamation of the long-standing amity which joins Greeks and Rus. . . ." Northmen all, Oleg too, whose name derives from the Scandinavian Helgi.

The agreements gave Rus traders generous terms concerning customs duties, visas, ships, food and supplies, dwelling area—even bath facilities. A regulation provided for recruiting Rus warriors into the service of Byzantium. To shoulder the ax in the Varangian Guard was a coveted honor.

THERE IS LITTLE in Istanbul to remind you of all this. Where chariots raced in the hippodrome, only a column and obelisks remain. City walls, once 13 miles around, slump in disarray; the relict aqueduct grips the heart. And—yes—the greatest of all testimonials to the power and piety of Miklagård endures: the vaulting basilica

of Hagia Sophia, a museum now. To pause among its marble splendors, to contemplate the mighty dome intermediary with heaven, is both a sadness and an affirmation. The rich circumstance has vanished; the mind struggles to conjure the pomp of a hundred Varangian Guardsmen trooping with their axes behind a newly crowned emperor. But the majesty of Hagia Sophia can still stir the soul, as it did the Emperor Justinian when in the sixth century he completed the church: "I have surpassed thee, O Solomon!"

A Viking also left his humble imprimatur. You must climb to a high balustrade in the south gallery if you would see the only living sign of a Northman from the glory days. A few runes cut in the marble railing, worn and embossed with pigeon droppings, have been deciphered. They spell "Halvdan," a name of Viking-age currency.

The Viking age: in time, a mere 250 or so years; in place, the known world and beyond. The fief of those adventurers who took the eastern road extended from Scandinavia to wild Slav rivers to the Caspian and Black Seas to Constantinople.

The passage of such as these transcends finite dimensions. Epic journeys belong to immortality. For the Rus, that is requiem enough. □

Storing Up Trouble . . .

HAZARDOUS WASTE

At an abandoned dump near Swartz Creek, Michigan, a technician scoops up an oily sludge containing PCBs, toxic organic chemicals. Thousands of such sites clogged with deadly waste present the nation with a monumental cleanup task.

By ALLEN A. BORAIKO
SENIOR EDITORIAL STAFF

Photographs by
FRED WARD
BLACK STAR

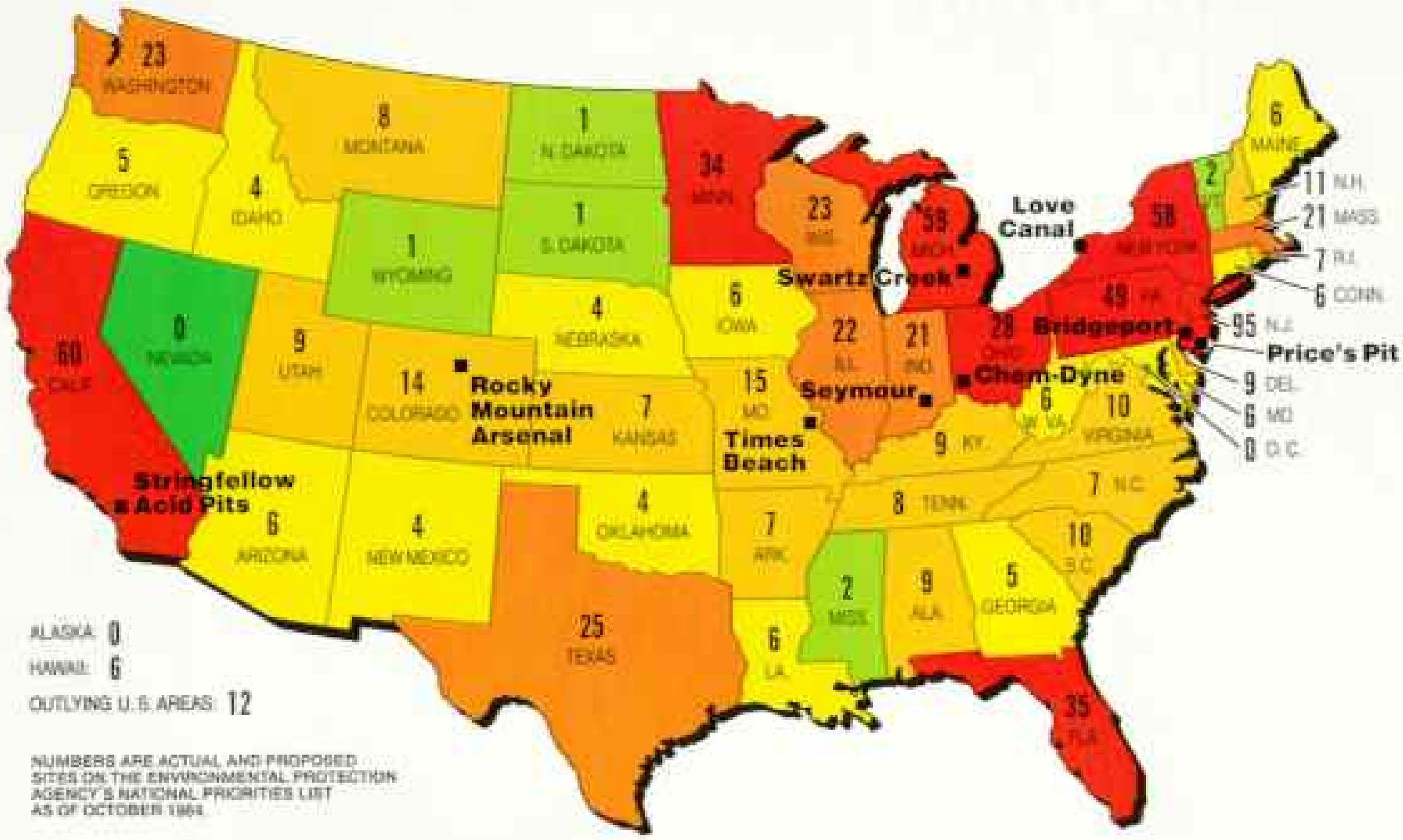
PETITE AND TRIM at 66, with whitening hair wisping from a bun and a brooch at the lacy throat of her high-collar blouse, Verna Courtemanche suggests a tintype schoolmarm. She has, in fact, taught mathematics in Michigan schools. Parallel lines never met in her classroom, but in the geometry of her life Verna has converged calamitously with hazardous waste. Under way at her doorstep is the cleanup of one of the nation's most threatening chemical dumps.

Verna lives outside Swartz Creek, at a country crossroads 60 miles northwest of Detroit. For weeks last summer 50 trucks a day rumbled by her house ferrying contaminated soil from a nearby field to a landfill in Ohio. To purge the field of toxic metals, used motor oil, drug and dye by-products, and other industrial waste, backhoes and bulldozers have scooped and scraped 120,000 tons of earth. That's merely a first cut, however, at the pollution left by Verna's former neighbor Charles Berlin.

In 1972 Berlin and a partner opened a hazardous waste incinerator. Often it was overloaded, smothering the countryside in acrid smoke so dark and dense that firemen on the horizon would take it for blazing houses and race over. The corrosive murk turned convertible car tops into literal ragtops, reddened children's faces with rash—swelled eyes shut. Verna and friends harried state officials by telephone, rally, and letter for four years before Berlin's smudge pot was permanently closed.

Innocent victims *of noxious fumes from the Swartz Creek dump, citizens living near its incinerator and foul lagoons saw their home values plummet and believe that their health is threatened.*

Verna Courtemanche, fifth from left, led a decade-long fight to get a federal and state cleanup under way. The owner of the facility, when faced with legal action, abandoned the site and declared bankruptcy.

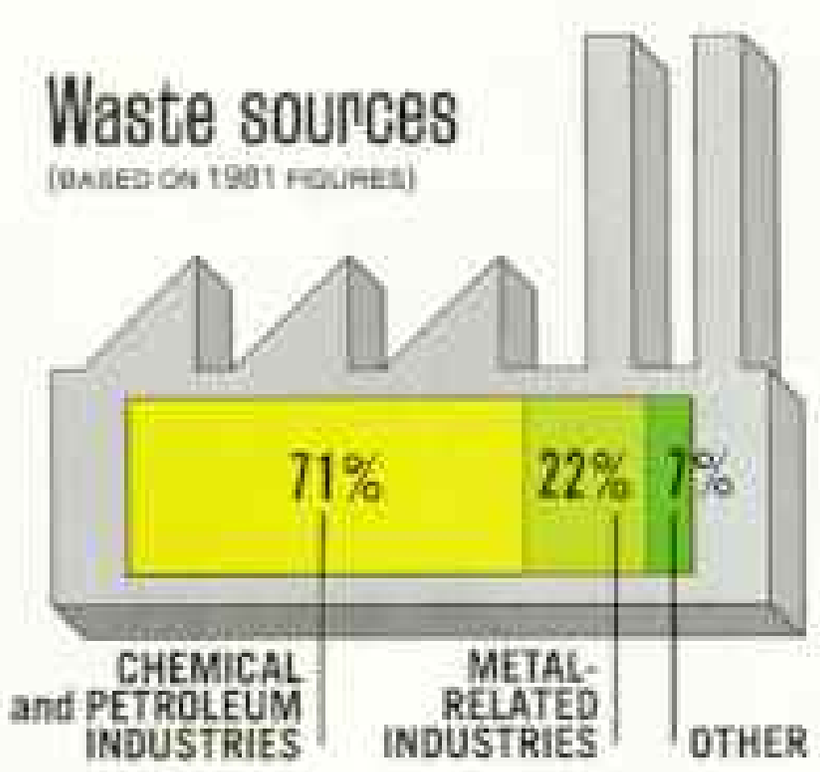


National hit list for waste cleanup

DESIGNED TO IDENTIFY the most hazardous sites in the nation, the National Priorities List of the Environmental Protection Agency (EPA) continues to grow as states scramble to locate dangerous sites within their borders. At stake are billions of dollars in federal cleanup funds.

*By October of last year the EPA had designated or proposed for the list 786 waste sites (**above**). The agency estimates that the list may eventually contain a total of 2,500 sites.*

*Of 264 million metric tons of waste regulated in 1981, most came from the chemical and petroleum industries (**right, middle**). About two-thirds of the total was treated by various methods (**right, bottom**) to reduce its volume or render it less toxic. The remainder was stored or disposed of*



NGS CARTOGRAPHIC DIVISION
RESEARCH: WILLIAM L. BLEWITT PRODUCTION: ROBERT E. HARDING

In 1980 Berlin declared bankruptcy. During the next three years, investigators unearthed behind his incinerator five storage tanks and the first of 33,000 drums. They were bursting with waste that Berlin had been forbidden to burn, yet still allowed to haul—from chemical plants, auto factories, steel mills, refineries, railroads.

Find followed find. In the grim stew of a holding pond, one million gallons of oily muck were laced with polychlorinated biphenyls—PCBs. Until their United States production ended in the late 1970s, PCBs lent durability to hydraulic fluid, to coolant for electric transformers, and to plastics—wide use that now makes PCBs a universal as well as persistent waste, one that accumulates in fish and causes animal cancers.

In another pond, it was believed that drums of hydrochloric acid and barrels of cyanide lurked like mines, needing only a blow for their chemicals to leak, mix, and form a cloud of lethal gas. When the pond was safely dredged in May 1983, Verna and the other 165 evacuees cheered. Today they find they were given a reprieve only to serve an indeterminate sentence.

"We're prisoners," Verna told me. "We can't sell our homes, we're afraid to drink from our wells, and out-of-town friends shy from visits. My sister-in-law won't take gifts of my raspberry jam any more."

MICHIGAN and the U. S. Environmental Protection Agency (EPA) have so far spent six million dollars at Swartz Creek, and some of the 200 firms whose waste was dumped there have pledged 14 million dollars more. Many tons of tainted soil remain, leaching contaminants to local aquifers with every rain. To map groundwater pollution will take several years; eliminating it—if needed and if possible—could take decades.

"At times," says Verna, "I've almost felt that addressing the problem of hazardous waste just makes it worse. You scream and holler, government acts, and easy answers elude you. But your only choice to solve the problem is to give it more attention, more effort. We're learning to do that, but I wonder if we're learning fast enough."

It is no small irony that Charles Berlin began storing up trouble in Swartz Creek at the height of national campaigns to curb environmental pollution. In the early 1970s visibly smoggy skies and cloudy streams got headlines, not hazardous waste. Out of sight, it was still largely out of mind.

Then, in 1978 at Love Canal in Niagara Falls, New York, rain popped leaking drums out of the ground on a black tide of long-buried chemicals. Hazardous waste has been front-page news ever since.

Illegally buried drums *exhumed by cleanup crews at Swartz Creek yielded a witches' brew of cyanide, pesticides, acids, and PCBs.*

Though the cleanup is not yet complete, 120,000 tons of waste and contaminated soil from the site have been reburied elsewhere. Investigators continue to monitor contaminated aquifers that may take decades to purify.


PAINT THINNER

It has driven hundreds of families from Love Canal and made a ghost town of Times Beach, Missouri, permanently evacuated in 1983. Dusty dirt roads there had been sprayed a decade earlier with oil contaminated by dioxin, a highly poisonous waste product of some industrial chemical reactions. EPA had its own exodus in 1983, when administrator Anne Burford and other top officials resigned. They left amid public outcry about feeble regulation of hazardous waste and pinchpenny delay in using a five-year, 1.6-billion-dollar "Superfund." The fund was set up by Congress in 1980 to bankroll the cleanup of old waste dumps and spill sites posing grave danger to water supplies or human health.

At the root of all this trouble is waste that EPA classifies as toxic, ignitable, corrosive, or dangerously reactive. Such waste is an environmental tar baby no modern society can shake off. It clings to us as paint sludge from appliance factories, as dregs of chrome and nickel from metal-plating shops, as spent raw materials for varnish, carpets, and detergents at chemical plants. We're dogged by solvents that have dry-cleaned our clothes and degreased microchips for computers. Mercury in an exhausted watch battery is hazardous waste. So is the butane residue in a disposable cigarette lighter and the lye in an "empty" can of oven cleaner.

No one knows the true sum of our toxic throwaways, but the 264 million metric tons regulated by EPA in 1981 would fill the New Orleans Superdome almost 1,500 times over. Since 1950 we've disposed of possibly six *billion* tons in or on the land, steadily increasing our potential exposure to chemicals that can cause cancer, birth defects, miscarriages, nervous disorders, blood diseases, and damage to liver, kidneys, or genes.

WILLIAM FRASER

Even ordinary garbage *can be hazardous, including paint thinners, pesticides, bleaches, and PCBs in old TV sets arriving at BKK Landfill (**facing page**) near Los Angeles. Millions of homeowners and small businesses send trash daily to municipal landfills, most of which lack safeguards to prevent leakage; some have contaminated local drinking water.*

*To curb groundwater pollution, Florida sponsors statewide collections of household wastes. A woman in Miami (**above**) turns in toxic trash.*

PARTLY BY LUCK and partly because we now sweep less hazardous waste under the rug than a decade ago, we've so far escaped a major health disaster. Yet in critical areas the effort to control dangerous waste stands at a stalemate, and we risk making a bad situation worse.

To be sure, we've made some progress. In 1976 Congress passed the Resource Conservation and Recovery Act. RCRA directed EPA to regulate hazardous wastes for the first time, requiring them to be tracked and handled from creation to disposal at licensed and inspected facilities that have plans and money for safe closure and years of monitoring. As RCRA has raised disposal costs, many companies have altered their operations to reduce waste or to reuse it for energy and raw materials.

Congress intends RCRA to prevent another Love Canal, the catastrophe that prompted creation of the Superfund. The

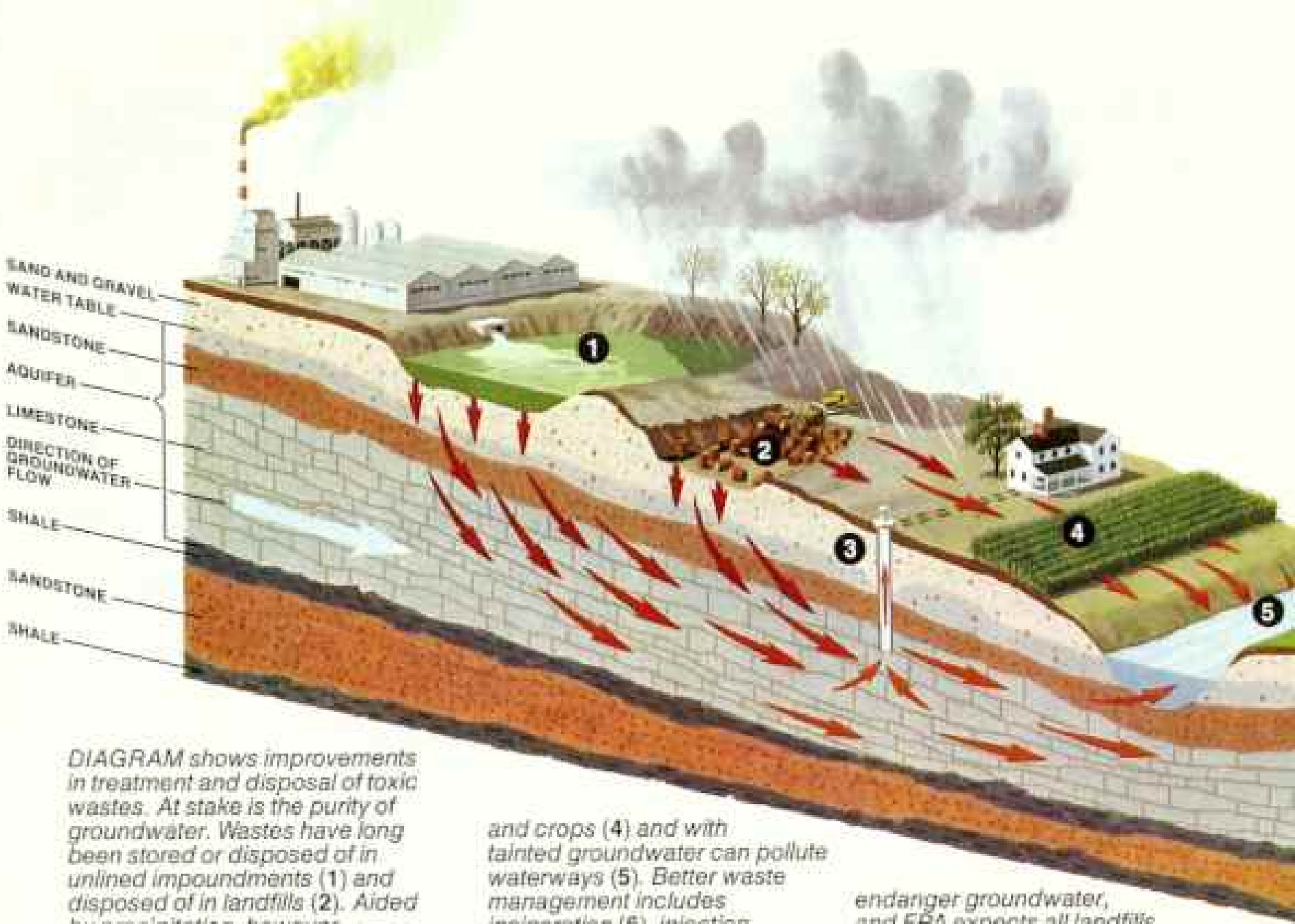


DIAGRAM shows improvements in treatment and disposal of toxic wastes. At stake is the purity of groundwater. Wastes have long been stored or disposed of in unlined impoundments (1) and disposed of in landfills (2). Aided by precipitation, however, wastes can migrate into groundwater and wells (3). Surface runoff contaminates land and crops (4) and with tainted groundwater can pollute waterways (5). Better waste management includes incineration (6), injection between rock layers (7), and landfills with liners (8) to stop leakage. Injection wells can endanger groundwater, and EPA expects all landfills to leak eventually. Monitoring wells (9) are required at both types of disposal sites.

fund paid to muck out the PCB-laden lagoons at Swartz Creek and to clear similar immediate threats at about 400 other dumps by early this year. Soon to be renewed, it may expand to more than ten billion dollars. Meanwhile environmental groups and chemical companies have formed a nonprofit corporation—Clean Sites Inc.—to aid the cleanup of at least 20 dump sites by the middle of 1985.

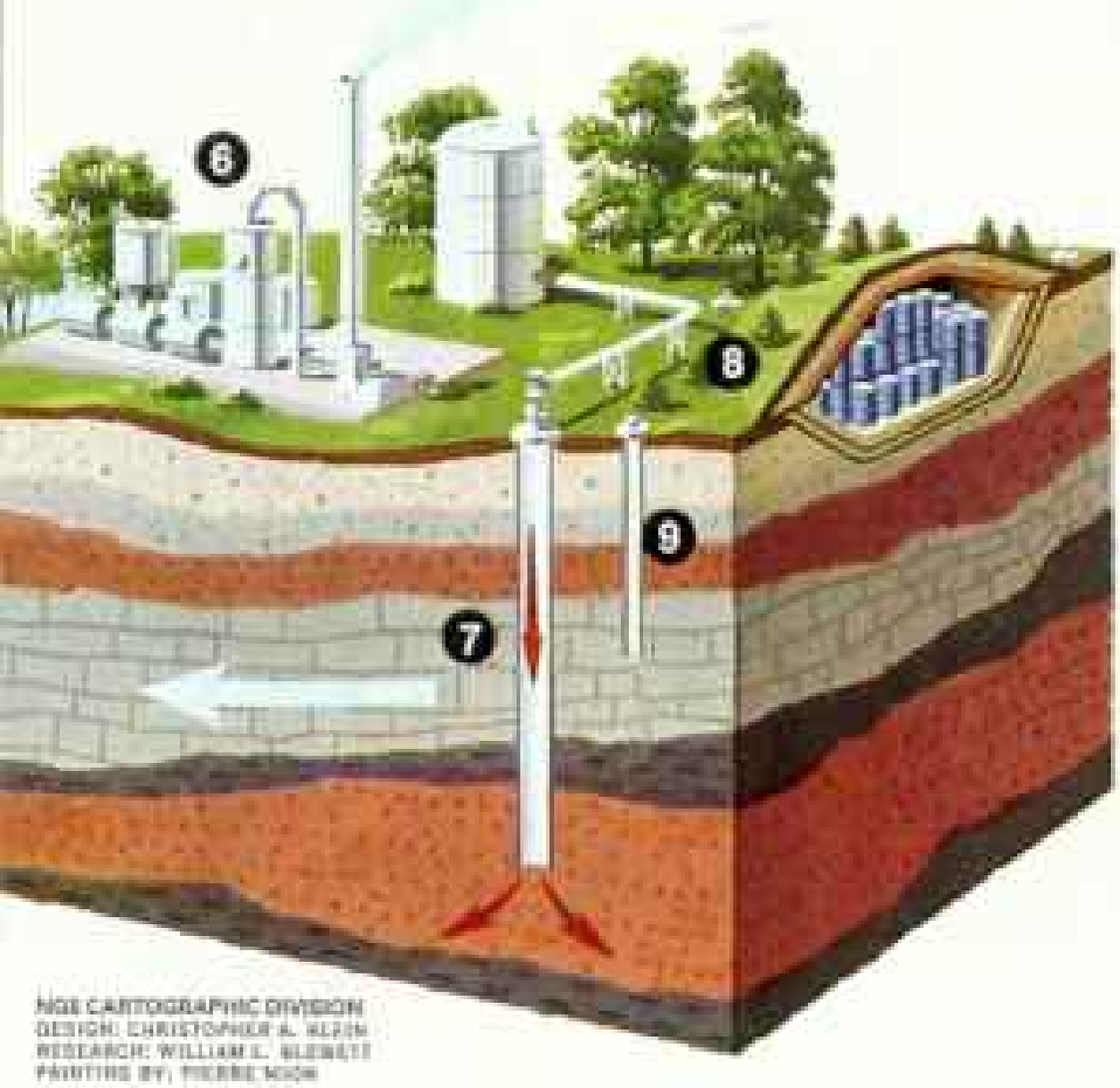
As heartening as these improvements are, there's less to them than meets the eye. Vast amounts of hazardous waste still go unregulated. For example, EPA exempts five million tons of industrial wastes discharged as domestic sewage, including most of the metal-finishing industry's toxic metal dregs. These pass through city wastewater treatment plants and concentrate in the sewage sludge we spread on soil and sink at sea.

The land remains the chief catchall for hazardous waste. But enforcement of RCRA rules and monitoring for groundwater pollution are spotty at most hazardous waste disposal sites—pits, ponds, deep wells, and landfills—many of which overlay or penetrate aquifers, natural underground reservoirs that supply much of our drinking water. Thousands of these sites hold old deposits of toxic liquids, yet they operate without liners and drains to stop and collect leakage—required at new disposal sites accepting less dangerous waste.

Landfills, even poorly monitored ones with suspected leaks, receive most of the waste exhumed at Superfund sites. Chemical treatment can detoxify it and incineration can destroy it, but reburial costs less, at least in the short run. EPA lists 786 Superfund sites nationwide, has fully cleaned 12, and expects eventually to purge 1,500 to 2,500 at a cost of as much as 23 billion dollars. Even this estimate may prove low, however, if old ghosts rise from new graves.

Finally, it doesn't help that PCBs, PCP, TCE, and the other specters that haunt waste dumps can't be seen but seem inescapable. With refined detection methods we can

Lancing the earth *nearly a mile deep, a well* ***(right)*** *near Corpus Christi, Texas, injects acids, caustics, and toxic solvents between layers of rock in an ancient seabed. Chemical Waste Management, the world's largest hazardous waste disposal firm, operates the well, one of the many that handle 60 percent of the toxic waste disposed of in the U. S.*



NGS CARTOGRAPHIC DIVISION
DESIGN: CHRISTOPHER A. KLEIN
RESEARCH: WILLIAM L. ALLEN
PAINTING BY: PIERRE MION

now find invisible traces of waste almost anywhere we look in water, soil, and air. But even experts don't always know if or how seriously these subtle threats endanger our health. Fearing the worst, we've grown as grim about hazardous waste as people menaced by plague, and in the bitterest irony of all, modern waste treatment plants that could spare us future harm and worry are no more welcome in our communities than dumps. NIMBY—"Not In My Backyard"—has become our watchword.

MIRED IN SUCH A MESS, you take comfort where you can find it.

"We're doing a lot better than a few decades ago," says Robert Forney, executive vice president of E. I. du Pont de Nemours & Co., the leading U. S. producer of synthetic chemicals. "If we clean up our past mistakes and adhere rigorously to recent improvements in managing toxic waste, we'll catch the problem in time."

Chemical companies create two-thirds of our regulated hazardous waste, almost 180 million tons in 1981. The industry detoxifies the bulk of its harmful by-products, and as the richest and best-policed waste makers, firms like Du Pont pay out much of the estimated five billion dollars spent annually in the U. S. on hazardous waste control.

At Du Pont's mammoth Chambers Works beside the Delaware River in New Jersey, I clambered the catwalks of a wastewater treatment plant that scrubs 40 million tons of toxic manufacturing residues a year. Ninety-nine percent is water, drafts of the Delaware mixed with railcars of lime and carbon to form an acid-neutralizing slurry. Dirty whitecaps rode this churning cocoa into settling tanks where pollutants sank like silt. Rendered chemically inert, they were later dredged and pressed into gray cakes as big as cartwheels and sent to a company landfill, the irreducible minimum of waste from the Works.

There would be more if Du Pont did not also maintain colossal vats of waste-eating

Some 50,000 drums *of chemical waste clogged a 13-acre disposal site near Seymour, Indiana, a dumping ground for close to 400 companies. Chemical Waste Management commenced a cleanup in December 1982, sampling chemicals in each drum (**above**) and placing leaking drums in transport containers (**right**). Wastes included cyanide, arsenic, PCBs, toxic metals, solvents, napthalene, and 200 pounds of explosive material.*

Under threat of suit, 24 of the polluting companies have so far put up 7.8 million dollars to finance the surface cleanup. Other firms have agreed to contribute at least an additional 5.5 million dollars to purge pollutants from subsoil and groundwater. At many sites, the EPA can sue noncontributing companies for triple damages.

bacteria, cleansing water on its way back to the Delaware. Linger downwind, and your nose swoons from overwork.

Often it makes sense to feed waste to a fire instead of running it through the wash, and two million tons a year go into industrial incinerators. At a Dow Chemical Company plant near Baton Rouge, Louisiana, I found a cavernous rotating furnace whose hellish heat reduces toxic organic waste—steel drums and all—to steam and to ash that can be safely buried.

Other incinerators at Dow's Louisiana Division burn toxic waste to generate steam heat and cut fuel bills. Economy measures are nothing new in big industry, but they have special appeal considering Superfund provisions that hold corporations liable for the negligence of hired waste haulers and disposal firms. The less waste to be gotten rid of outside the company fence, the better.

Called on twice in two years to share cleanup costs, at Swartz Creek and at another mismanaged disposal site, General Motors has begun storing automaking supplies in reusable bulk containers, leaving fewer 55-gallon drums to dispose of, with residues of such poisons as engine coolants. Allied Corporation reacts a caustic sludge with other hazardous waste to synthesize a raw material for gases in air conditioners and refrigerators. And 3M, Minnesota Mining and Manufacturing Company, sells its ammonium sulfate to fertilizer makers, who convert this corrosive by-product of videotape manufacture into plant food.

SUCH INGENUITY shows that industry can reduce hazardous waste and handle it safely when enticed by a savings or a profit and goaded by potential penalties. Yet most often the carrot is too small and the stick too little.

For example, although incineration reduces the volume and dangers of hazardous waste, industry cremates less than one percent of its toxic castoffs. Most companies view incineration as an option only for those with money to burn—it costs $50 to $800 per ton of waste, three times more than to bury it. Not surprisingly, industry goes first to the disproportionately cheap landfill.

California has banned burial of wastes with high levels of cyanides, PCBs, toxic

Too contaminated *for humans, Times Beach, Missouri, was bought by the EPA in 1983 for 33 million dollars. Homes were purchased, this one (**below**) for $26,800, and arrangements were made to relocate 2,200 residents. Meanwhile, access to the town was—and is—strictly controlled (**right**). The culprit was 2,3,7,8-TCDD, one of a class of chemicals called dioxins. Ten years earlier dioxin-contaminated oil had been sprayed on the town's roads to control dust. Soil tests revealed that the town had dioxin levels as high as 1,100 times in excess of that considered acceptable. Now the EPA considers ways to sanitize the town, including moving its tainted soil or paving it over.*

BOTH BY SCOTT DINE

metals, or strong acids and has hiked landfill fees to encourage chemical treatment, incineration, and recycling. But well-intentioned legislators forgot that regulations can't be made in a vacuum. Last year shipments of PCBs from California to Idaho's sole hazardous waste landfill tripled to 90,000 tons.

That might have been avoided if landfills everywhere had to charge according to the full cost of coping with their hazards. We might be better off, too, if government put as much stress on reducing and reusing waste as on regulating it. In 1981 U. S. industry recycled barely 4 percent of its toxic byproducts, partly through waste exchanges, organizations that transfer one firm's waste to another firm as raw material. Despite the potential of waste trading, since 1979 EPA has spent almost no money and assigned only one man part-time to promote it.

Much more serious, EPA's budget for drafting and enforcing waste control regulations is one-fourth less today than in 1981. Recent increases have not restored deep cuts made early in the Reagan Administration, which argued that any slack could be taken up by the states, since they may administer RCRA with federal authorization and money. But EPA has begrudged both.

Sue Moreland, executive director of the Association of State and Territorial Solid Waste Management Officials, told me: "RCRA authorization has been a sham, and the environment has suffered because of it. This year 50 states must share 47 million dollars in federal aid for waste control. Meanwhile personnel are diverted from inspection and enforcement to paperwork, because to win authorization, state regulations must be rewritten to conform with federal standards, even if they make no sense." West Virginia told EPA it had no need to control waste transport by trolley car—objection overruled. Landlocked Vermont has had to regulate ocean-disposal barges.

"Less than a decade ago we had *no* national program to manage toxic waste," I was reminded by John Skinner, director of EPA's Office of Solid Waste. He nonetheless conceded that "on average, 60 percent of major disposal facilities don't obey all the new laws and regulations. And both we and the states have been slow to inspect and curb violators. We're starting to crack down, but for years government at any level wasn't moving fast enough to prevent trouble."

Even today violations at legitimate disposal sites usually draw only a warning letter, and illegal dumpers stand every chance of escaping EPA's thin net of 35 criminal investigators. The most likely dumpers are small and mid-size companies harder put than big industry to afford increasingly expensive pollution controls.

In Los Angeles, where he suspects that 80 percent of all toxic waste is improperly disposed, city attorney Barry Groveman leads the Toxic Waste Strike Force—an environmental SWAT team drafted from state and county health departments and city police, fire, and sanitation forces. Offenders nabbed by the strike force risk jail, fines, and the shame of having to repent their dumping in full-page newspaper ads.

"We're trying to redeem an honor system that incites people to be dishonorable," Groveman told me. Nights can find him and his raiders in sewer manholes, placing pollution detectors downstream of a suspect firm. By day they may helicopter up the concrete banks of the Los Angeles River, alert for stains betraying illicit discharges. This surveillance led one day to a pipeline that one company built to dump caustic wastes in a sewer presumed to be outside the strike force's jurisdiction. City attorneys convinced a judge it wasn't, and the judge convinced the guilty firm's vice president—with a $75,000 fine and four months in jail.

"ANOTHER DODGE is to spray toxic waste on ordinary trash in conspiracy with bribed garbagemen," says Dr. Alan Block, a University of Delaware criminologist and research director of the New York State Select Committee on Crime. "Compact the trash, send it to a city landfill, and who'll know?"

Dr. Block has found organized crime "at every level of the toxic waste disposal industry—in hauling, landfilling, incineration, and recycling—all over the country. This stems from the mob's domination of garbage disposal in the Northeast, and from the appalling futility of environmental regulations and their poor enforcement. Organized crime is besting disorganized government."

For this he partly faults lax monitoring of

*"**Our goal** is to send polluters to jail," says Barry Groveman, a city attorney for Los Angeles. In two years as chief of the city's Toxic Waste Strike Force, Groveman has put 11 chief executive officers of L.A. firms behind bars.*

He holds a pipe that a steel-processing company used to dump toxic metals, caustics, and acids down city and county sewers. Groveman and his 51-member environmental SWAT team monitored the discharges to verify the pollutants, then raided the polluters.

The company's vice president went to jail, and the firm paid a $75,000 fine along with $500,000 in cleanup costs. Now other companies contact Groveman for assistance in observing the law.

waste shipments. EPA requires these to be tracked by manifests filed with state authorities and listing the origin, nature, and destination of transported waste. "Few states check out discrepancies in manifests," Dr. Block told me, "so they're widely doctored. And often it's easier to get a permit to haul waste than a license to cut hair."

Worse, Dr. Block says hundreds of legitimate hazardous waste disposal companies must buy permission to operate alongside competitors allied with or controlled by organized criminals. Payoffs go to mobsters through a national network of loan sharks. Passed on to customers as a cost of doing business, this tribute to criminals is a hidden tax on lawful waste disposal.

Indiscriminate burning of toxic waste in residential and commercial boilers nets the mob still more money. Some liquid wastes can be mixed with heating oil and safely burned in the boilers of hospitals, schools, and apartment and office buildings. Unregulated by EPA, this blending annually supplies consumers some 19 million tons of low-cost, recycled fuel. But sham recyclers have been watering down immense amounts of it with the waste of companies attracted by cheap, no-questions-asked disposal.

At Congress's insistence, EPA might curb this abuse in 1986. Last year New York State set limits on how much waste may be mixed with heating oil and restricted recycled fuel to high-temperature burners. Dr. Block believes, however, that 40 percent of the heating oil sold in the New York City area continues to be laced with toxins that only an industrial incinerator can adequately combust—and that ordinary boilers are spewing into the sky.

Through another loophole in the law, four million tons a year of hazardous wastes slip into municipal sanitary landfills from which they steadily leak. EPA now allows "small-quantity generators"—you, me, the local exterminator or dry cleaner—to discard like a banana peel all but the most deadly waste, as much as one metric ton a month. And our trash includes an amazing array of toxic stuff: insect sprays, antifreeze, chlorine bleach, nail polish. Only a handful of the nation's 15,000 sanitary landfills are built to capture and drain away these poisons before rain flushes them down through the soil.

Since federal money for inspections ended in 1982, only a few states regularly check to see if such leachate is percolating into groundwater. More than one city landfill is a

Superfund site, and Congress has recently ordered EPA to narrow its one-ton-a-month exemption to 220 pounds. Some states are stricter, and some hold collection drives. Last summer, during Amnesty Days, the people of one Miami suburb alone turned in 12 tons of hazardous waste that would otherwise have gone out with the garbage.

HAD WE BEEN SO CAREFUL all along, we might not be so worried today about groundwater pollution. The vast majority of us have safe drinking water, but our supplies are not so well distributed that we can afford to add hazardous waste to them, already burdened with highway de-icing salts, farm sprays and fertilizers, and seepage from gasoline and septic tanks.

Many large cities—Tucson, Memphis, and Miami among them—rely entirely on groundwater. So do most rural Americans. They tap a resource more plentiful than all the water in the Great Lakes, and man-made pollution corrupts only one percent of it.

"Unfortunately," says David Miller, a leading hydrogeologist, "that tiny bit is often fouled just where a lot of people need it." Toxic waste contaminates the groundwater supply drawn on by three million people on Long Island, New York, including Miller. In New Jersey, Atlantic City shifted its well fields to escape chemicals seeping from Price's Pit, a Superfund landfill a mile away.

Latest word in landfills, *a crater near Emelle, Alabama* ***(below)****, carved into a layer of nearly impermeable chalk 700 feet thick, promises safe containment of hazardous wastes for 10,000 years, according to Chemical Waste Management. The pit, the 18th to be dug on a 2,400-acre tract, will eventually hold hundreds of thousands of tons of waste.*

A truck filled with liquid waste from the abandoned Chem-Dyne dump in Hamilton, Ohio, is sprayed with hot water to remove surface contaminants ***(left)*** *before proceeding to an incinerator in El Dorado, Arkansas.*

Storage that works. *Using tunnels created by salt mining* ***(right)****, Kali und Salz AG near Heringen, West Germany, stores solid waste in drums 2,300 feet below ground. Manager Norbert Deisenroth* ***(above)*** *charts the location of more than two million barrels. Deep, dry, and geologically stable, the facility is one of the world's safest.*

In Japan, which has no disposal procedure for PCBs, capacitors containing the chemicals pile up at a warehouse in Kawasaki ***(below)****.*

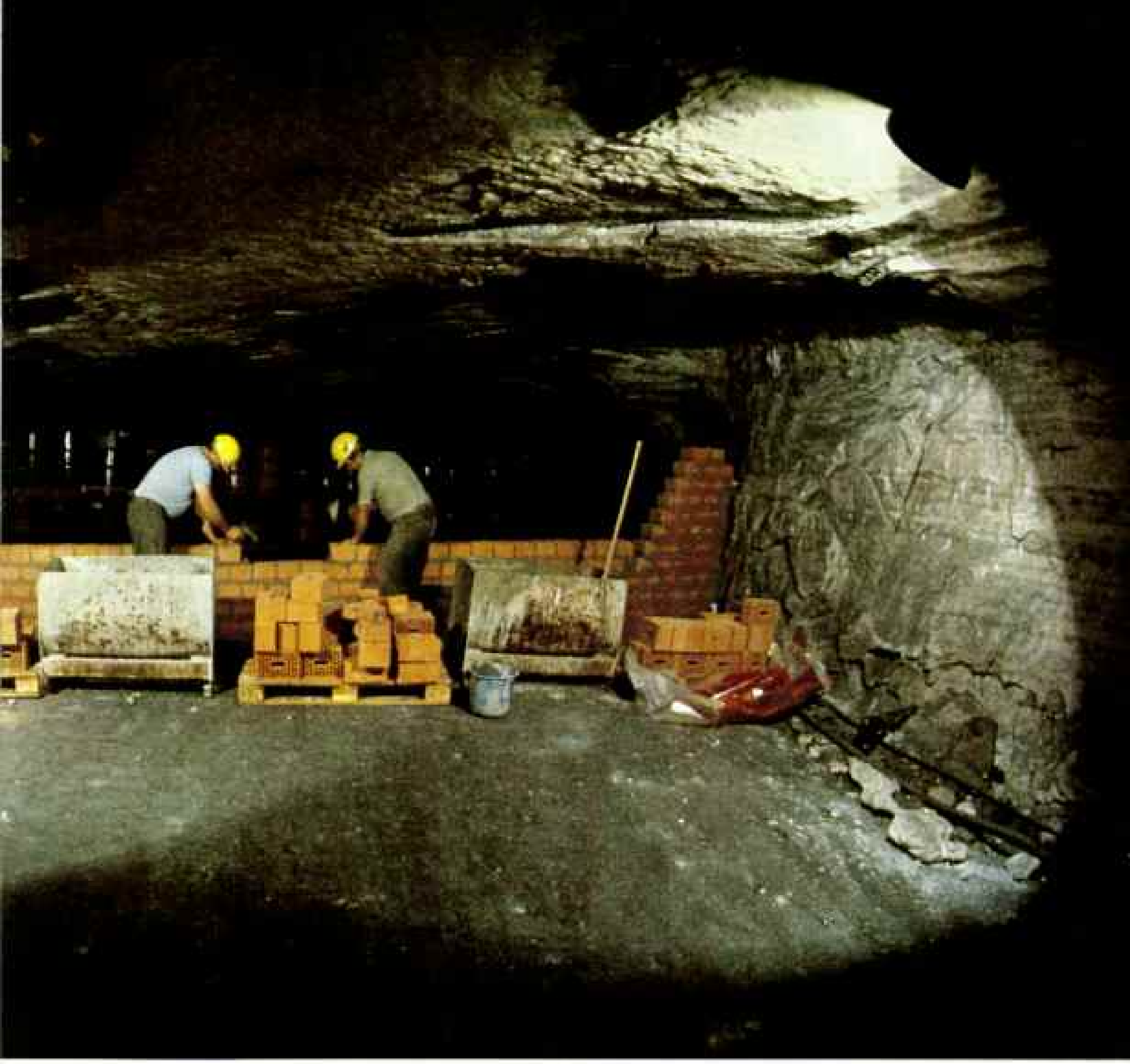
Tap water was turning laundry yellow and pots black.

Groundwater is polluted at the majority of Superfund sites, especially where toxic liquids were pooled in pits and ponds to evaporate. Marian Mlay, director of EPA's Office of Groundwater Protection, told me that thousands of the more than 181,000 impoundments still in use hold hazardous waste and were designed to leak.

"They were meant to leach waste into the ground as much as to evaporate it," she said. "Many impoundments are on soil so porous that their builders couldn't have threatened groundwater more if they had tried."

In a canyon 50 miles east of Los Angeles an engineer showed me drainage pumps at

National Geographic, March 1985



the Stringfellow Acid Pits. This Superfund site still holds most of the 34 million gallons of solvents, acids, toxic metals, and DDT sent there between 1956 and 1972. Until capped with clay in 1981, ponds overflowed during winter storms. Waste taints the groundwater serving nearby homes, and despite ten million dollars spent to halt it, a finger of pollution has poked into an aquifer supplying seven eastern Los Angeles suburbs. Half a million people live there.

Cleanup costs soar at Superfund sites with sullied groundwater, climbing, for example, to a projected 1.8 billion dollars at the U. S. Army's Rocky Mountain Arsenal in Colorado. Stringfellow could cost 60 million dollars to sanitize. Facing such bills, EPA has decided on a policy of triage. The agency plans to clean up essential aquifers but will likely abandon others and pipe in drinking water from elsewhere. In some places EPA will try to manage contamination with pumps and containment methods so that it does not reach the public.

Joel Hirschhorn, director of a 1983 study of hazardous waste for Congress's Office of Technology Assessment, thinks containment schemes are the Maginot Line of those who even now don't grasp the scope of our toxic troubles. Noting how pollution outflanked EPA at Stringfellow, Hirschhorn told me: "I doubt we'll come fully to grips with hazardous waste until more of us are affected by groundwater contamination. That

will be traumatic for millions of Americans. It's one thing to hear about a dump across town and quite another to be warned not to drink the water from your own tap. The crisis is almost inevitable because even if we had full compliance with EPA regulations, they don't protect our water or our health."

Hazardous waste does seem certain to infiltrate drinking water for years to come. EPA plans to bar new landfills and lagoons above vital aquifers, to ban burial of some solvents, and to require liners at many old impoundments, but leaks need not be stopped or even located.

ABOUT 60 percent of all toxic waste legally disposed of in the U. S. is pumped down injection wells, to be imprisoned between layers of impermeable rock. Near Corpus Christi Bay, amid the puncture marks of Texas oil drillers, I visited a well that each month swallows as much as six and a half million gallons of caustic liquors from refineries.

The well belonged to Chemical Waste Management, the world's largest waste disposal company. Under high pressure, treated waste shot down a steel pipe clad in concrete—down past the brine of the intruding Gulf of Mexico; down through layers of dense clay; down, finally, to the sand of an ancient sea nearly a mile beneath my feet. And shale under it all, a subterranean breakwater marking the bottom line.

I asked the well supervisor where the sidelines were. "You can't be sure where or how far and fast injected waste will spread out,"

***Telltale cloud** from the incinerator ship Vulcanus II in the North Sea **(right)** is mostly steam and hydrochloric acid, neutralized when it contacts the sea. Though apparently safe, incineration of hazardous waste at sea is not permitted in U. S. waters.*

*Most industrial waste generated in Bavaria, West Germany, is shipped to incinerators at Ebenhausen. Here a crane operator **(left, above)** mixes liquid and solid wastes and feeds them to an 1800°F inferno. Guppies **(left)** must survive for 24 hours in the plant's treated wastewater before it is released into the Paar River, a tributary of the Danube.*

he said. "It might hit something like a deposit of clay and flow around it like an amoeba, taking the path of least resistance."

If waste hits cracks and crevices in fractured rock, it can flow to groundwater. To limit such mishaps, most waste wells have been drilled in the well-mapped geology of Texas and Louisiana petroleum fields. For half a mile around the Chem Waste perforation at Corpus Christi, old gas and oil wells have been sealed top to bottom, so that errant waste has no pipeline to drinkable water. Monitoring wells stand watch.

Last year, from Chem Waste wells in Ohio, 45 million gallons of steel-pickling acid and other wastes seeped into porous sandstone. Well-casing cracks and corrosion were at fault; for this and other violations Ohio fined Chem Waste $10,000,000.

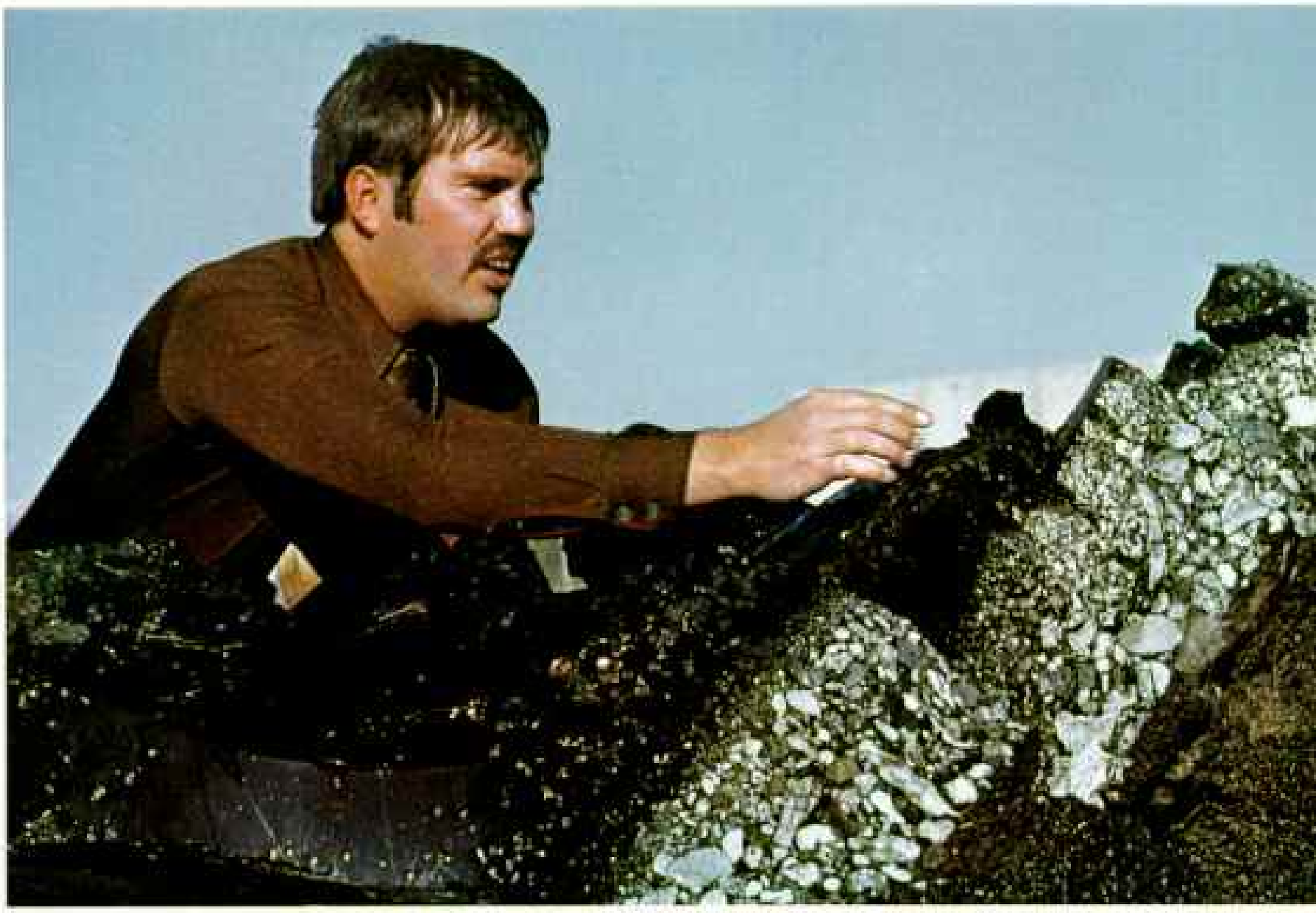
In Emelle, Alabama, Chem Waste runs a 2,400-acre landfill, the country's biggest. Its trenches resemble open-pit mines cut into 700 feet of gray chalk. Chem Waste hopes they'll hold waste secure for 10,000 years.

At trench number 20 I watched trucks switchback into the earth, their gears grinding out a dinner call to roaring bulldozers waiting to snuffle in the arriving waste like eager pigs. They tamped drums with chalk and heaped cement dust into watery black sludge to solidify it and neutralize acids. A diesel pig snorting smoky satisfaction nudged broken barrels from a Superfund dump in Indiana up next to a leachate drain.

Ringed with monitoring wells and capped by clay when full, the Emelle trenches may be the safest of the nation's 199 active toxic waste landfills. EPA assumes all will leak and forbids burial of high-hazard liquids. Yet it will permit a landfill with a plastic liner as thin as a raincoat to open in a swamp.

"Every landfill poses a future threat," allows William Hedeman, the EPA official in charge of Superfund cleanups. A good many involve old landfills, and EPA tries to recoup its costs by settlement or suit when it can find those liable. This replenished the Superfund by a mere seven million dollars before it was exhausted early last year. "That hardly enables us to keep a finger in the dike," says Hedeman. "Some sites may cost hundreds of millions each to remedy."

Congress is about to renew and expand the Superfund and may lay out a cleanup



timetable, unhappy that although EPA has removed imminent hazards at hundreds of dumps, only 12 have been fully purged. But deadlines may not help much.

"When Congress wrote Superfund into law in 1980," William Hedeman told me, "it ordered EPA always to choose the most cost-effective cleanup remedy. Nobody wants toxic waste in their backyard, but the law is skewed toward leaving some there. We may haul away drums and dirt and leave groundwater contaminated because it's cheaper to pipe in water than to clean the aquifer. And it's hard to move fast when you don't know which remedies will work."

AT TIMES BEACH, the Missouri town emptied by dioxin, the immediate remedy has been to buy the town and relocate 2,200 people, at a cost of 33 million dollars. The town is one of more than 40 sites in Missouri under investigation by EPA, which is testing methods to detoxify or incinerate dioxin-contaminated soil. But getting rid of dioxin could prove easier than learning whether we really need to.

Vanishingly small doses of dioxin cause miscarriages, birth defects, liver damage, or death in laboratory animals; to guinea pigs it's 200 times as lethal as strychnine. But mammals vary in sensitivity to chemicals, and dioxin's only undisputed, but not inevitable, effect in humans is a skin rash, sometimes severe and lasting. Even workers heavily exposed in industrial accidents seem not to have suffered worse. Nor have scientists found any abnormal rates of illness among former residents of Times Beach.

Still, animal tests indicate dangers, and the long-term health effects of dioxin remain unknown. That's true of practically all toxic wastes: A health survey hardly ever establishes whether they slowly and subtly poison us.

"That demands proof of cause and effect that science cannot now provide," says Dr. Roger Cortesi, head of EPA's Office of Health Research. "Usually people's exposure to chemicals is uncertain, not enough people can be studied to reveal minute health effects, and detectable injuries may have other causes or take years to appear."

This makes it difficult to measure risks. Most of us don't even try: We conclude that

Solid ally *in the war on waste, an experimental vitrification process developed by Battelle Pacific Northwest Laboratories of Richland, Washington, fuses contaminated soil into obsidian-like glass (**left**), more durable than marble or granite. Electrodes placed in the soil carry current to convert the soil into a 3000°F molten mass. As the soil cools, it solidifies. Thus contaminated soils could be rendered harmless in place, instead of being carted off to a landfill.*

*Recycling means business for the Oil and Solvent Process Company of Azusa, California, where a column of recycled lacquer thinner, cleaned by distillation, bubbles pure and clear (**right**). Environmental and technical director Ken O'Morrow holds a glass cylinder of used thinner in his left hand. "We recycle about six million gallons of solvents a year," says O'Morrow. "This conserves resources and helps alleviate the disposal problem."*

Plowed under, *oily wastes from petroleum refining at Chevron's El Segundo, California, facility (**right**) are attacked by hydrocarbon-hungry bacteria naturally occurring in the soil. The bugs convert the hydrocarbons into harmless carbon dioxide and water.*

*Scientists Stephen Boyd and Daniel Shelton at Michigan State University examine an enlargement (**left**) of an anaerobic bacterium that has the potential for removing chlorine atoms from various waste materials, thus making them less toxic and more vulnerable to bacterial attack.*

injury from hazardous waste is always as probable as it is possible—that if the worst can happen, it will. I asked Dr. Donald Barnes, EPA's chief adviser on dioxin, how regulators determine degrees of risk.

"When we assess the seriousness of a potential threat to health," he said, "we always lack full information. So we cautiously make worst-case assumptions, such as that dioxin causes cancer in humans as easily as it does in rats. To that assumption we add others—for instance, a conservative estimate of the dioxin exposures that might put you at risk of developing cancer. A prudent regulator acts on these assumptions as if they were realistic in every situation. That confuses people into taking them as documented fact, but things are not always as calamitous as they seem."

EPA is checking hundreds of possibly contaminated factories and dumps for dioxin and surveying its level in the environment. Municipal incinerators emit dioxin—as may home fireplaces—and residues may remain in forests, fields, and lawns from dioxin-tainted herbicides, common until EPA largely halted their use in 1979.

The dioxin molecule is exquisitely difficult to identify. But in Midland, Michigan, where Dow Chemical has been testing soil, fish, and river water for dioxin from company discharge pipes and incinerators, chemists using ultrasensitive instruments can detect it at parts-per-quadrillion levels. That's like zeroing in on one drop in 12 billion gallons of water.

EPA suspects that dioxin causes some human cancers and says Dow is the main dioxin source in Midland, a legacy of past production of the herbicide 2,4,5-T. Dow suggests that dioxin is naturally widespread, and while it can persist in humans, it does so at harmless levels. That thesis escaped trial by jury early in 1984, when Dow and six other companies settled out of court with thousands of veterans who claim injury by the 2,4,5-T in Agent Orange, a defoliant that was sprayed on Vietnamese jungles.

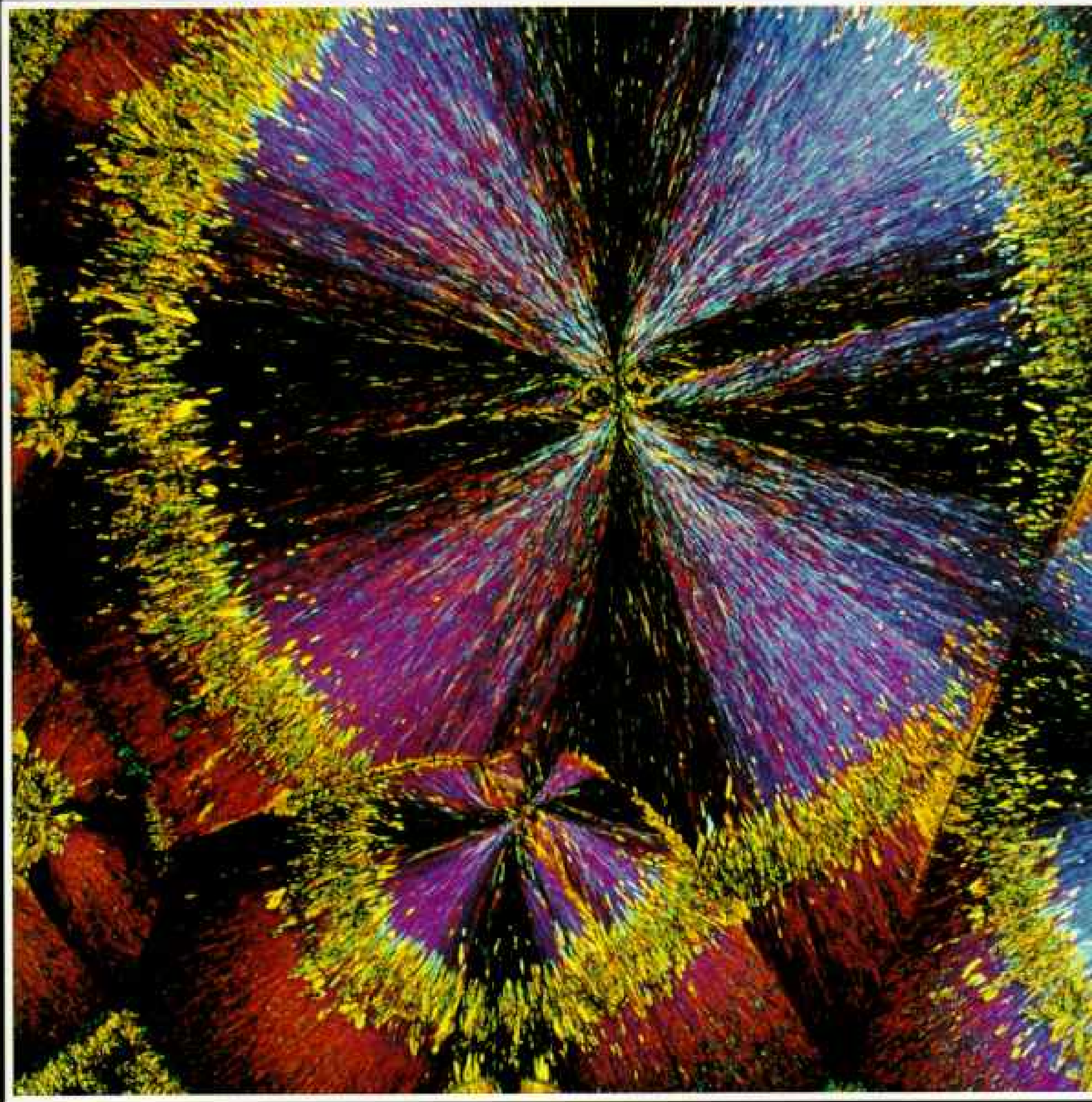
Dr. Vernon Houk, director of the Center for Environmental Health at the National Centers for Disease Control in Atlanta, Georgia, told me that we can reasonably associate disease with more recent toxic encounters—assuming significant exposure. But what is "significant?" We rarely know.

"Our skill in detecting toxic chemicals exceeds our ability to medically interpret what we find," says Dr. Houk. "Risk assessment at most dump sites is somewhat less precise than a five-year weather forecast."

GERT Heinemann canvasses Europe for customers for the *Vulcanus II*, a seagoing incinerator ship out of Rotterdam in the Netherlands. He sees from the inside how Europeans manage—and mismanage—their hazardous waste.

"I'd do more business if England stopped

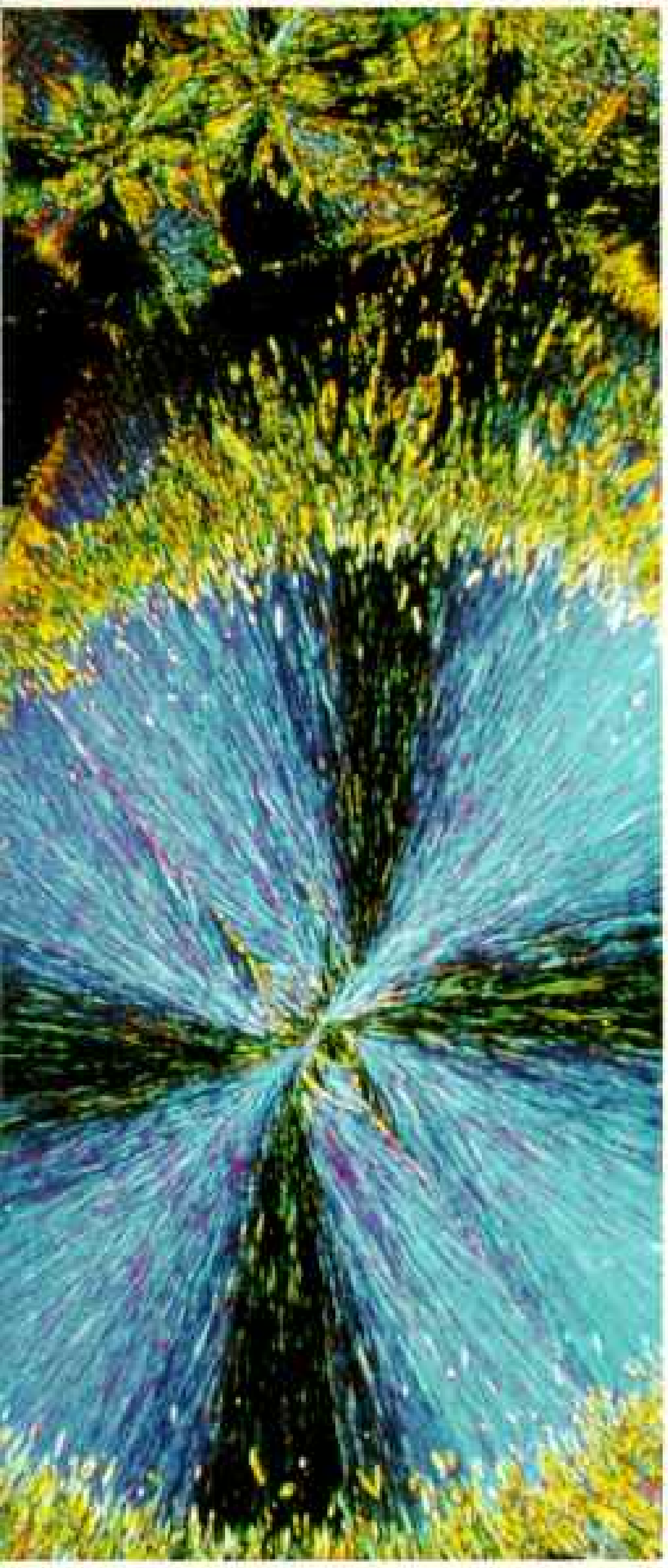

CAUTION
KEEP OUT
CUIDADO!



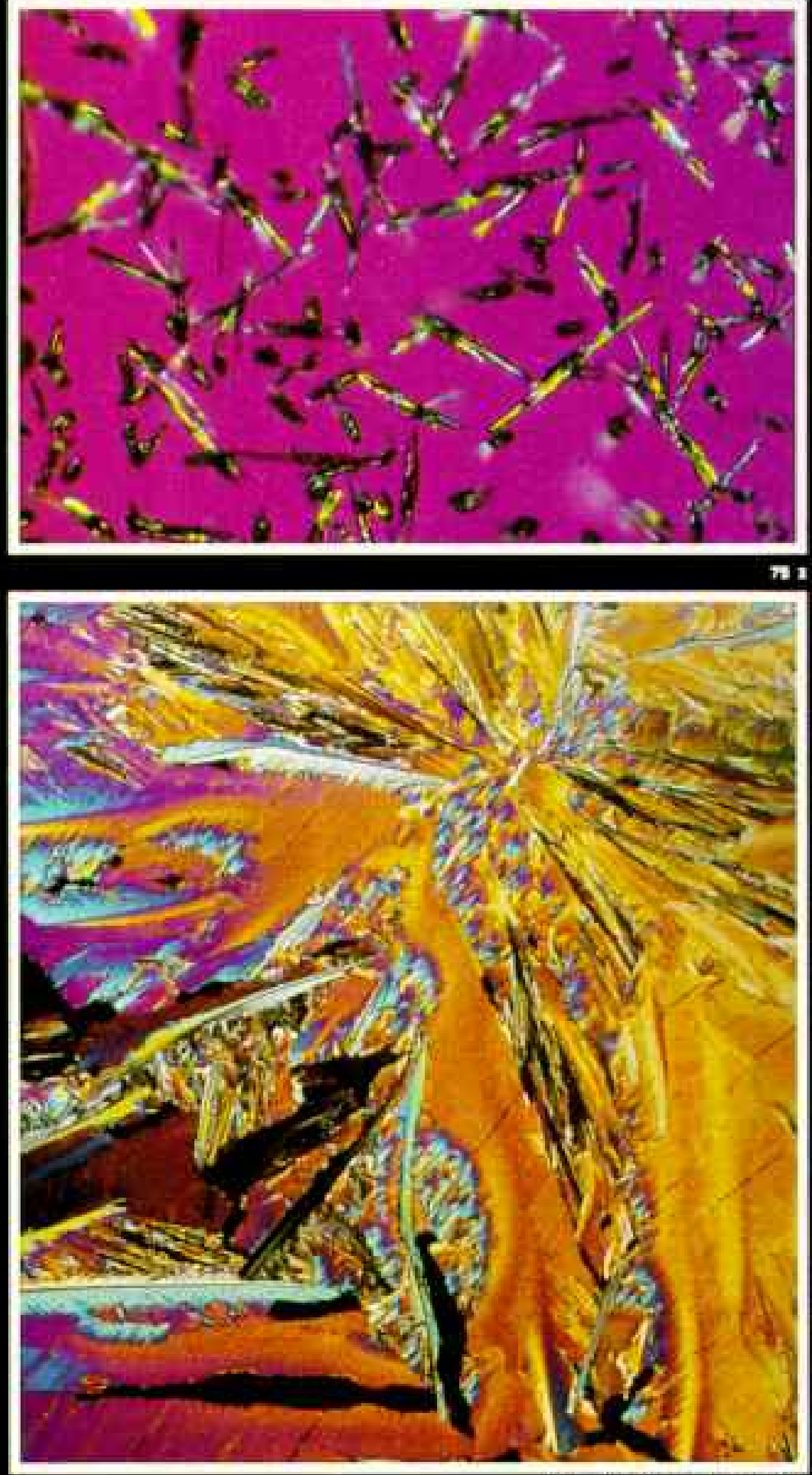
Deadly beauty of hazardous wastes

POLARIZED LIGHT *reveals the crystalline structures of toxic materials with unusual clarity.*

DDT (above), the wonder pesticide of World War II, was eventually banned in the U. S. when scientists found that it had moved up the food chain, even into mothers' milk. Lethal to laboratory animals, 2,3,7,8-TCDD, or dioxin (right, top), is the most toxic synthetic organic chemical known to man, although it has yet to claim a human victim. The herbicide 2,4,5-T (right, center) is one of the ingredients in Agent Orange, the controversial defoliant of the Vietnam War. Phenol (right), a toxic organic compound, serves as a building block for chemical products including resins, dyes, disinfectants, and lubricating oils.



MAGNIFIED 85 TIMES



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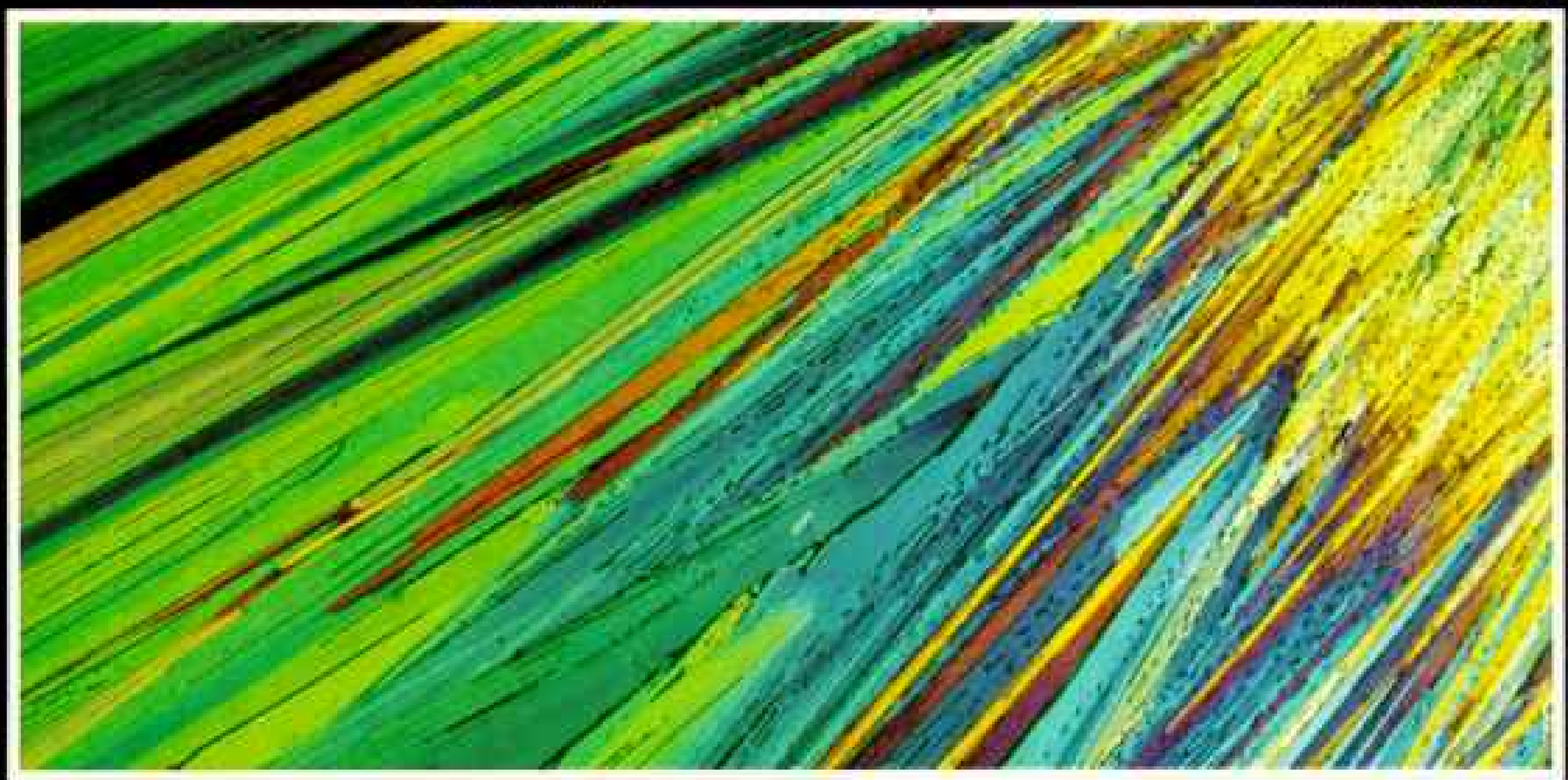


Brain, liver, heart. . . . *Just about every organ from a laboratory rat is represented in a series of tissue sections mounted on slides (**right**) at Dow Chemical's Toxicology Research Laboratory in Midland, Michigan. Histologist Debra Wackerle arranges them for examination by a veterinary pathologist.*

Earlier, laboratory animals had been given graduated doses of a new compound. By taking tissue sections of various organs and examining the slides, the company can identify which organs have been affected, helping to gauge the level of exposure considered safe.

*In a metabolism test at Dow (**left**) research biologist Mark Dryzga collects urine from a rat to find out how much of a new compound is absorbed by the rat and how fast it is eliminated. From such tests Dow can determine how much of the compound might accumulate over time in the tissues of an animal.*

dumping in old mines and in the North Sea," Heinemann told me. "Italy? A basket case! Sweden agitates piously against ocean incineration, but lets its industry give us waste anyway—keeps it out of Swedish landfills."

Flying over the North Sea a few days later, I peered into the huge incinerator stacks of the *Vulcanus II*, glowing orange with burning waste. Gray wisps of steam carried away dilute hydrochloric acid, which fell to the sea and turned to salt. By neutralizing its exhaust with seawater instead of expensive stack scrubbers, the ship can dispose of waste at half the cost of incinerating it on land. For years EPA has considered allowing *Vulcanus II* and a sister ship to incinerate waste in the Gulf of Mexico, but Gulf coast residents who fear toxic slicks and dead fish have kept the idea in dry dock.

In Bavaria and in two other West German states, collecting stations funnel most toxic waste to regional incinerators and landfills funded by industry and government. East Germany, however, serves as Europe's dumping ground to earn hard currency. Crude pits there take foreign waste at such low rates that West Germany has limited border crossing points for waste shipments—lest "toxic tourism" grow.

THE DYNAMICS of disposal in Germany impressed me most at a salt mine on the East-West frontier. Since 1972 Kali und Salz AG has bricked up waste in caverns left by miners, salting it away in formations stable for 250 million years and presumed immutable for eons more.

"Each year we mine, we gain 30 more years of disposal space," said engineer Norbert Deisenroth, showing me maps. Dated and multicolored, they cataloged 400,000 tons of waste in drums. "Purple . . . August 14, 1978 . . . Kepone pesticide . . . Virginia." West Germans must cope with old dumps and half-forgotten war rubble containing live bombs and chemical weapons, but they've avoided calamity comparable to the dumping that in the 1970s extensively polluted Virginia's James River with toxic residues of Kepone production.

The Japanese, otherwise fastidious, have suffered cruelly from careless disposal of hazardous waste. In the 1950s at Minamata Bay in southern Japan, waste mercury from

a chemical plant contaminated fish, eventually inflicting disfiguring paralysis or slow death on thousands of people, including children in the womb. Minamata disease hit central Japan in 1965, and harbor dredging at the site of the first disaster threatens to send mercury up the food chain once again.

In Haginoshima, a farm village on Japan's west coast, elderly Miyo Komatsu graciously bowed to meet me despite the agony of bone-splintering cadmium poisoning. Japanese have named Miyo's affliction after the cry it wrings from its victims: *"Itai, itai. . . .* It hurts, it hurts. . . ."

"Itai-itai disease is chronic," explained Dr. Noboru Hagino, who in 1961 linked it to rice from paddies polluted by toxic waste from a mine upriver of his ancestral village. "It mainly affects aged women, after repeated pregnancies. Calcium drawn from a woman's bones by her growing child is replaced by cadmium, and in time bones can so soften that they snap at a sneeze." Miyo was brought to Dr. Hagino in a sling, with 28 major fractures.

The cadmium dumping ended in 1971, when villagers won a lawsuit. More than a hundred have died, but Miyo and other survivors draw benefits under a unique Japanese law that aids nearly 85,000 people injured by air pollution or hazardous waste.

Proposals to give similar help to Americans come up often in Congress but never survive debate. For people like Verna Courtemanche of Swartz Creek, the only hope of redress for anxiety, economic loss, and bodily harm is to chance a long and costly court battle against a polluter. "That's woefully inadequate," says Congressman James Florio, who helped write the Resource Conservation and Recovery Act and the Superfund law. "We're not spending billions to clean up dumps because they're eyesores—they threaten public health. Ignoring the injury they cause people is illogical and unjust."

But government relief makes even less sense to Michael Horowitz, general counsel of the U. S. Office of Management and Budget. "If you want to understand the explosive implications of such schemes," he says, "look at black-lung compensation for coal miners. When it began in 1969, nobody thought it would cost more than 300 million dollars. Now it costs the Treasury almost

***Minamata disease** still leaves its legacy of suffering in Japan. Hundreds of tons of mercury discharged into Minamata Bay in the 1950s by a chemical company found its way into the food chain, affecting thousands of people. The disease causes loss of motor control, disfiguring paralysis, and mental disorders.*

*Confined to Meisuien Hospital, an institution for Minamata sufferers, 28-year-old Kazumitsu Hannaga (**left**) cannot hold his head upright. Another Minamata victim, Asao Tanaka (**below left,** at right), patiently wipes drool from the chin of her mercury-poisoned daughter Jitsuko. Asao's older daughter died 27 years ago from Minamata disease, and her husband, a fisherman, is also a victim.*

*Exposure to chromium dust in a Japanese factory burned the connecting tissue between the nostrils of Denkichi Konuma (**right**).*

"Itai, itai—*It hurts, it hurts.*" *Cries of Japanese victims provided the name of a cadmium-caused disease that makes bones so fragile they can be broken by a mere handshake. By-product of zinc refining, cadmium-polluted drinking water from the Jinzu River caused Miyo Komatsu (**above,** left) to shrink 12 inches as her vertebrae collapsed.*

Dank lagoon *of yet another abandoned disposal site, near Bridgeport, New Jersey, contains tons of sludge and nearly three million gallons of oil contaminated*

two billion dollars yearly. Imagine multiplying a small cohort of miners by the number of people potentially exposed to toxic waste. If two children near a dump develop leukemia, and health statistics suggest that eventually 12 children will sicken, do you compensate just the two, or 12, or every child for miles around because you can't predict exactly which ones will get the disease?"

ONE HALLMARK of our recent experience with hazardous waste is naïveté. Industry is too trusting of supposed state-of-the-art lagoons and landfills. The Reagan Administration thought a nation that had voted for less government would tolerate less protection of the environment. Congress overrates the power of law to budge economic forces, social inertia, and scientific unknowns. TV and newspapers supply a catalyst for cleanup with the drama of people trapped by dumps, but seldom ask whether the engine of reform can go anywhere other than in circles if its only fuel is alarm. And we all want a solution overnight to a crisis decades in the making.

But long neglect is hard to relieve, not least because we can't always agree on what to do with hazardous waste. Caught up in debate that is more often confusing than

by PCBs. Nearly one-third of the storage tanks contain hazardous waste. The EPA-estimated bill to clean up the site: 50 to 60 million dollars.

conclusive, lawmakers, scientists, industry, and the public fall badly out of step with each other and sometimes march off in entirely different directions.

The people of Warren, Massachusetts, could reasonably object, "Why here, in *our* town?" as they turned back the attempt of a developer and a state commission to locate a waste treatment complex in their community last year. And the commission could legitimately ask, "If not here, *where?*"

"Technologically, toxic waste is no harder to control than air or water pollution," says William Ruckelshaus, twice administrator of EPA. "But toxic waste frightens people more because we're less certain about the dangers it poses—risks we likely can't eliminate, only reduce. We may suffer more recrimination, false starts, and environmental insults as we tackle this dilemma, but there's no doubt of our solving it."

Verna Courtemanche hopes so. "I'd like to think I'll live long enough to see an end to problems with hazardous waste," she told me. "I want a new water supply, and I want the government to monitor 'my' dump for at least 50 years and promise that the land will never be a field for crops or a playground for kids. That's not ideal, but it's probably the best we can do. So there it is." □

Susquehanna: America's

By PETER MILLER Photographs by

Small-Town River

WILLIAM T. DOUTHITT BOTH NATIONAL GEOGRAPHIC STAFF

A quiet neighbor to farm families in the "Endless Mountains" of Pennsylvania ***(left)****, the Susquehanna belongs in spirit to small towns, canoeists, fishermen, and kids in inner tubes. Though the longest stream on the U. S. East Coast, it is too twisting and shallow to be an avenue of commerce. As familiar to residents as an old flannel shirt, the river flows through a region that has seen hard times and fought for a fresh start.*

ON A BALMY SUMMER evening in Millersburg, Pennsylvania, when the shadows have grown long and the streetlights are coming on, a stern-wheel ferry with four cars on it sets out across the Susquehanna. If you felt like it, you could wade across the river right behind it. The Susquehanna is that shallow.

The river has never been a main route for commerce like the Ohio or the Hudson, even though it's the largest river by volume and length on the East Coast of the United States. When Capt. John Smith set out to explore it in 1608, his boat was blocked by boulders only a few miles from its mouth on Chesapeake Bay.

Instead, the Susquehanna has become a river of small towns and small cities. Of red-brick houses along the railroad tracks with six pairs of blue jeans on the line. Of pancake

Football weather lures three boys to turn a sidewalk into

breakfasts at the American Legion on the first day of small-game season. Of cider mills and pumpkin patches. Of barbershops where haircuts are four bucks and tonic costs an extra 50 cents.

It's a river of second chances, where immigrants from Germany, Ireland, Poland, Russia, Italy, Lithuania, Serbia, Slovenia, Bulgaria, as well as Laos, Cambodia, Vietnam have started over again as Americans.

It's a river of communities visited by hard times. When the lumber, coal, steel, and railroad industries fell into decline, company towns were stranded. Yet people stayed put, and new businesses slowly took root.

Though beautiful in many quiet ways, the Susquehanna's not scenic wilderness like the Snake River or the upper Rio Grande, nor is it tapped for irrigation like the Colorado. A mile wide in places, it conceals its size

a stadium in the river town of Danville, Pennsylvania.

among the low ridges and gentle valleys of New York, Pennsylvania, and Maryland.

No, the Susquehanna is a river of Sunday canoe trips, of fishing from a bridge, of muskrat trapping along the muddy banks, of jogging on a city flood dike. As it flows through towns, it ties them together, lending a tone to daily life. It's a river that dwells among people and mirrors their resilience.

THE NORTH BRANCH has its beginning near Cooperstown, New York, at Otsego Lake. By the time it flows past the dairy farm of David and Cathy Johnson 35 miles away, it has grown from a quiet brook into a fair-size country stream.

"I can't talk to you right now," said Cathy. "I've got a busload of preschoolers coming in at any minute to see our pumpkins." They were piled all around us—sugar-pie pumpkins, with Indian corn, winter squash, green and yellow gourds, potatoes, and apples—all grown by the five Johnson youngsters. They sell their produce at a roadside stand they call the Covered Bridge Farm Market. David Johnson was in the barn moving corn silage with a small front-end loader. The pungent, sweet smell of manure filled the air. David hopped out of the cab and shook my hand.

"Oh sure, the Susquehanna River Valley here is about all dairy farming," he said. "My wife and I were both born and raised in Delaware County, and our parents and grandparents farmed here too. The valley is a natural transportation corridor. My milk goes straight to New York City by truck every other night. Besides, the climate is good. River fog can hold back the frost, and that gives us a longer growing season for corn and alfalfa.

"Today I'll put in four hours of milking, two hours of feeding, and six hours of field and crop work," he said. "It's a good life if this is what you want. If not, it's a hard way to make a living."

A workingman's utopia took root a few miles downriver in the present Triple Cities area of Binghamton, Endicott, and Johnson City. There's a story that Italian immigrants landing at Ellis Island in the first part of the century knew only three words of English: "Which way E-J?" They were headed for the Endicott-Johnson Shoe Company, which by 1917 was one of the largest in the nation.

Under the guiding hand of George F. Johnson it grew into a complex of 27 factories employing 20,000 workers in three communities. "Geo. F.," as he was known, not only paid a reasonable (if modest) wage but also built thousands of houses for his employees and sold them at cost. He put in streets, lights, and water and sewer systems. He erected churches, created baseball parks, built schools and hospitals, and even the Enjoie Health Golf Course at which all were welcome. He provided his workers with free medical care, free legal advice, and instituted a profit-sharing system. Every baby born to a company family started life with a ten-dollar gold piece. At Christmas every boy or girl under 16 received a new pair of shoes. These innovations in "welfare capitalism" helped the company avoid labor problems at a time when unions were organizing workers in other cities. Though the work could be grueling and tedious, complaints remained relatively few from E-J employees, whose ranks often included several members of each family.

Al Maturani began working here at 17, six years after leaving Italy. Al works in the same factory today, sometimes at a machine of the same vintage, that he did when he started in 1936 (page 361). His specialty is toe lasting, or fastening the front leather of a shoe to the sole, and his fingers move with confidence as he taps here and adjusts there.

There was friendly rivalry in the early days between E-J workers and the people at IBM, which started in Endicott in 1911 as the Computing-Tabulating-Recording Company. The IBM staff was considered straitlaced compared to the fun-loving shoemakers. "We had a slogan," said Al. "While IBM is thinking, E-J is drinking."

A LIGHT SNOW was falling on Sayre, Pennsylvania, as trainmaster Jim Macri and I waited by the side of the railroad tracks for Conrail's night freight from Elmira. The tracks hug the river for 86 miles as it cuts through the "Endless Mountains," some of the steepest hills along its length. The river is actually older than these hills, which it eroded as they were uplifted 100 million years ago.

Susquehanna River

DRAWING STRENGTH from 27,570 square miles of New York, Pennsylvania, and Maryland, the 444-mile-long Susquehanna provides half the fresh water to Chesapeake Bay, which fills the river's ancient channel to the Atlantic. Polluted by raw sewage 20 years ago, the river now runs cleaner, though acidic mine runoff still leaves parts of the West Branch lifeless. Toxic wastes dumped illegally down old mine shafts may still drain into the river.

James Fenimore Cooper, who popularized the American frontiersman, made Otsego Lake the setting of his 1841 novel The Deerslayer. Cooperstown was founded by Cooper's father, William.

Cooperstown

Otsego Lake

Susquehanna

Binghamton

Johnson City

Endicott

NEW YORK

PENNSYLVANIA

Sayre

Settlers from Connecticut battled with Pennsylvanians for control of the Wyoming Valley during the Yankee-Pennamite Wars in the last half of the 18th century. Resolution of the dispute was an early test of the Articles of Confederation.

Towanda

FRENCH ASYLUM

A group of French aristocrats sought asylum during the French Revolution at a bend in the river near Towanda. There is a legend that the queen, Marie Antoinette, was also to flee here, but she never escaped from Paris.

Scranton

Wyoming

Pittston

Forty Fort

Wilkes-Barre

Renovo

Hagerville

Jersey Shore

Williamsport

SUSQUEHANNA STEAM ELECTRIC STATION NUCLEAR

West Branch Susquehanna

Lock Haven

Logaston

Danville

Susquehanna

Centralia

Mount Carmel

Northumberland

The Florida Fruit Farm in the hills near Logaston was the headquarters of Prince Farrington, one of the most successful bootleggers in the East during Prohibition. Known for his generosity, he was famous as a local Robin Hood.

Millersburg

Columbia was among the places considered in the late 1780s for the nation's permanent capital. Congress looked for a site along the Susquehanna before deciding upon the Potomac.

Carrolltown

Juniata

Enola

Harrisburg

Steelton

Middletown

Lancaster

PENNSYLVANIA TURNPIKE

Goldsboro

THREE MILE ISLAND NUCLEAR GENERATING STATION

Wrightsville

Columbia

York

PEACH BOTTOM ATOMIC POWER STATION

CONOWINGO DAM AND HYDROELECTRIC STATION

Havre de Grace

Chesapeake Bay

PENNSYLVANIA

MARYLAND

NORTH

30 km

30 mi

NGS CARTOGRAPHIC DIVISION
RESEARCH: JOHN D. TREIER
PRODUCTION: JAMES E. MCLELLAND

The Susquehanna River

Baseball heroes *of the future take the field each August at the Little League World Series in Williamsport, Pennsylvania (**right**). Established here in 1939, the Little League today has programs in 24 nations. Legendary big-league players such as Babe Ruth (**above**) are remembered at the National Baseball Hall of Fame and Museum in Cooperstown, New York, where townsfolk (**top**) decorate the main street for Christmas. The Susquehanna begins nearby in the waters of Lake Otsego.*

From ledges overlooking the river, Iroquois scouts could keep watch on key trails entering their territory from the south. As the 17th century waned, the militant Iroquois battled the Susquehannocks downriver for control of the Dutch and English fur trade. The river shares its name with this lost tribe.

A locomotive crept from the darkness about 9:30, rumbling, growling, shaking the earth like a massive beast. Its headlight was so bright that I could barely see the rest of the train as it crept through the falling snow. I grabbed the ladder and swung up into the warm cab.

"We're pulling 51 cars tonight with three engines," said engineer Don Hoey. "That's 8,300 horsepower." The cab sat as high as the crossarms on the power-line poles and rocked from side to side. The night's cargo was a mixed load of lumber, paper towels, rock salt, and coal. Nineteen of the train's cars were empty, to be dropped off at factories along the river.

As the train rumbled through the night, I thought again of the Indians who once lived here. Our route south was the same as that taken north by Gen. John Sullivan in 1779 when he laid waste the Seneca and Cayuga, two nations in the powerful Iroquois Confederacy. A year earlier an Iroquois force assisted by British and Tory soldiers

A square deal for workers *was the philosophy of shoemaker George F. Johnson, whose factory employees in 1921 erected this arch (**above**) at Johnson City, New York, and another at Endicott. In return for hard work and loyalty, "Geo. F." gave his workers a shorter workday, free medical care, and low-interest loans for*

had killed about 300 American troops at Wyoming, near present-day Wilkes-Barre. Survivors of that battle were executed the same night, some, according to legend, by an Indian woman who danced around them.

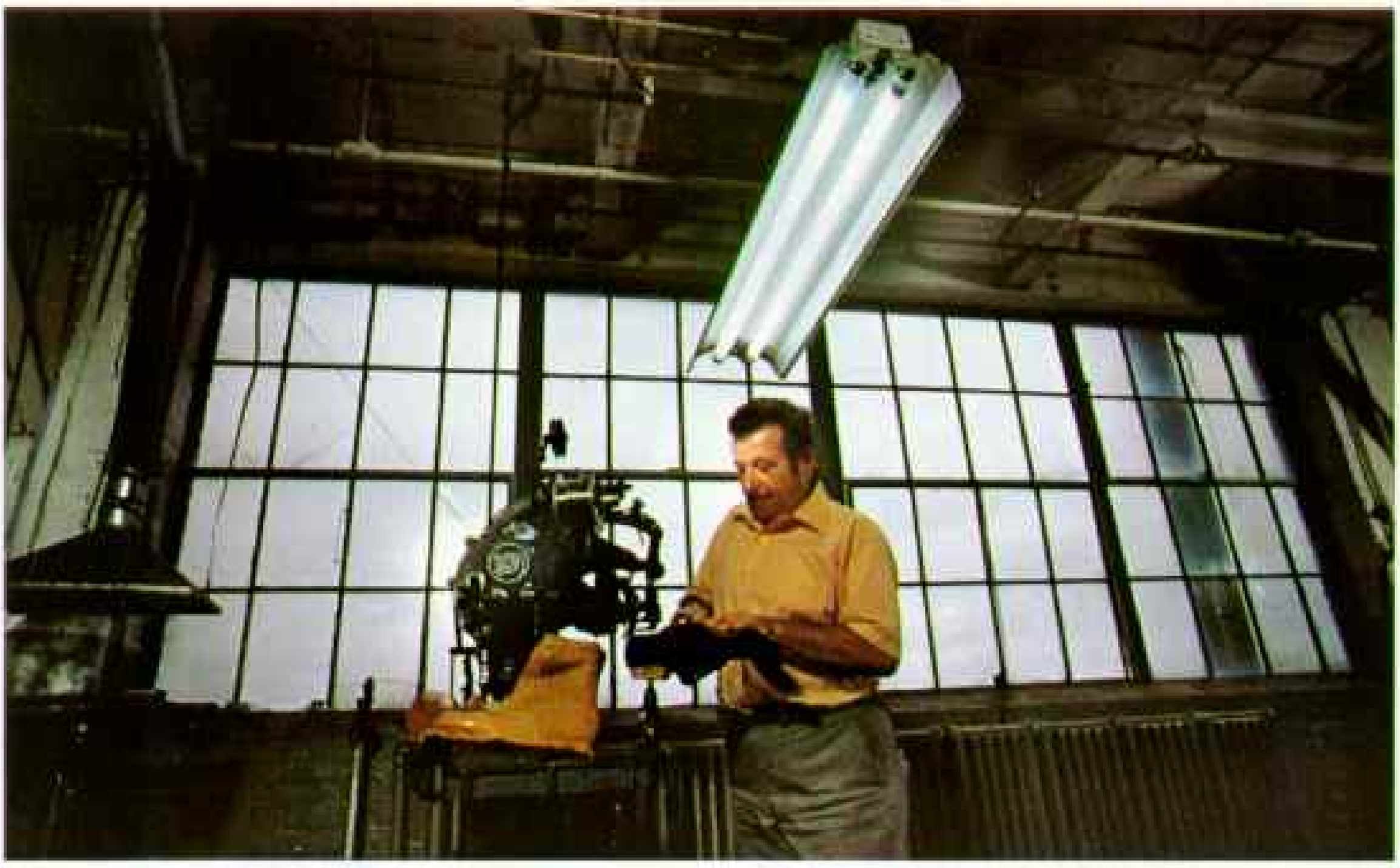
At the height of the Revolutionary War the Iroquois so concerned George Washington that he gave General Sullivan and Gen. James Clinton at least 3,500 soldiers from the Continental Army. His orders: "the total destruction and devastation of their settlements and the capture of as many prisoners of every age and sex as possible."

Fireman Tim Jacoby jolted me back to the present when he suddenly started blowing the whistle and flashing the headlight. Deer were standing ahead of us on the tracks, their eyes glowing green in the engine's beam. "You have to do that," he said, "or the beam will hypnotize them, and they won't be able to move." But it didn't seem to work. They stood frozen as we barreled along. At the last minute Jacoby killed the light. There was a flash of white tail, and I braced for the impact in the darkness.

But the impact never came. The train just kept rumbling through the night. And when the light snapped back on, there was nothing on the tracks but a light-falling snow.

A GENTLE COMPANION most of the time, the Susquehanna went on a rampage in the city of Wilkes-Barre in 1972. "A man with a bullhorn was standing on the dike telling people what to do," said Roz Smulowitz, who was living near the riverbank at the time. "My children and I had been filling pillowcases with sand all morning as the river kept rising. Suddenly the man said, 'Everyone evacuate, the dikes are giving way!' Right near the corner of our street, where the river makes a little bend, the dike was folding. It crumbled and began to seep. We watched a few moments, then 'whoosh,' the water came through. We ran for our lives."

It was the most extensive flood in modern Pennsylvania history. For five days in June the remnants of Hurricane Agnes dumped as much as 18 inches of rain on the Susquehanna River basin. Wilkes-Barre's dikes were constructed to withstand a 37-foot crest, four feet higher than that of the last major flood, in 1936. But the waters reached



new homes. He also built parks, schools, hospitals, and churches. Al Maturani ***(above)*** *started working for Johnson in 1936, shortly after emigrating from Italy. Today he fastens soles to shoes and boots in the company's Alpine plant, often using the same kind of machine he started with half a century ago.*

almost 41 feet before they stopped rising.

"The river dug up the entire street," Mrs. Smulowitz said. "It tore six-foot-diameter sewer pipes out of the earth and deposited them on my daughter's bed on the second floor. One side of our house just collapsed when it was lifted off the foundation. Until you live through a disaster of that kind, you never think of water as being so violent."

The dike gave way on the other side of the river at about the same time. The current churned through a cemetery in the town of Forty Fort, disinterring hundreds of caskets. "It was a terrible sight," said Ernest Casterline, who was operating a front-end loader to carry sand to volunteers. "Coffins were lifted up by the river and broken open on fences. There were bodies all over. One casket ended up in the window of a service station eight blocks away."

About 80,000 people in Wilkes-Barre and nearby towns were displaced by the flood; 25,000 houses and apartments were damaged. The downtown district was ruined.

But the disaster had a remarkable side effect. Nearly two billion dollars in emergency aid started flowing in from the federal and state governments. Towns reconstructed sewer systems and built parks. Businesses rebuilt, or even expanded, with low-cost loans. Plans made before the flood to renovate Wilkes-Barre suddenly became possible. The city spruced up its downtown Public Square with sidewalk canopies to create the atmosphere of a fancy mall.

"There's no question that Wilkes-Barre is better off today than it was before the flood," said Horace Kramer, who served as chairman of a redevelopment board that worked for ten years to repair the flood damage. "But there's no way you can truly compensate people for the trauma and the losses that we all suffered."

THIS AREA suffered a completely different kind of loss in 1959, when a bizarre accident put an end to its era of deep mining for anthracite. "I was only nine when it happened, but I could never forget it," Barry Stocker said. A coal company was mining beneath the river near Pittston and accidentally punched through the river bottom, which collapsed. Twelve miners were drowned, and for three days in

"I can't resist a good accordion," *says John Kolcun of Binghamton, New York, whose collection of 60 has a squeeze-box for any occasion. John also collects*

figurines—more than 400 by his count—every one with an accordion. Retired from IBM, he plays his music at nursing homes, hospitals, and charities.

The logger's saw *still roars in forests along the West Branch, where Bob Zwald* ***(above)*** *fells trees for a small logging company. In the mid-19th century, thousands of rafts like these* ***(right bottom)*** *floated timber downriver each spring. Loose logs were collected by a fencelike boom in the river near Williamsport, then hailed as the logging capital of the nation. The Millersburg Ferry* ***(right top)*** *runs the nation's last wooden stern-wheel ferries.*

January 1959 water poured into the mine.

"They tried to plug up the hole by pushing railroad cars into the river," he said. "They started with tiny gondolas, the kind they took into the mines. But that didn't work. So they tried regular-size cars, and the hole sucked them down too. I remember seeing a huge whirlpool out there and a 50-ton railroad car tilting end up in the water as it went down. They must have dumped in 30 to 35 cars. It was scary."

Eventually the river was diverted so the hole could be filled up with slag, but not before it drowned two billion tons of anthracite coal in deep water. True, the hard-coal

WYOMING COUNTY HISTORICAL SOCIETY AND MUSEUM

industry had all but died in this region years before. But the river accident sealed its fate.

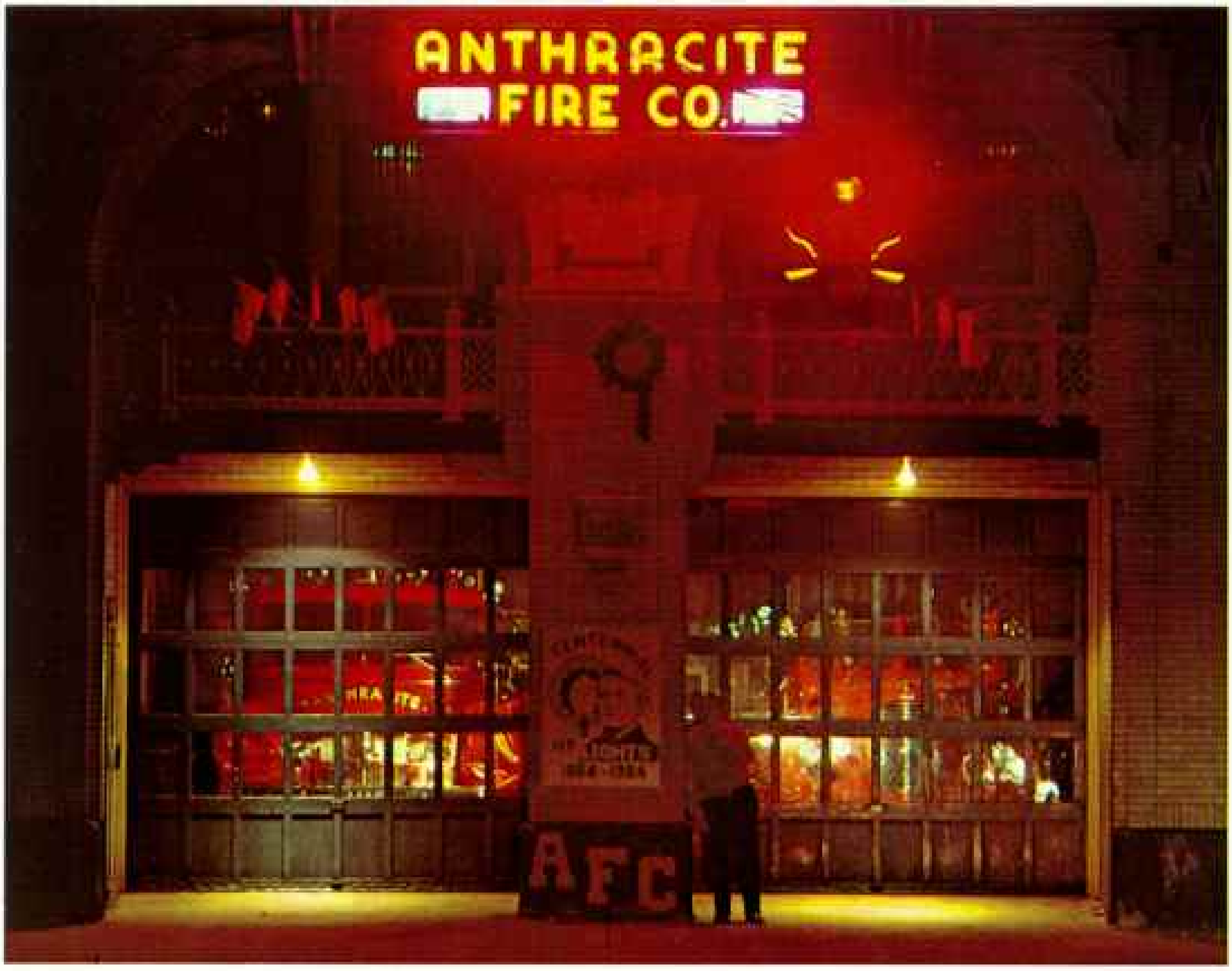
Coal had been king here since the 19th century. It spurred the construction of rail lines and canal systems and the creation of company towns throughout the hills. Unions were born to fight the powerful mineowners, who ignored the workers' squalid living conditions and dangerous duties. And in the hard times after the Civil War a secret gang of Irish laborers called the Molly Maguires used murder and terror to intimidate mine bosses and fellow workers.

The legacy of the coal era has been bitter for Centralia, a mining town settled in 1841. A fire has been burning out of control for the past 23 years in abandoned coal tunnels beneath the town (pages 368-9).

Todd Domboski fell into one of the mine shafts in 1981. The 12-year-old was crossing a lot behind his grandmother's house when he stopped to look at a wisp of smoke in the grass. "The ground just opened up beneath me," he said, "and I fell in over my head. I was grabbing onto roots, or anything I could get, and yelling. The earth was moist and sweaty. I couldn't catch a breath."

Todd's cousin Eric Wolfgang saw Todd's orange cap in the hole. He reached down and pulled *(Continued on page 370)*

A million or more hunters *from some 45 states fill the Pennsylvania woods on the first day of deer season—a holiday in many school districts. A pair of hunters near Renovo (***right***) drag a young buck to the road. At the Buckhorn hunting camp near Haneyville (***above***) breakfast begins with "Wimp" Beach rolling dough for sticky buns as Jim Maguire offers advice. At least 250,000 deer a year are taken in Pennsylvania, a culling considered necessary to control the enormous deer population of 865,000. Some 45 deer-hunting accidents are reported annually.*



The earth is on fire *beneath Centralia, Pennsylvania. An uncontrollable inferno has been burning for 23 years in a maze of old mine tunnels. The fire may have started at a trash dump on the edge of town* ***(right)****, where vents now release steam from the smoldering subterranean blaze. On a hillside a mile and a half away flames flicker eerily from an exposed coal seam* ***(left)****.*

Deadly carbon monoxide seeping into basements caused Centralia families to have gas monitors installed in their homes. After all attempts to extinguish the fire failed, the federal government in 1983 approved a 42-million-dollar plan to buy out residents wanting to leave. Many accepted the offer, but a few, such as Mary Lou Gaughan ***(right)****, refused to abandon the dying town. "Our houses may not be mansions," she said, "but to us they are palaces."*

Many families relocated in nearby Mount Carmel, whose oldest firehouse ***(above)*** *proclaims the mining heritage of the region. Here in the heart of coal country, Thomas Edison installed electric lights in 1884, making this town one of America's first to be electrically lighted. A century later townsfolk celebrated the event with a festival.*

Todd out unharmed. The temperature inside the mine shaft was later found to be 350°F; the hole, at least 80 feet deep.

The fire is thought to have started in a trash dump on the edge of town. It slowly spread through the honeycomb of tunnels beneath Centralia and today burns in three places. The woods beside the state highway into town look as if a plane had crashed. Trees lie twisted and smoldering, and sulfurous steam rises from the embankment.

When I first visited Mary Gasperetti in late 1983, she was living with her husband and two children in a "fire-impact zone." Only 225 feet from her backyard underground fires smoldered at 700°F. As we talked in her living room, a gas detector clicked and hummed beside the sofa. Installed by state officials, it was monitoring levels of poisonous fumes from beneath the house. "I worry sometimes that it isn't working right," she said. "I'm scared that some morning my family won't wake up."

A year later Mary's fears were over. Government officials, under a three-year, 42-million-dollar program, had purchased her family's home, allowing them to move to Mount Carmel, where the Domboskis and other Centralia families had fled.

Not everyone, however, plans to leave. "I'm staying," said Jim Reilley, "and so are my mother, my sister, and my brothers." The Reilleys live in the hamlet of Byrnesville, adjacent to Centralia, where the mine fire is still spreading. "They aren't going to pay me enough to make a move worthwhile," he said. "Besides, the fire's going to pass at least 200 feet below my house. So I'm not really worried."

With roots that go back generations, many residents have strong bonds to the town. Others stayed in Centralia as long as they did only because they couldn't afford to start over again. A third were retired. Two-fifths earned less than $10,000 a year, many living on Social Security and black-lung benefits. They needed help to get their second chance. And they were finally getting it.

WILDER IN SPIRIT than the Susquehanna's North Branch, the West Branch begins near Carrolltown, Pennsylvania. Springwaters dripping down through the stones of an old railroad tunnel run north into the creek that becomes the West Branch. As it heads toward the main stem of the river at Northumberland 240 miles away, it flows through some of the state's finest wilderness.

This is deer-hunting country. And on the night before buck season opens, the roads leading into state forestland north of the town of Lock Haven are crowded with pickup trucks loaded with hunters.

"Take a look at those coats hanging outside that camp," said lumberman Jim Maguire as we bounced down a dirt back road past a brightly lit cabin. "That's so they'll smell like outdoors instead of indoors in the morning. Those are serious hunters, I'd say. They've probably been washing with deer soap for the past few days, and then tomorrow they'll rub doe urine on their boots and clothes to mask their scent even more."

Bob Jacobs was serving turkey dinner to his two sons and four friends when we arrived at the Buckhorn hunting camp. "My wife doesn't understand this part," said Maguire as he helped himself to more potatoes. "I come out here for wholesome exercise, and I go back home ten pounds heavier."

It was raining at dawn, a chilling drizzle just this side of snow, when Jim pulled on a bright orange plastic rain suit over his coveralls and slogged off into the woods. "If we were a real gung ho bunch, we might be trying a drive this morning," he said. That's when three or four hunters whistle and holler to scare deer toward a waiting rifleman. "But in a miserable rain like this most guys would rather just wait under a tree."

We heard a few rifle shots as we moved through the rhododendrons and mountain laurel, and we saw scratches in the dirt where a buck had marked his territory. But we found no deer this morning. And when we got back to the cabin, it was good to see "Wimp" Beach rolling dough with a bourbon bottle for a fresh batch of sticky buns.

A rowdy breed of rivermen descended on Lock Haven town after 1835, when the West Branch Canal was completed. People who lived along the canal considered them "boisterous drunkards, brawlers, thieves, and despoilers of decent women." Their 80-foot canalboats boasted names like *Wild Irishman*, *Mountain Boy*, and *Farmer's Daughter*. But they also brought prosperity

to the region by linking it to the river's main stem 73 miles away.

Today the spirit of those river rats lives on in the stern-wheelers of the Millersburg Ferry, the *Falcon* and *Roaring Bull*, two of the last working boats on the Susquehanna. "These babies are homemade. This is grandfather-day technology," said Jack Dillman as we warmed ourselves by a wood stove in the *Roaring Bull*'s cabin. "This engine came from a 1948 Ford flathead six," he said. "It has a 1978 Paragon marine transmission, a drive shaft from an old Ford school bus, and a differential from a 1949 Ford truck."

Jack has operated this ferry for the past 17 years. When he was a young man he worked on steamboats dredging loose coal from the river bottom, coal washed downstream from the mines. Now Jack, with help from his wife, Betty, runs the stern-wheelers from March to December. The last ferry in operation on the Susquehanna, it carries automobiles and passengers about a mile across the river between Millersburg and Perry County.

"The river here is a creature of moods," Jack said. "In the winter it may be snowing outside and the islands are white like in a postcard. Then in the summer there's boating at dusk when everything's in shadow. You only have to get out six feet, and you're already in your own little world."

But when the wind blows, watch out. The ferry skids around like a car on ice because its bottom is completely flat. "We stop running if we see bad weather coming," Jack said. "But we don't always make it. On Ascension Day in 1982 I had to take 11 Mennonite buggies and wagons across the river from Millersburg. I got the first six across fine. But when I came back and got five more, a thunderstorm caught me in the middle of the river.

"It was thundering with lightning and the works, and the wind blew us right up against the dam," Jack told me. The Susquehanna here would normally be only a few inches deep if not for a small dam that backs up two to three feet of water for the ferry to operate. "So there I was with three buggies, two wagons, seven horses, and a bunch of Mennonite boys waiting for it all to go away. Fortunately the boys and the horses all took this in stride. All except for one horse, that is. You can still see his teeth marks on the rail."

NOTHING WAS TOO GOOD for Pennsylvania's new capitol in Harrisburg when it was built at the turn of the century. The soaring dome was patterned after St. Peter's Basilica in Rome. The Italian-marble staircase was inspired by the Paris Opera House. The ceilings were gilded and the floors covered in red tiles inlaid with scenes of Pennsylvania life. When the magnificent structure was dedicated in 1906, President Theodore Roosevelt was on hand to do the honors.

Investigators quickly discovered, however, that the new statehouse was also a monument to graft. Of 13 million dollars spent on the project, only 4 million dollars had been used for construction. The rest had gone into lavish furnishings, most of which carried inflated price tags. A $40 mahogany table had been purchased for $1,472. A $278 filing cabinet had cost $2,470. Chandeliers loaded with lead were bought by the pound. Desks went by the cubic foot.

The major contractor and 13 others were indicted in the scandal, but only 1.5 million dollars was ever recovered. Still, it's a magnificent building. Together with the 65-acre Capitol Complex of state office buildings it dominates the skyline just as the state government dominates the city's economy.

"We used to have three industries here: railroads, steel, and government," said Pete Wambach, Sr., a seasoned Harrisburg observer. "Now it's mainly state government. It's our factory. We raise our kids to work in it. Everything else surrounds it."

"The local economy has turned inside out over the past 60 years," said Paul Beers, associate editor of the *Patriot-News*. "We used to have 15,000 steelworkers and 18,000 railroad workers. At one point 400 trains a day were coming through the city. Now there are 3,600 steelworkers, 18,000 truckers, and 40,000 government employees."

Politics is the language spoken at Catalano's, a restaurant on the Susquehanna frequented by legislators, lobbyists, and lawyers. "More laws are passed in here than over the planning table," said owner Vince Catalano, who rose from a circle of friends to

A river of rail *spreads across Conrail's switchyard at Enola* ***(above)****, where 3,000 cars a day are routed to their proper destinations. The largest rail yard in the world when it was built in 1933, the 4.5-mile-long facility near Harrisburg is the second largest in Pennsylvania after one in Pittsburgh.*

The dome of the state capitol ***(left)*** *overlooks a quiet morning*

on the Susquehanna, the dividing line between economically troubled Harrisburg and growing suburbs to the west.

*At the Bethlehem Steel mill in nearby Steelton, Ren Miller (**right**) waits for rotary blades to cut lengths of new railroad rail. Completed in 1867, the plant was the nation's first built specifically to make steel.*

greet me. Photographs of Vince and his family line the walls around the bar. "I try to make sure the right people meet the right people," he said. "I try to keep up on who's who and what they're trying to do."

The golden age of wheeling and dealing, however, passed away with the decline of the big party machines. Republican organizers in Harrisburg were so strong in 1947 that one ward leader turned out 102 percent of the registered voters in his area for a local election. That same voting district was the only black neighborhood in America to go for Barry Goldwater in 1964.

Harrisburg has suffered from depressing urban problems in recent years: a 20 percent decline in population since 1970 as many whites moved to the suburbs; a relatively high crime rate; a shrinking tax base to pay for city services.

"This is a town that heard so many negative things said about it that we began to believe them," said Mayor Stephen R. Reed. "But now we're on the rebound. We're regaining our self-confidence."

Reed wants to see this city of 53,000 take more advantage of the river as it fights for a fresh start. "We own all the waterfront and nearby islands in the Susquehanna, and there's no reason why we couldn't create a place for shops and restaurants, for the performing arts or minor-league baseball or perhaps even a theme park," he said. The city has also been studying the idea of raising the water level to permit more sailing, boating, and waterskiing in the summer, when the river normally becomes too shallow.

"I see a major back-to-the-city movement now," said the mayor. "Our worst days are behind us."

The steely eyes *of assistant coach Joe Yetter* **(above)** *help forge champion high-school football players in Steelton, a hard-nosed Susquehanna mill town on the outskirts of Harrisburg. In the aftermath of a victory, cheerleader Trisha Parthemore* **(facing page)** *shares a moment with player Jim Mohn as he gives thanks in prayer.*

TAKING A TURN for the better, the Bethlehem Steel mill at Steelton was modernized in 1983 to make high-quality railroad rails faster. Completed in 1867, it was the nation's first plant designed specifically for steel and produced the first steel rails in the U. S. Today, stretching almost four miles along the Susquehanna, the mill still looks much as it did decades ago: a place of darkness and fire where strong men wrestle with elemental forces.

Smoke billows toward the rafters from huge furnaces. Molten metal boils and heaves like lava. Sparks fly from giant blades that cut red-hot rails. The smell of hot metal fills the air. "That man there is six foot six and weighs 330 pounds," a company man told me as we passed by one steelworker. "And the rest of the guys call him Tiny."

About a third of the workers in the plant live right here in Steelton, a small town with a big reputation. Since 1894 its high-school football team has won more games than all


BARBER
SHOP

but three other high schools in the nation. Yet with only 175 boys in the upper grades, it ranks 87th in size of 97 in its district.

"It's the whole steel-mill-town thing, the hardheadedness," said Jim Deibler, the team's coach. "We've got tough kids. They're used to it." The players who molded this tradition came from immigrant families attracted by the steel mill in the early 1900s. They were Irish, Germans, Italians, Slovenians, Croatians, Hungarians, Bulgarians, Macedonians, Serbians, and blacks from the South. The abundance of ethnic neighborhood bars and churches in town today reflects the presence of their descendants.

"It seemed like everybody worked at the mill when I was a kid," said John Beck, the school's director of men's athletics. "At lunchtime the women used to send the children down with hot meals for the men."

When I caught up with the Steel-High Steamrollers, they were playing the final game of the season. With eight seconds left on the clock, they were getting ready to try a field goal. If it went through the uprights, they'd win the championship. A parade would be held after the game—win or lose—and the team would ride through Steelton on fire engines. A lot was riding on that kick.

With eight seconds left, the center snapped the ball. The quarterback placed it. And the young Steel-High kicker sent it straight through the uprights.

WHEN THE SIRENS went off, I was sipping coffee at the 7-Eleven store in Middletown. The sound was heard in every community within ten miles of the Three Mile Island (TMI) nuclear power plant. A voice came on the radio's Emergency Broadcasting System saying it was only part of a drill. "There is no emergency. No action should be taken."

Like an awesome crippled giant in the middle of the Susquehanna, the nuclear plant has not operated since the accident on March 28, 1979. But a drill has been held

In no hurry *for his haircut, a patron browses through a newspaper in Steelton. Things never change much on the main street of town, which faces the steel mill and the Susquehanna River.*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Silent giants *of the Susquehanna, the cooling towers of Three Mile Island* ***(above)*** *look down on Goldsboro, Pennsylvania. The nuclear power plant has been quiet since March 28, 1979, when the nation's worst commercial nuclear accident crippled the newer of its two reactors, seen at right center. A decision by the Nuclear Regulatory Commission is expected this year on whether or not to allow the restarting of the older reactor. Maryland scientists near the river's mouth* ***(left)*** *take bottom samples to study the effects of radioactive discharges into the Susquehanna from Three Mile Island and Peach Bottom nuclear power plants.*

every year since then to test the reactions of power company staff and local officials to a similar crisis. This time state police took positions along evacuation routes. Red Cross workers checked supplies of cots and blankets. Agricultural scientists stood by to test milk supplies for radioactivity.

What really happened here six years ago? First, a pressure relief valve stuck open in Unit 2, the newer of TMI's two plants. For two and a half hours 21,000 gallons of radioactive water gushed into the basement of the reactor building; eventually nearly a million gallons from leaks and other sources accumulated in this building and the one next door. Second, plant operators, misled by inaccurate instrument readings, allowed the reactor to lose much of its cooling blanket of water. As a result, it seriously overheated in what could have become—but didn't—a potentially dangerous meltdown of the radioactive core.

The core, however, was ruined. A video camera lowered into the crippled reactor in 1982 revealed a five-foot hole in the center of the 100 tons of uranium fuel. Mangled pieces of fuel assemblies littered the bottom of the hole. Examination of particles from the debris later revealed that at least some of the fuel had come within 280°F of melting,

With designs on winning, *horse breeders Ron and Laura Kohr raise world-class trotters at Lauxmont Farms, an elegant 1,400-acre spread along the Susquehanna near Wrightsville, Pennsylvania. Seven stallion paddocks radiate from the stables,*

much closer than anyone had suspected.

GPU Nuclear Corporation estimates it will cost a billion dollars to complete the cleanup by 1988, after which it will be decided whether to decommission Unit 2 or try to repair it. In the meantime, GPU Nuclear wants to restart Unit 1, which was not involved in the accident. It costs 168 million dollars a year to buy replacement power while Unit 1 stands idle.

There have been many complications, however. About 95 million dollars' worth of changes had to be made to Unit 1's control room and emergency systems as a result of lessons learned from the accident. Also 45 million dollars' worth of repairs had to be made to 31,000 tiny tubes in the steam generators of Unit 1 when corrosion raised the possibility of dangerous leaks.

But more important, perhaps, the power company has not yet regained the confidence of the people who live nearby. A 1982 referendum showed that an overwhelming majority of voters in three counties did not want Unit 1 to start up again.

"People are very conservative here, but they have come to feel that they have too little control over their lives," said Louise Bradford, a part-time waitress from Harrisburg who works for the antinuclear group

each separated from the others to prevent friction among the heady horses. The river passes through Pennsylvania Dutch country here and the orderly, efficient farms of Amish and Mennonite families.

TMI Alert. "This is not a candy store we've got here. This is dangerous stuff."

ELECTRICITY HUMMED in the forest of wires overhead as we stood on the roof of the Conowingo hydroelectric station in Maryland, nine miles northwest of the river's mouth. The building vibrated from the turbines below. Mark Smith lit a cigarette as he leaned on the railing. The former turbine operator was enjoying the November sunshine and the chance to talk about the Susquehanna.

"There's good fishing down there," he said. "In the summertime, fishermen are elbow to elbow along that catwalk. There's catfish, walleye, even rockfish out there."

When Conowingo was completed in 1928, it was the second largest hydroelectric station in the country. Its cathedral-like windows bathed its original seven generators in light, creating the very image of high technology. Today it's one of 18 power plants in the Susquehanna basin—five hydroelectric, ten fossil fuel, three nuclear.

The water that churns out from beneath the station's turbines carries with it tons of small fish for the gulls. Squawking and carrying on around the dam, thousands of the birds fill the air with life.

But the water also carries nutrients and toxic materials from the Susquehanna's

27,570 square miles of drainage. And scientists say these ingredients are killing parts of Chesapeake Bay, into which the river flows.

The Susquehanna provides the Chesapeake with half the bay's fresh water—about 19 million gallons a minute—the largest discharge of any river on the Atlantic except Canada's St. Lawrence. Yet it also provides two-fifths of the nitrogen and one-fifth of the phosphorus that are "over-enriching" the bay's waters.

An excess of these nutrients has caused harmful blooms of algae that choke out underwater grasses by obscuring sunlight. Decomposing algae on the bay floor consume oxygen needed by fish, crabs, and other creatures to survive. Nitrogen and phosphorus, both used in fertilizers, come mainly from cropland runoff, although sewage treatment plants also contribute phosphorus. To cut down on such unwanted nutrients, federal officials over the next four years plan to add 40 million dollars to programs in Pennsylvania, Maryland, Virginia and the District of Columbia. They want to give the bay another chance.

A *STRANGE* thing was happening down by the river. The swirling white cloud of gulls below the dam was parting as two large brown newcomers glided in among them.

"Those are juvenile bald eagles," said Robert Schutsky as he looked up from a small telescope by the riverbank. "I've been studying them for the power company."

Out on a rock in the middle of the river a mottled brown juvenile was pulling apart a fish as I peered through the telescope. I was surprised to realize that two small black birds standing nearby were actually large crows dwarfed by the eagle.

"Most people think of bald eagles as living among the mountains out west. But there are lots of them in this part of the country too," Schutsky said. "I saw 11 here last Wednesday." The birds nearly disappeared not so long ago because of pesticides, hunting, and loss of habitat, but the Susquehanna holds great promise again as a nesting ground for eagles. With its broad expanse and long reaches of quiet forests, it has just the right combination of shelter, food, and solitude. "We see more of them here today than we've seen in a decade. A lot of people who know both the birds and the river well are very optimistic."

That's the way it is with the Susquehanna. It draws you back. Through good times and bad, it carries the promise of another day. To the eagles today it offers what it's given to so many others in the past. A new opportunity. A chance for a fresh start. □

Neither fish nor fowl *will elude Ted Krolick, who carries a gun while fishing in case a duck wings by. Leave it to the Susquehanna, river of second chances, to bring out a fellow's resourcefulness.*

Miniature Horses

By R. L. BLAKELY

Photographs by THOMAS NEBBIA

Every inch a healthy horse, *though only 16 inches high, a 24-pound newborn colt* ***(facing page)*** *finds his legs on his trainer's arms. Officially, mature miniature horses can be no more than 34 inches at the base of the mane. A year-old stallion shod in infant sneakers* ***(above)*** *will probably not top 30 inches, but as pets and investments such lilliputian horses stand tall.*

THE LURE of the outdoors had been too strong that summer afternoon, and I puttered around the yard. My miniature horses, Little Man, the stallion, and Tina, the mare, stood at the pasture fence, the picture of dejection. Sad eyes watched my every move. Tina uttered a long, shuddering sigh, and Little Man's head drooped.

I knew this routine by heart—it's the same ploy your dog uses at your dinner table, the "poor little neglected me" routine. Despite all arguments for a balanced diet of hay and horse feed, I uttered my own sigh and fetched the Ritz crackers, aware that, to the horses, I have only two speeds when distributing treats—too slow and not fast enough.

Little Man stopped abruptly in midcracker. His head jerked up. He froze. Then he galloped across the pasture. From a clump of black locust trees, a horse and rider were heading up our driveway.

Little Man uttered a screaming whinny. Challenged by a stallion, the intruder stopped, snorted, reared, and tore back down the driveway as if his life depended on it. Little matter that his challenger weighed a scant 200 pounds and could have galloped right under him. The resident stallion had told him to "Git!" and he was "gittin'," his rider desperately hanging on to the pommel.

Little Man, stopped by the far fence, stood tossing his head, snorting, pawing the earth in frustration. Tina now pushed her velvety muzzle at me as if to say, "Well, that's taken care of. It was stallions' work anyway and not our concern, and may I have another cracker please?"

That's the way it is with most miniature animals. Whether called dwarfs, toys, bantams, or miniatures, they seem to see themselves as full-size. A bantam rooster is as cocky as any Rhode Island Red; dwarf goats will butt heads no matter the size of their opponents; Netherland Dwarf Rabbits are as feisty as rabbits get. Even a Chihuahua will bare a tooth at an intruding Great Dane.

In turn, full-size animals generally react as if the little ones matched them in stature. Good horse manners prompted that intruder's hasty exit from Little Man's territory.

Miniature horses are horses first, miniatures second. They come in all horse colors, and currently in two general varieties—a

sturdy draft-horse type and a more elegant fine-boned type. In time we may have all the major breeds in miniature form. If you were to see a photograph of a very good mini, with nothing to show scale, you would find it hard to tell that the animal was not full-size. Yet miniature horses have an appeal all their own and are now riding a crest of popularity.

The American Miniature Horse Association in Burleson, Texas, the largest registration organization, lists more than 7,000 minis. And that number grows by a hundred or so new registrations each month.

"You should see horse-show visitors crowding around the minis—like flies coming to honey," registrar Barbara Ashby told me. I recalled a photo of Barbara seated in a chair with a foal asleep on her lap. First fascinated by their size, most people become

R. L. Blakely is director of the Sedgwick County Zoo, Wichita, Kansas. **Thomas Nebbia**'s photographs have appeared frequently in the GEOGRAPHIC since 1959.

Precious cargo, *four-month-old Little Hot Stuff (**above**) flies to a show with her award-winning breeder, Sister Mary Bernadette Muller, a vicaress of the Order of St. Clare in Corpus Christi, Texas. Her contemplative monastery supports itself in part by raising miniature horses, most of which sell for about $3,500. But exceptional Little Hot Shot (**right**) brought $17,500 and his sire $30,000.*

charmed by their friendly, confident nature.

Horses shorter than 14½ hands (58 inches) at the withers (top of the shoulders) are technically ponies. The Shetland, around 43 inches tall, is called a pony, not a miniature. Miniatures start nine inches shorter, and prices go up as size goes down.

"For a mature animal 32 to 34 inches you could expect to pay $1,000 and up; 30 to 32 inches, at least $5,000; 30 inches or less, probably $10,000 or more," Jack Gerhart, AMHA's former president, told me. "In the East, add perhaps another $1,000." That's pretty expensive just to have something cute grazing in the backyard. Many miniatures, however, are bought for breeding, as an investment.

"What advice would you give those starting out?" my wife, Jane, and I asked breeders from California to the Carolinas. Joan Embery, mini-horse breeder, television personality, and goodwill ambassador for the San Diego Zoo, spoke for all: First, be well informed.

"Read everything you can about horses, talk to breeders, as many as possible, and find a good veterinarian. Mini care is basically the same as for any horse.

"Too often people make an emotional choice, purchasing a young animal because it's so cute. It's wiser to buy a mature animal so you know what size you are getting. An excess inch or two can turn a $4,000 'mini' foal into a $400 adult."

No taller than a Great Dane, *champion mare Silver Dollar lounges with breeder Rayford Ely* (**facing page**)*, who founded the World-Wide Miniature Horse Association. "But you can't housebreak minis any more than a full-size horse," cautions Ely. Declared a "city treasure" of Oakland, California, his minis bring cheer to nursing homes* (**above**).

DRIVING through soft green pine forests northeast from Atlanta, we came to a white house at Lavonia, Georgia, comfortable in a shady grove behind its board fence, a venerable magnolia beside its screened porch. In the adjacent pasture tiny heads popped up from their grazing. I spotted a little buckskin mare—my favorite color, tan with dark mane and tail. We were at the home of Bond's miniature horses.

Moody and Lucy Bond have been breeding minis for 40 years. It started as a hobby, "to see how small we could breed horses and still maintain good conformation."

Not easy. Some miniatures "look like sausages," legs short in proportion to their heads and bodies. Ideally, body length should about equal height. How do the Bonds achieve their goal?

"Trial and error—lots of it," said Lucy. Attesting to their success is her estimate that more than a thousand of the minis in this country are descended from their stock. This puts them in a class with the Falabella family of Argentina, ranchers and longtime horse breeders whose world-famed minis have contributed to many bloodlines.

When interest in miniature horses began to boom in the early 1970s, mail arrived at Lavonia from all over the world. Visitors included Malaysian Prince Mahmood Iskandar from the state of Johore. The Bonds, who had retired from their chicken business when the price of fryers fell to nine cents a pound, now also retired from their farm-supply business. They converted the long, low chicken house to stable some 100 horses.

Putting on his battered planter's hat, Moody invited us to follow his pickup there.

Inside, the first to greet us was a shiny black stallion with arched neck and tossing head, 27½ inches tall. Tiny steeds crowded around, giving us a going over with inquisitive muzzles. Five youngsters raced back and forth along the barn's center corridor, having more fun than a boxful of kittens.

"What good are they?" snorts Moody when anyone pops that frequent question. "What good's a diamond ring?"

The first to greet us at Van 't Huttenest Miniature Horse Farm in the Great Smoky Mountains in North Carolina was a Bouvier des Flandres, a Flemish farm-dog breed. Bounding effortlessly over a chest-high

fence, she gave us a perfunctory sniff and, duty done, departed.

In 1974 Mark Verhaeghe came here from his native Belgium with 39 of his miniature horses. His fascination with miniature creatures showed in his farm: scores of miniature asses, zebu cattle, goats, bantam chickens. Only the feed bills were full-size.

"With Europe's limited farm space you may have enough room to keep a riding horse," Mark said. "On that same pasture you could breed several minis."

Some of his horses can be traced back to the herd of two English sisters, both titled Lady Hope, who began to breed miniatures in the 1860s. Small horses seem to have occurred occasionally throughout history, though many stories over the past 300 years go undocumented. We know that horses small enough to pull carts in mine shafts worked in Europe's coal mines. The Ladies Hope gave the tiny equines class. Alas, the secret of what stock they used died with them.

Wendy Hall, a trainer from Asheville, joined us in the Verhaeghe kitchen. I asked how minis compared with others in trainability.

"That depends upon how they've been raised," she told me. "If they're raised as family pets—and probably most of them are—they're very responsive and therefore rather easy to train."

The Verhaeghes pastured some 50 brood mares together with a herd of miniature zebu cows. The cows stood and stared at us in their wide-eyed, vacant, bovine way. The mares, each heavy with foal, pressed close, "friendlier than a wet bird dog," as Jane put it.

IN FACT, people who've had bad experiences with Shetland ponies often comment that minis seem much sweeter tempered. I asked Dixie Blasingame, who has raised both on her Shadow Oaks Ranch near Vista, California, why that was so. "Some Shetlands are just plain nasty," she admitted. "But they're not born bad. They become that way when they're turned over to children too young to care for any pet. That doesn't often happen with minis—perhaps because they're so expensive."

Minis not only like people, they help them. Dr. Ronald Martens, a veterinarian at Texas A & M University, studies infectious diseases such as pneumonia in foals. He uses miniatures for his research because they're easier to manage and less expensive to feed than full-size horses.

Sister Mary Bernadette Muller of the Order of St. Clare in Corpus Christi, Texas, candidly declares that her herd of minis helps support her monastery. "We had a sad-looking 20-acre field that needed something. Miniature horses were just the thing," she explained. The order took out a loan, built a stable, started with a single stallion and 15 mares. Now they're selling as many as ten minis a year.

She told of one family, each member having a different reason for wanting a miniature. The son wished to breed it, the daughter sought a pet, the mother wanted to use it for driving, and the father was looking for a company mascot for his radio station. "A miniature is everybody's horse."

Eye-catching in local parades, the monastery's horses pull carts and sulkies. "Even a relatively inexperienced person can handle them," Sister Bernadette says.

In Oakland, California, Rayford Ely's minis spread cheer in nursing homes to great therapeutic effect and take part in civic events. Oakland, giving special dispensation for a horse farm within the city limits, considers these minis a "city treasure."

MANY VOICE CONCERN that currently there are a number of miniature horse registries in the United States, pointing to the dog world where the American Kennel Club is virtually the only register of dogs. Or to Canada's single official registry, the Canadian National Livestock Records. Rayford Ely, founder of the World-Wide Miniature Horse Association, believes there should be two—one to register all minis and one for the "Rolls-Royces" of miniature horsedom. While other registries set a maximum of 34 inches, the WWMHA will accept only horses 32 inches or under. Horses 30 inches and under get gold-seal certificates; those between 30 and 32 inches, silver.

In Ely's Horse Hotel three-time world champion Arabian King, 28 inches tall, and others in Ray's elite herd dwell in stalls hung

with framed pictures. Not horse pictures but landscapes, as in your living room.

Ray is optimistic that owners simply in it for the money will be eclipsed in time by sincere, knowledgeable breeders. "Right now the organizations need to provide high standards and leadership. If we watch conformation as well as size and color, the mini will remain popular. It's really very simple—no funny-looking horses."

Inbreeding, often blamed for poor proportions by those who don't understand the process, is merely a way to produce individuals with the same characteristics. If you inbreed individuals with desirable qualities, you tend to stabilize these; if you start with poor stock, you'll get those "funny-looking" horses. At Texas A & M University, geneticist Nat M. Kieffer told me: "The secret to good end results is that you must cull—remove from your breeding stock those animals that don't exhibit the traits you desire.

"The Thoroughbred," Dr. Kieffer went on, "traces back to three stallions and perhaps 50 mares. They were intensely inbred. All Morgan horses trace their ancestry from a Vermont stallion named Justin Morgan."

BACK HOME IN KANSAS I pondered myths I'd heard over the years about the origin of miniature horses. One story has it that the little horses were found stranded in some box canyon, where years of short rations had reduced them to today's size. This imaginary canyon is variously reputed to be in Argentina or Australia or the southwestern United States.

Perhaps the most persistent fiction is that today's mini is a throwback to eohippus, the "dawn-horse" of the Eocene, only 10 to 20 inches tall. Like its relatives, the ancient tapir and rhinoceros, eohippus had four toes on its front feet, three on the rear, and teeth adapted to a forest diet of soft leaves. Eohippus died out about 50 million years ago in both North America and Europe.

Seeing eye to eye with a goose *does not necessarily signal agreement between the bird and high-priced stud Red Man, Jr., of Marion, North Carolina. Some breeders of full-size horses also look askance at the miniatures. Descended chiefly from Shetland ponies, minis were probably first bred in the mid-19th century. Small horses once entertained European royalty and labored in the coal mines of Europe and Appalachia. Today two physiques prevail—a fine-boned variety and a stocky draft-horse type.*

Later ancestral horse types moved from their forest niche out onto the grassy plains. Their teeth had to accommodate to hard siliceous grass. No longer could these protohorses slip away through thick forest when danger threatened. Escape now demanded speed and endurance. Limbs grew longer. Extra toes became vestiges externally not visible.

Fossil records mark this transition over the 50 million years since eohippus. Although the mustangs running wild in our western mountains and plains are descended from domestic horses brought by Spanish explorers, some prehistoric horses might still have survived in North America as recently as 11,000 years ago. Early Americans may have hunted and eaten these horses but did not domesticate them.

The first domesticated horse probably derived about 5,000 years ago from one or more species of wild horses of Eurasia. Today only seven species represent the ancient family Equidae, which comprises all the horses, asses, zebras, and onagers. The only wild true horse is Przewalski's horse of Mongolia and western China. Highly endangered, this species' sole hope for survival seems to lie in established captive herds.

I LOOK OUT over the pasture where Tina and Little Man are grazing. The 22-year-old stallion lifts his head to check his domain with nostril, ear, and eye. Somewhere, a full-size mustang on a western mountainside and a sleek Thoroughbred on a Kentucky stud farm are doing exactly the same thing.

Satisfied, my little stallion arches his neck and trots briskly over to touch noses with his mare. They are miniature only in size, not in spirit. They're all horse—every inch of them. □

Miniature horseplay *pits stallion against stallion on a farm in Horse Shoe, North Carolina. Identical to full-size horses in instinct, gestation, and life span—but easier to manage and cheaper to feed—minis are ideal for equine veterinary research. And they take quickly to training. Four-year-old Chips, at right, has been taught to water-ski.*

HAITI'S VOODOO PILGRIMAGES

Of Spirits and Saints

Article and photographs by CAROLE DEVILLERS

COLORFUL AND NOISY, the crowd snakes along the path through lush vegetation to the sacred waterfalls. In front of me a group of women sings in Haitian Creole, "Jean-Baptiste ô, if it weren't for you, I would be crushed . . . St. Jean-Baptiste, without you they would eat me like a peanut!" Shouts and laughter mingle with prayers and the cawing of crows bustling about in the early morning sun.

Once again, as in each July, *mapou* trees nod in silent witness to a boisterous pilgrimage that brings thousands to Ville Bonheur, a village in the mountainous heart of Haiti, some 60 twisting, potholed miles north of Port-au-Prince, the capital. Ville Bonheur —which means "happiness town"—is also called Saut d'Eau, or "fall of water," after its sacred cascade in which devotees come to bathe (following pages).

The trees stand silent, but not inanimate. According to Haitian folk belief, spirits may reside in them, as well as in waterfalls, springs, and ponds. Trees are considered natural temples by generations of worshipers flocking to this mecca of voodoo.

Voodoo. No, I'm not alluding to zombies—the living dead, raised from the grave to become mindless servants of some sorcerer who has gained evil power over them. Or the pushing of pins into a victim's image.

That is black magic, or its Hollywood stereotype. And while black magic still persists in Haiti and elsewhere, it is not the same as voodoo, which many sociologists and ethnologists now regard as a bona fide religion. True, there are some voodoo priests and priestesses—*oungan* and *mambos*—who "serve with both hands," or practice sorcery as well as voodoo. In fact, the voodoo faithful expect that a priest will be well versed in black magic in order to counteract the malignant plots of others.

Inherited from West Africa, voodoo is essentially a cult of the spirits. Its Creole name, *vodou*, derives from *vodun*, which means "spirit" in the language of the Fon people of Benin and Nigeria, West Africa.

Afro-Haitian belief acknowledges God as *Gran Mèt*, creator of heaven and earth. But the Almighty Master of the universe, too remote to involve Himself with

To ensure good health, *a young pilgrim stands anointed with grain and water by an oungan, or priest, during the spirited festival of Vyèj Mirak, the Virgin of Miracles. Such practices are a part of voodoo, a folk religion that uplifts Haiti's poor with a mix of Christian and African beliefs. In a moving moment of the festival, suppliants rejoice amid the sacred falls at Saut d'Eau* ***(following pages).***

the daily problems of mankind, has delegated spirits to serve as intermediaries. These *loa* are associated with vital forces such as water and fire, love and death. Voodooists "serve" these forces to keep in harmony with them and thereby avert disaster.

Thus, a voodooist will consult the spirits to seek their approval or counsel before engaging in any activity. The opportunity to dance, sing, express themselves, and feel important when a loa comes down to possess them gives people an outlet for distress and relief from despair.

Many outsiders regard voodoo with contempt as a primitive cult having no place in modern civilization. But its followers find in it what people everywhere demand of their religion—solace in their present lives and the anticipation of a better life in the hereafter. And so long as the daily life of most Haitians is a hard one, so long as the people remain fearful of magic spells and evil spirits, voodoo will remain the refuge of the masses—a means of lessening the misery in their lives.

From the mid-1600s African slaves transported to Haiti were forbidden by their French masters to practice their ancestral religion. Forced converts to Roman Catholicism, the slaves never deserted their spirits, but secretly worshiped them in the guise of Catholic saints.

Voodooists do not regard this blending of the two faiths as profaning Christianity, but rather as enriching their voodoo cult. Not so the Catholic Church. In 1941 the church, backed by Haiti's government, began a brutal but short-lived "antisuperstition" campaign. Temples and cult objects were burned and sacred trees cut down in an effort to eradicate voodoo. In vain.

Today nothing shows this synthesis of faiths better than two festivals celebrated in July. To experience them was to immerse myself in sparkling waters and sylvan beauty—also in mud and blood.

THE FIRST FETE, the one at Ville Bonheur, commemorates the apparition of Vyèj Mirak—the Virgin of Miracles, Our Lady of Mount Carmel—atop a palm tree. The emotional response from Catholics and from voodooists—some of whom saw the Virgin as Ezili Freda, the

Possessed by the snake god, *Danbala Wedo, who is believed to inhabit the Saut d'Eau waterfalls, a violently trembling woman is restrained by other worshipers (**facing page**). As another pilgrim is pounded by the falls, it appears to believers that his life force is strengthened (**above**). The July festival commemorates a reported 19th-century sighting of the Virgin Mary atop a palm tree. Some voodooists identify her with Ezili Freda, the loa, or spirit, of love.*

spirit of love—inspired Haiti's most popular pilgrimage.

"It started long before I was born," says local lawyer Stanislas Jeannot, now in his 70s. "My father told me that a man named Fortuné, searching for a lost horse, came to a palm grove. Dazzled by a flash of light, he looked up and saw the Virgin nestled in the palms. He notified the authorities."

Word of the vision spread. Stories were told of the blind and the deaf miraculously restored to sight and hearing. Soon Saut d'Eau became a center of devotion for Christians and voodooists alike.

As pilgrims swarmed in, superstitions multiplied. Food offerings mingled so often with votive candles that the church decided to put a stop to what seemed more like idolatry than Catholic religious fervor. That was during the American occupation, between 1915 and 1934, when U. S. Marines were sent in to restore order in a country wracked by anarchy.

"I was an altar boy at the time," recalls Jeannot. "The French priest at Saut d'Eau asked a couple of marines to help get rid of what he thought to be a mere superstition. They took pistol shots at the vision. It simply moved to another tree. They shot again, yet the vision remained.

"Finally, they had townspeople cut down the grove. As the palms fell, the vision changed into a pigeon and flew away. It never returned."

"Actually," adds another villager, "the pigeon fell into the nearby waterfalls for which Saut d'Eau is named, thereby blessing them. That explains why Catholics also go to the falls—the whole region is a *lieu saint*, or holy place."

Well-worn spirits: *Zaka Mede, patron of agriculture, and other loa adorn a woman's jacket (**above**). A man's costume (**right**) shows possession by a spirit who is thought to give him the power of prophecy. In traffic to and from the falls (**facing page**) a woman carries a jug for sacred water. Although such signs of faith abound, poverty taxes the loa's power with pleas for health or for good harvests.*

THE CELEBRATION of Vyèj Mirak takes place July 16. Long beforehand gaily painted trucks and *tap-taps*, or pickup trucks, emblazoned with *Christ Capable, Don de Dieu* ("gift of God"), or *Merci Vierge Miracles* start unloading pilgrims and vendors by the hundreds. They come from Cap-Haïtien in the north, from Jacmel and Les Cayes in the south, from the Dominican border, even from New York City, Miami, Montreal.

Those fortunate enough to have family in town or to find a room to rent have a roof over their heads. Most sleep under the stars. By sheer good luck I met a teacher who sheltered me in the school.

The days before the Virgin's celebration are unofficially dedicated to the loa. From dawn to sunset pilgrims flow between the town and the waterfalls.

"Men bèt, men bèt!—Watch for the animal!" I quickly draw aside to let people on horseback pass. The half-hour hike to the falls includes a steep, stony climb, exhausting under the hot sun. So locals make a few extra coins renting their horses to cityfolk.

For many pilgrims, however, walking is imperative. *"Map fè jubile mnan*—It is a self-sacrifice," explains a woman carrying her belongings on her head in typical Haitian manner. For some the walk is a hardship ordered by spirits they have somehow offended. These penitents, clad in patchwork clothing and living off alms, travel great distances to visit the pilgrimage site.

At no other time, with the exception of

Carole Devillers reported on the village of Oursi, Upper Volta, and the Wayana Indians of South America in the GEOGRAPHIC's April 1980 and January 1983 issues.

Carnival, will one find such classes and conditions rubbing shoulders: ragged poor, well-to-do bourgeois, beggars, young men out for fun, streetwalkers, Catholic nuns, voodoo priests—all heading to the waterfalls in the name of the Holy Virgin.

Pilgrims make ritual stops at certain trees. A multitude of candles burning on the roots of an imposing ficus tree marked the most important station, consecrated to Legba, loa of communications and master of roads and pathways. Often identified with St. Peter, traditional Christian doorkeeper of heaven, Legba is always the first loa to be invoked in voodoo rites. If not, the other spirits, which he dominates, may not respond.

A STEEP SLOPE brings us to the falls. For long minutes I am lost in awe at the magnificent panorama. In three gleaming waterfalls encased in greenery, the Tombe River plunges more than a hundred feet. Small wonder such a place would be considered a divine sanctuary.

On a promontory overlooking the falls stands a ficus tree surrounded by a hubbub of worship. I make my way toward it. Nobody notices. Eyes fixed on the flames of their homemade candles or looking up into the sky, palms outstretched before them, the worshipers implore with heartbreaking sincerity the benevolence or forgiveness of loa and saints alike.

Peasant metaphors poignantly express down-to-earth problems: "*Manman la Vyèj*, my baby is dead. Give me another! If you answer my prayer, I will be like butter in your frying pan—you may fry me, sauté me, do whatever you wish. . . ." "O Zaka Mede [loa of agriculture], I am the melon, you are the knife. Only you know what's inside me, know I am not bad. Then help bring me good harvests this year!"

After a long monologue one woman falls to her knees and bursts into tears. Clinging to the tree, she cries out, "*Bon Dye Gran Mèt-la*, 'they' want me to return to ashes and dust. But I haven't done anything! What am I to do?"

Despite the exuberance and joy that pervade these pilgrimages, the anguish that emerges reveals a people beset by economic insecurity, disease, and superstitious fear. To better their lot, pilgrims offer eggs, rice and beans, cooked chicken, pleasing to the spirits. Others have oungan or mambos wash them with a mixture of water, corn, cassava, and coffee to remove bad omens. A pregnant woman who has difficulty bearing children gives a few pennies to an oungan to tie a blessed cord around her distended belly. After a designated time she will take it off and attach it to the tree consecrated to the loa she has invoked. I saw dozens of such twisted two-colored strands on trees.

Belief in their magic gives the voodoo priesthood income and social power. By contrast, "leaf doctors"—those who prescribe leaves and herbs to cure ailments—have no special access to the loa.

After devotions it is customary to cleanse oneself by bathing in the falls' icy waters. Shouting and laughing, jumping from rock to rock, all day long a restless crowd, mostly female, romps amid the water's roar.

Some remain dressed. Others don bathing suits. Most strip down to panties.

"Haitian women are modest, always covering their breasts," declares Max Beauvoir, a former biochemist who has become a voodoo priest. "But here I believe we are celebrating a cult to the mother goddess. Women open up and throw themselves in the water as into their mother's bosom."

All around me, people soap themselves, shampoo their hair, rinse under the massive torrents. Mothers bathe babies. Some fill bottles to take the miraculous water home. A woman discards her old clothes in the stream. "*Map kite tout mizè ak tout giyon* —She is throwing away all her bad luck," someone translates. Then the woman puts on new, previously blessed clothes.

Suddenly a woman screams, staggers. Trembling from head to toe, she collapses like a rag doll. The loa has answered her call. People crowd around to prevent her from harming herself on the rocks. Others touch her to share in the divine presence as she crawls down the falls like a snake. "*Danbala ap monte li*—Danbala is riding her!"

A leading voodoo spirit, symbolized by the snake, Danbala Wedo has chosen to reside in this grandiose setting. With him dwells his wife, Aida Wedo; their rainbow symbol gleams through iridescent droplets. Here also dwells Ezili Freda, spirit of love.

The woman possessed by Danbala now

Voices ring in harmony *as Christians and voodooists hail a Madonna and Child, paraded around the town of Ville Bonheur on July 16, a church holiday. Catholic pastors work in vain to end the melding of saints with African spirits brought to Haiti by the voodooists' enslaved forebears.*

becomes the "horse," losing her own personality to take on that of the spirit who rides her. Conceiving each loa to have human characteristics, voodooists can identify the spirit by the behavior of the possessed.

Next morning everyone honors the Virgin. By 9 a.m. believers of both faiths pack the church square. Beggars and hawkers of pious images mix their clamors with the honks of trucks still bringing latecomers. It is nearly impossible for anyone to circulate, except pickpockets. One, I discover, has relieved me of my wallet. Belatedly I find a safe place atop a huge truck christened Butterfly. From here I can view a flood of fervor. *"Ave Maria. . . ." "Manman Mari. . . ."* Thousands of voices in unison take up Catholic and Creole hymns blasted over loudspeakers. The village priest conducts Mass from the church balcony. Afterward a statue of Mary is tenderly handed down and paraded through town.

"Viv la Vyèj! Viv la Vyèj!" Yelling and gesticulating, the crowd surges wildly around the flower-decorated float. The sun shines high in the sky. A glorious day.

"I wouldn't miss this for the world!" a Port-au-Prince resident exults. "Every year

for 30 years I have come to give thanks. Even when I lived in New York, I made a special trip for this fete. I have asked for nothing that the Virgin has not granted me."

NINE DAYS LATER, St. Jacques Majeur—St. James the Greater—brings pilgrims together about 60 miles north of Saut d'Eau, in Plaine du Nord, a village near Cap-Haïtien. Here voodooists immerse themselves in mud instead of water.

Because old lithographs represent St. Jacques on horseback brandishing a sword, he has been assimilated with Ougou Feray, the African god of war, high in the voodoo pantheon.

"Both pilgrimages are cults to life," Max Beauvoir told me. "They are related, first, by natural elements. Water is the element that sustains life, and mud—silt—the element from which life came." Secondly, Max believes, the pilgrimages are related by the loa's affinity: "Ezili Freda is Ougou's mistress, you understand."

Knowing that voodoo celebrations usually precede Christian ones, I arrive in Plaine du Nord several days ahead of St. Jacques' feast day, July 25. Sisters of the Dominican Order kindly put me up.

The place is filling fast. In the village square, the clutter of religious medals, images, candles, and bicolored cords on vendors' wooden stands mixes oddly with plastic shoes, brassieres, chamber pots, kitchen utensils, pipes, and padlocks.

Women with big cooking pots distribute rice and beans to the poor, who rush in and cling to the kettles like bees on a honeypot. Gullible peasants, drawn by games of chance set on tables as shaky as the dealers' scruples, gamble away the little they have.

"All these people are from out of town," the sisters tell me. "Our villagers have gone to other pilgrimages where we won't see them. They know the church condemns superstitious practices."

Trou St. Jacques (St. James's Basin), at the village edge, is a rectangular mud pond spreading across a wide dirt road, leaving only narrow paths skirting its sides. Popular memory has it that the hole started in 1909 when the Gallois River flooded the newly built Centenary Road. Later the pond grew bigger when sand was dug from it for construction of the police station. When rains fail to provide plenty of mud for the festival, pails of water are poured into the basin.

But no shortage this year. What a sight! Boys, glistening with mud from head to toe, crawl around in sheer delight, searching the bottom for coins tossed by pilgrims. Alert to catch some in midair, they eye the crowd pressed around the pond, lighting candles along its banks, addressing prayers and recriminations to Papa Ougou and St. Jacques, pouring into the basin colorful offerings of the loa's favorite food and drink: rice and red beans, meat, rum, red soft drinks, red wine. . . .

Behind them, others sing and dance as three drummers, sweat streaming down their faces, make martyrs of their instruments with raging energy. Hearing the calls of "Lan Ginen"—the voodooists' term for Africa—the dancers work themselves into a trance.

Suddenly a woman cleaves through the throng and hurls herself, fully dressed, into the pond. Possessed by Ougou, she rolls and writhes in the mud, splashing all around her. Others, possessed by the loa, join her. I see an image of the genesis of man as I watch these live clay statues emerge from the silt.

With divinity now dwelling in them, the possessed offer to share their special powers by rubbing bystanders' legs and arms with this curative mud, filling bottles, giving babies a mud bath as a shield against illness, answering questions about the future.

Oungan and mambos, seated on stools by the pond, also give consultations. "There is more to voodoo than religion," Max Beauvoir had told me. "Where licensed physicians number only one to 7,000 inhabitants, and herbal remedies and faith healing prevail, oungan are considered doctors as well

Adding earth to water's purity, *a festival at Plaine du Nord nine days later focuses on a mud pond where pilgrims ritually immerse themselves. Some are possessed by Ougou Feray, loa of war, who is linked with St. James the Greater, a figure traditionally depicted with martial airs—riding a horse and brandishing a sword.*

Tumult of drums and voices *surrounds the pond. Its mud, valued as a curative, fills one bather's bottle (***above***). Youngsters wallow for hours to seek coins tossed in as offerings along with food and drink in Ougou Feray's color, red; his followers, as well, usually wear red. Filled with his power, young women dance in ecstasy (***facing page***).*

*Ougou's role as lover of Ezili Freda, an important spirit at the Ville Bonheur rites, ties the two festivals, some believe. But here at Plaine du Nord, animal sacrifice plays a more prominent part. After a bull is cleaned and perfumed, it is slaughtered by machete (***below***) and offered to Ougou. Celebrants then drink the animal's blood from a gourd. Another rite called* pase poul, *frequently performed as a cure, involves brushing a chicken against a patient's body so it may absorb the malady, then twisting off the fowl's head.*

A number of those attending this Ougou-St. James celebration are outsiders, just as many Plaine du Nord villagers, mindful of their church's strong disapproval, have left for pilgrimages elsewhere.

as priests. Voodoo conditions all aspects of life—economy, moral codes, welfare, medicine, justice."

IN A POPULAR TREATMENT, the *pase poul*—literally, "pass the chicken"—impurities and bad spirits are transferred to a chicken by brushing the patient's body with it. Then the "doctor" grasps the fowl by the neck and whirls it until the head twists off.

I thread through the fervid devotions and chicken whirlings toward a bull being readied for Ougou (page 406). Many voodoo celebrations include animal sacrifice. Today Ougou will receive offerings of several bulls and goats.

As I reach the buttress roots of the tree to which the bull is tied, a possessed woman clings to me, mumbling incomprehensibly. She rubs her sweaty face against mine, caresses me, then goes on her way. "The loa likes you," a man remarks matter-of-factly. Whether or not divine approval had been shown me, I feel accepted by everyone.

After cleansing, perfuming, and powdering the bull to make it agreeable to the loa, an oungan offers it leaves. The bull munches them, signifying the loa has accepted the sacrifice. Hands stretch out to touch the sacred animal and absorb some of its divine nature. A mambo, possessed by Ougou, jumps on its back and bounces in ecstasy, chicken in one hand, candle in the other. The drums beat on, provocative and hypnotizing.

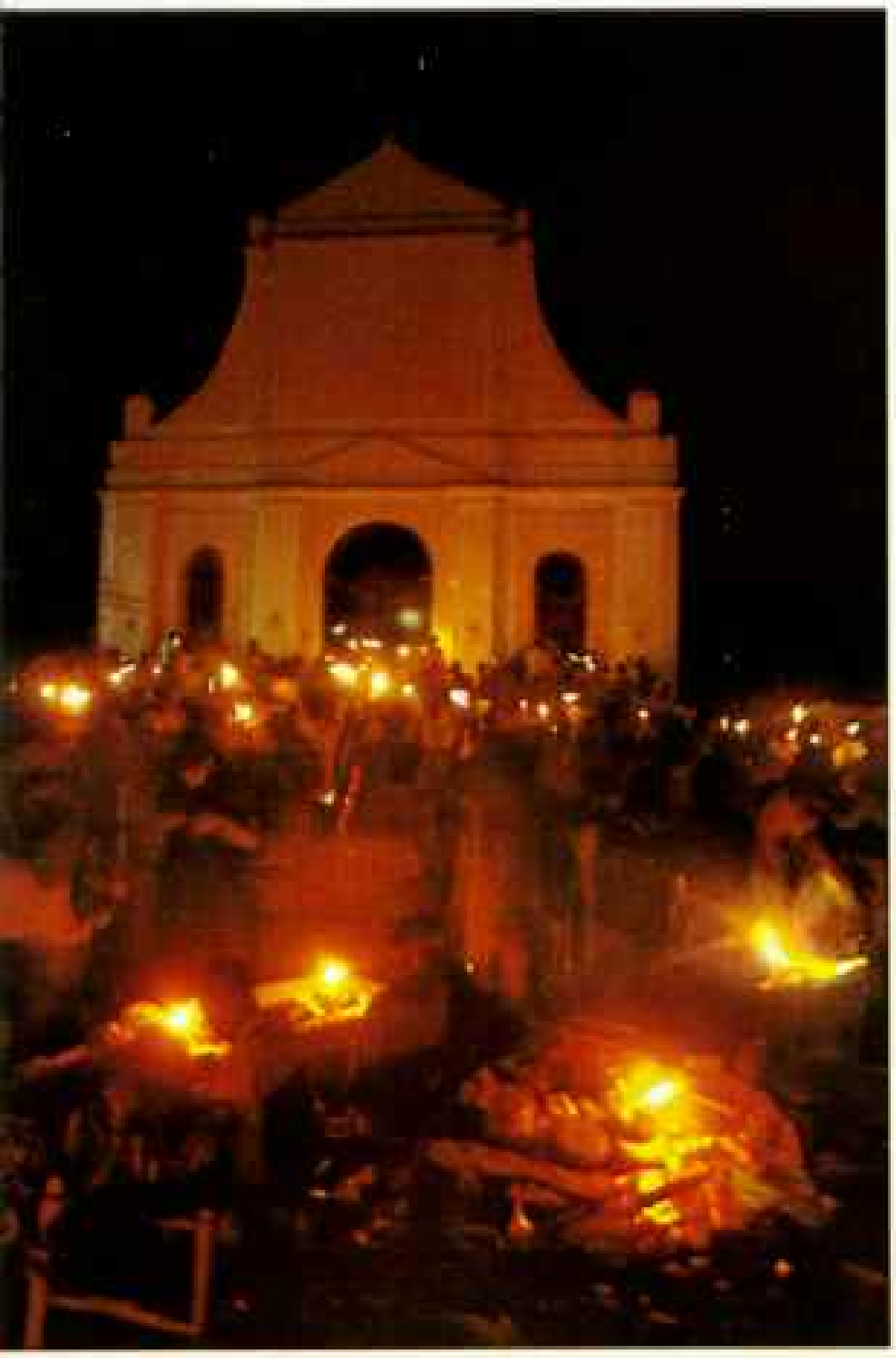
Amid this exaltation, the oungan hacks the bull to death. In dying, the animal transfuses its life force to the loa. Its flesh and blood restore Ougou's divine energy.

This is communicated to celebrants as they drink the bull's warm blood from a calabash passed around by the oungan.

Then it happens! A push when I least expect it. And here I am in mud to my waist in the middle of the pond. I hear hysterical laughter. I turn to see a young woman in red, possessed of Ougou. As someone helps me pull away from this viscous mud, he confirms, "You have been blessed by St. Jacques for the whole year!"

Evening brings St. Jacques' devotees and Ougou's servants to the doorsteps of the closed church. There they pray by the dim light of their votive candles. In the background resound the notes of musicians calling young and old to all-night dancing.

On July 25, the Catholic feast is observed with a simple Mass in church. Many pilgrims have already gone. Others, rallying round local trucks, do not wait for the end of the service but hurry on to Limonade for St. Anne's feast, celebrated on the 26th. There, with the same fervor as for Vyèj Mirak and St. Jacques, they will hail Mary's mother and implore their loa to be kind to them. Until next year. □



Rather than curse the darkness *of a church closed in reproof of idolatry, candlelit pilgrims gather outside to pray to Ougou and St. James on the eve of the Catholic saint's feast. The following morning, July 25, a celebratory Mass finds scant attendance by voodooists, most already drawn away by distant drums.*

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YOUR SOCIETY ON TV

An invitation to celebrate a birthday and a birth

I GROW LESS FOND of birthdays as I accumulate them, but there are a few I welcome, such as the one coming up on March 13, when the Public Broadcasting Service celebrates a full decade of National Geographic TV Specials.

The 90-minute program will show highlights from the 40 Specials produced since 1975, a memorable part of PBS's history as well as our own. Two of them are the most widely viewed programs ever broadcast by PBS; 13 are in the top 25 most watched.

PBS's fund-raising Festival, which runs from March 9 through March 24, underscores the public commitment to maintain quality television. Public Television stations and Gulf Oil Corporation underwrote the commemorative Geographic program especially for this spring's Festival. Commercial television has its "ratings sweeps" months, when its most attractive programs are aired, often competitively, to produce ratings that will attract large advertising dollars. PBS asks viewers to keep its system going. It expects the Geographic "Super-Special," if I may call it that, to air on more than 130 stations and raise more than the million dollars produced by our "Save the Panda," which ran during Festival in 1983.

Since 1975 our Specials have attracted over four and a half million dollars for local PBS stations in viewer pledges.

This is a different but equally satisfying result of the conviction, shared from the first by our production partner, WQED/Pittsburgh, and our underwriter, Gulf Oil (now part of Chevron), that large numbers of the American public want and will support good programming. The pledges that come to local stations are genuine votes of confidence and support. We are delighted to be a major part of this year's Festival.

Watching the rough cut of this unfolding chronicle of the past decade was a moving experience. Old friends of ours like Louis and Richard Leakey, Jane Goodall, Valerie and Ron Taylor, and Carol and David Hughes recall the exciting search for early man and some of the most stunning wildlife, undersea, and exploration photography ever made. Who can forget Jane joining the chimpanzee group for the first time, or Dian Fossey with a favorite gorilla friend, Digit, and the dreadful moment when his corpse is carried into camp? Or the moment of exhilaration when a deaf woman hears for the first time? The PBS audience exulted in that moment ten years ago and will again.

The unforgettable scene in the Hall of Military Glory at Volgograd, the lion attack at a water hole in Etosha, the finding of Spanish gold off the Marquesas Keys, sporting with gray whales in a Baja California lagoon—a thousand images of the natural world and the world of man's imagination unfold in a video diary that still spellbinds.

The celebration on PBS comes at an appropriate time for us for another reason: Next month our Society launches its first venture on cable television, when National Geographic Explorer premieres on the Nickelodeon basic cable network. Explorer will be transmitted weekly via satellite to some 3,850 cable systems and more than 25 million households across the U. S. We intend to bring the same quality and excitement to cable as have marked our decade of PBS programming—with the same conviction that viewers are entitled to something better than the least common denominator.

Gilbert M. Grosvenor

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY

THE PFIZER HEALTHCARE SERIES

Arthritis pain? You *can* get help.

Medical experience has shown that people with arthritis can benefit greatly from proper treatment. Unfortunately, many of the almost 40 million Americans with this sometimes disabling disease fail to seek the advice of their doctors. That's a shame, because much *can* be done to ease the pain and inconvenience that you may be living with daily.

Recognizing arthritis in its early stages is important.

The signs of arthritis are easy to spot. There is usually some swelling and/or redness, but the main tipoff is pain. You may feel it in one or more joints of the hand, or in your wrists, elbows, knees or shoulders. Typical symptoms also include early morning stiffness or aches, difficulty in movement or bending, and tenderness around the affected area.

Arthritis is found in people of all age groups, from children to the elderly. Of the over 100 forms known today, the two most common are *osteoarthritis* (usually associated with aging) and *rheumatoid* arthritis (often the most debilitating kind). Both forms are more prevalent in women than in men. Their causes, as well as cures, are at present unknown.

Quack treatments—they can cost you more than money.

Ever since the first man or woman felt the pain of arthritis, someone has claimed to have a "miraculous cure" for the disease. Unfortunately, these and other so-called "miracle" treatments *cannot* cure or even help your arthritis. They often do result in a waste of money, and more importantly, a delay in proper treatment that *can* help.

Your doctor's treatment—still the best treatment.

Modern treatment for arthritis has come a long way. A range of advanced therapies, including new medicines, is being used to lessen the pain while increasing your activities. Today there are drugs available which are not only very effective, but can also reduce the number of doses previously needed to as little as one per day. A personally tailored program of exercise and rest is often used to strengthen joints and help them keep moving smoothly. Your doctor can also instruct you on ways to help yourself at home (hot baths, massage).

Arthritis *can* be helped. And while it's you who must take that first step in seeking treatment, it's important to remember that your physician, along with other health professionals, is there as part of the overall health support system. We call it...

Partners in Healthcare:

You are the most important partner.

Only you can make the decision to see your doctor. It is you who must decide to accept the guidance and counseling of your physician and other healthcare professionals. When medicines are prescribed, only you can take them as directed.

Your doctor interprets the warning signs, orders your tests, and makes the diagnosis.

Along with the proper program of rest and exercise, your physician also prescribes the best medication for you among those available—considering each drug's characteristics—and monitors your progress.

All those who discover, develop, and distribute medicines complete the partnership.

Pfizer's ongoing research brings you essential medicines for a wide range of diseases. Through development of these and many other medications, along with providing important healthcare information, we are fulfilling our responsibility as one of your partners in healthcare.

For additional information on arthritis, please contact your local Arthritis Foundation Chapter.

For reprints of this Healthcare Series, please write: Pfizer Pharmaceuticals, Post Office Box 3852AR3, Grand Central Station, New York, NY 10163

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Photographed by Wendell Metzen. ***Florida Panther:*** *Genus: Felis Species: concolor Subspecies: coryi* ***Adult size:*** *Total length including tail 1.8—2.1m* ***Adult weight:*** *27—59kg* ***Habitat:*** *Mixed swamp forests in southern Florida* ***Surviving number:*** *Estimated at about 20 to 30*

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

The Florida panther or puma has been called a symbol of the wilderness that still remains today. Survivors of a population that once roamed much of the southeastern United States, these big cats blend naturally with the trees and grasses of the wetlands, and stay as far away as possible from people, making any sighting quite rare. Today, these sleek and graceful-moving predators are in imminent danger of extinction.

The Florida panther could never be brought back should it vanish completely. And while photography can record it for posterity, more importantly photography can help save it and the rest of wildlife.

Photography can contribute to the study of the panther and the protection of its habitat, both of which are needed for the animal's future survival. Photography can also serve as a vital educational tool, helping to promote a better understanding of not only the panther but the vanishing wilderness it represents.

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

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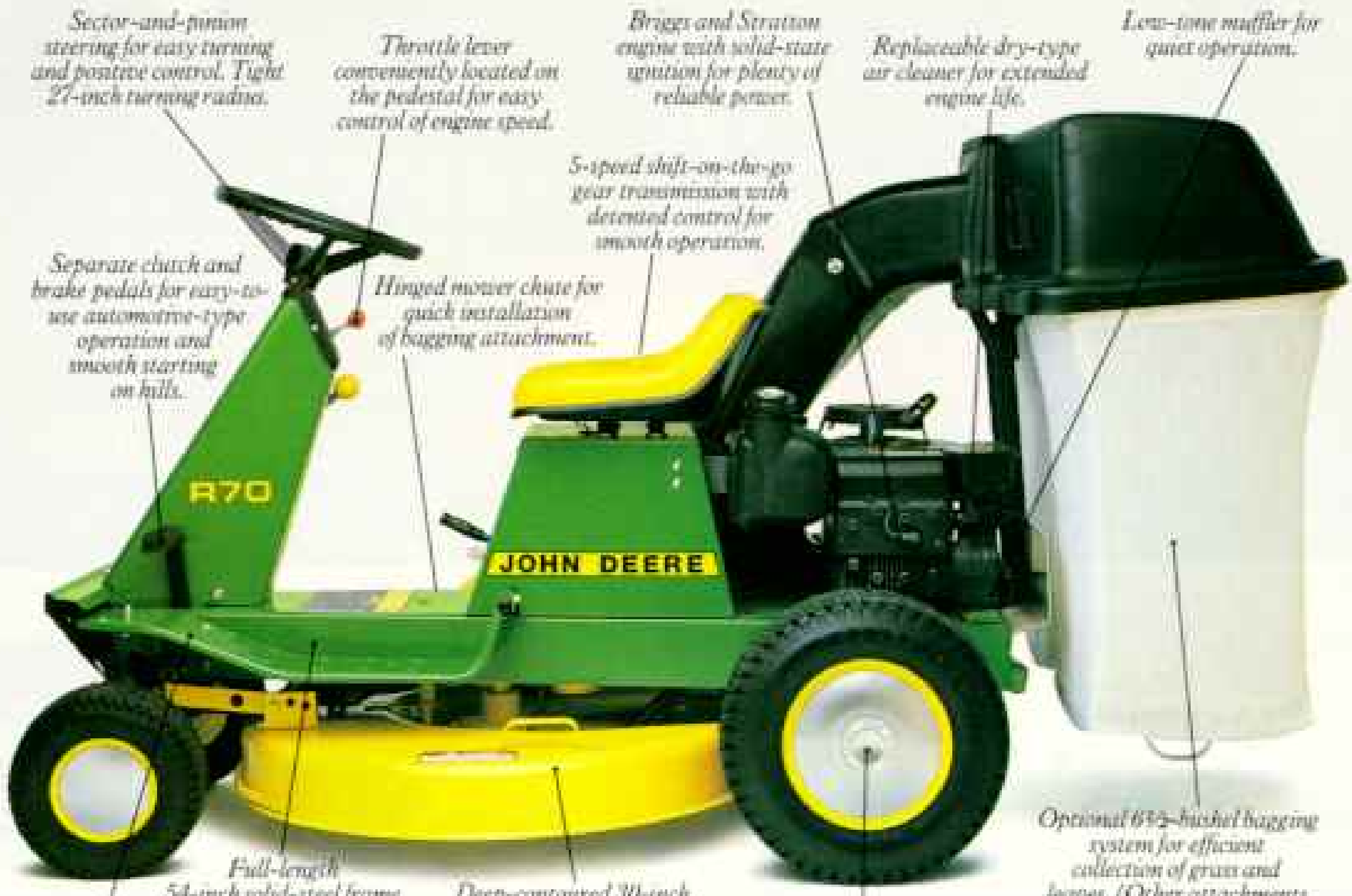

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Members Forum

Chocolate

Being on a diet forbidding me from enjoying the "Food of the Gods," I found Gordon Young's article of November 1984 the most "delicious" piece of chocolate I have tasted lately.

Samira Deeb
Washington, D. C.

One minor correction. Ruth Cleveland, for whom the Baby Ruth candy bar was named, was the *eldest* daughter of President Grover Cleveland, not the youngest. She was born in October 1891. Her sister Esther, the only child of a President born in the White House, arrived in September 1893. Three more children followed.

Cleveland K. Evans
Ann Arbor, Michigan

While peripheral to the story of chocolate, the descriptions of sugarcane and carob are incorrect. The former, though long grown in the New World, is not a native, but Asian. The latter is definitely not a pine, but a tree legume resembling the locust.

Steven W. Stelk
Alexandria, Minnesota

The evergreen carob, a member of the pea family, was incorrectly equated with "pine." We said that Spain imported cane sugar from the New World, without meaning to imply that sugarcane originated there.

As for tooth decay from chocolate: As a dentist's wife and mother of three I know that chocolate, eaten in moderation, is much better than sugar-water candies and lollipops that are sucked and kept in the mouth for longer periods of time, sometimes for hours.

Joan L. Gerber
Rochester, New York

Your article touched on the importance of cocoa beans in the economies of developing countries but omitted the fact that farmers in Peru are moving away from illicit coca production (cocaine) to new high-yielding crops such as cocoa beans. When a substitute for an illicit crop is made profitable and the risk is made higher by enforcement, an assured income to a farmer becomes more attractive.

Matthew C. Freedman
Falls Church, Virginia

Antarctica

I read with enjoyment "Icebound in Antarctica" by David Lewis (November 1984). I congratulate him and the other members of the expedition for the forthright reporting of stresses and conflicts of living in the close environment over a prolonged period of time. It was unexpected to gain insight into small-group conflict from your magazine. I look forward to reviewing the published data of Mimi George and her conclusions. They may have relevance in my clinical psychiatric practice for understanding the disintegration of small family units.

Conrad H. Daum, M.D.
Salem, Virginia

While captivated by this tale of danger and scientific exploration, I was disappointed in the repeated reference to the unsuitability of two crew members. Its relevance to Ms. George's doctoral thesis was obvious. However, the continual mention needlessly belabored the issue.

Gregory A. DuBois
Westover Air Force Base, Massachusetts

Mimi George can do all the anthropological studies she wants, but my experiences of life tell me the root cause of the trouble on the expedition was sexual jealousy. NASA and others who are interested, please take note.

George W. Howe
Fredericksburg, Virginia

Explorer David Lewis's article reads a little like one side of a divorce case. Were engineer Norman Linton-Smith and zoologist Jamie Miller given an opportunity to rebut Dr. Lewis's charges of recalcitrance, apathy, and incompetence?

Winston Beaumont
Wrightwood, California

Group dynamics was a research goal of the expedition and, therefore, a valid part of Dr. Lewis's article. Linton-Smith and Miller were given an opportunity to respond to the assessment of their performance, and, as was reported in the article, they "vigorously dispute these conclusions and challenge the data upon which they are based."

David Lewis's story must not go unchallenged with respect to his statements about Jamie Miller and me. To belittle the contributions of the two people who kept the home base safe for the return of the four is ungrateful. If Lewis genuinely considered us unreliable and capable of only "simple tasks," would he have left Jamie and me in charge?

Norman Linton-Smith
Kangaroo Ground, Australia

Africa Adorned

Angela Fisher's documentary (November 1984) leaves wrong notions that Africans are simple

black people who run around naked, paint their faces and dance strange dances, worship trees and rocks, and kill lions and elephants for food and each other for pleasure. In Ghana, at least, we do not "run around naked" nor smear our faces dancing strange dances. By and large, there is no more superstition in Ghana than in Kansas.

John O. Adu
University Park, Pennsylvania

As a custom jeweler and interior designer, I found Angela Fisher's article very sensitive. Africa's imaginative craftsmanship stands right along with the crafts movement in the U. S.

Jan Goodsite
Riverside, California

Angela Fisher refers to "the magnificent crown . . . worn by kings of Nigeria's Yoruba people." For the past 130 years, however, the Yoruba-speaking people have been divided into a large number of separate kingdoms, each of which has had its own king. The crown on page 602 appears to be that of the Alafin of Oyo.

Leslie P. Green
Poole, Dorset, England

Waterfowl

I must commend NATIONAL GEOGRAPHIC for the highly informative article on just some of the problems facing the waterfowl of North America (November 1984). Through your efforts, perhaps some changes will be initiated by persons who, up to now, have not given waterfowl a second thought. It would be comforting to believe that my children will thrill to the rush and whispering of wings each fall as I have.

T. Alan Garrett
Wilmington, North Carolina

The caption on page 568 refers to "potholes gouged by glaciers." These potholes (or kettle holes) are formed by the melting of ice masses or blocks that were buried, completely or partly, in the glacial deposits.

Edward Leith
Winnipeg, Manitoba

You state that brant resume their migration from the Alaska Peninsula when the mood strikes. There is more to it than mood. In 1979, while I was employed by the National Weather Service at Cold Bay, Alaska, the refuge manager pointed out that the brant depart after a vigorous low-pressure system moves east from the area, thereby using the strong tail wind on the back side of the storm. I saw this in 1980, '81, '82, and '83.

Jim Hunter
Seldovia, Alaska

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Grenada

Thank you for Mr. Cobb's excellent article on Grenada (November 1984). This past July my wife and I found the people friendly and warm to visiting strangers. We too found "invasion" to be an unacceptable term to 85 to 90 percent of the people we talked to. They felt as much a part of the rescue mission as did the medical students.

Keith A. Johnson
Hudsonville, Michigan

I was fascinated and disturbed by Charles Cobb's article on Grenada. Controversial questions have been raised by the continuing U. S. occupation of the island and the troubling political landscape in the wake of last year's invasion.

There were some 600 Cuban construction workers and a small military detachment working at the island's new airstrip. It is deceptive to call them "well trained" (does he mean skilled in construction work?), and anyone who saw them arriving back in Cuba knew they were construction workers, not soldiers.

The number of U. S. combat troops was underrepresented. At least 6,000 were involved; 8,000 medals were handed out.

The article's interviews were short but good. Welcome as the U. S. presence may be to many islanders, so too the Cuban presence was welcomed by islanders, perhaps for different reasons.

Donald E. Matson
Gardiner, Maine

Farm Patterns

Just after a week's workshop in tapestry weaving led by British weaver Tadek Beutlich, what a great inspiration to come home and find the September 1984 issue with the photo story "Patterns of Plenty: The Art in Farming." The designs look like tapestries woven with the true feeling of nature.

Ron Gentile
Bulawayo, Zimbabwe

Is it really art? Although the excellent photographer may be an artist, the actual farmer is not. He does not intend to create an artwork any more than a spider does when it spins a web. Surely the aesthetic quality of these fields is incidental to their functional purpose.

Jane Press
London, England

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

"Nuclear-generated electricity has become one of the basic props supporting the entire national economy."

Dr. Lynn E. Weaver
Dean, School of Engineering
Auburn University

Is there a connection between nuclear energy and economic growth? Some little-known facts show how America's nuclear power plants benefit the economy.

In the next two years, more than 20 new nuclear plants are due to join the 85 already generating electricity in this country. Electricity for refrigerators, streetlights, assembly lines, computers, subways, and a thousand other elements of modern American life.

Nuclear saves money and fuel

Despite the high price tags on some of the new plants, the average cost of generating U.S. nuclear electricity will still be under a nickel per kilowatt-hour.

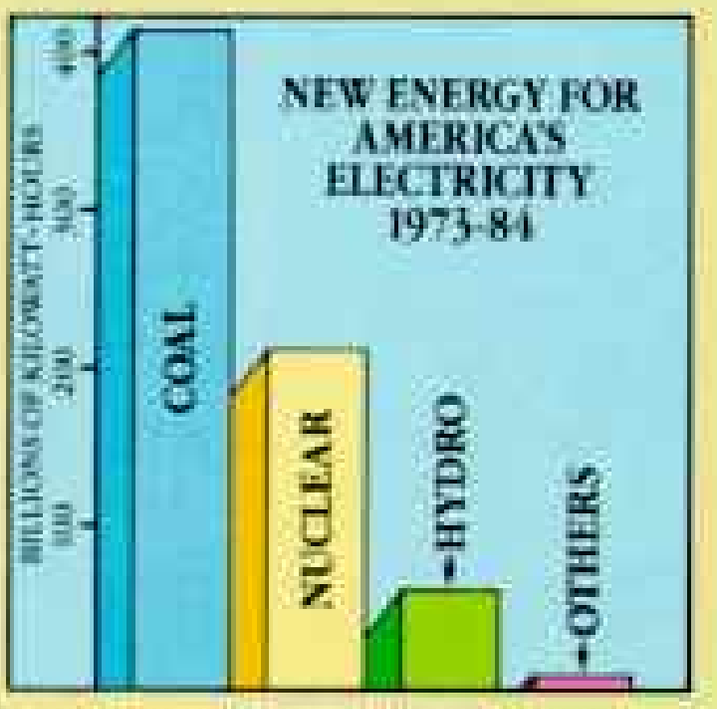
That's economical energy. Nuclear power saved American consumers about $3 billion in 1983 alone, compared to what the electricity would have cost coming from coal- and oil-fired plants.

What's more, using nuclear fuel cuts energy imports and takes some of the pressure off our shrinking domestic reserves of oil and natural gas.

An electrifying economy

The U.S. Gross National Product is a basic measure of economic activity. Since 1973 the GNP has grown by 30%, which closely parallels the 32% growth in the nation's electricity demand.

But over the same period the direct burning of fuels for *non-*



Coal and nuclear energy have provided over 90% of all the new electricity added to our energy supply since 1973. This has enabled utilities to reduce their consumption of more costly oil and natural gas. Source: Energy Information Administration/U.S. Dept. of Energy.

electric energy has actually gone down, as the economy converts to more electrical energy.

What many people don't realize is that most of America's new electricity is coming from coal and nuclear power. Electricity growth in 1984 was 62% coal and 22% nuclear, according to the Federal Energy Information Administration.

The key to energy independence

The growing supply of electricity from U.S. coal and nuclear also reduces our dependence on *imported* energy. Greater use of domestic electricity sources means fewer U.S. dollars sent abroad.

Nuclear power and coal can meet the country's growing electrical needs *and* help reduce our dependence on foreign oil.

For a free booklet on this subject, write the U.S. Committee for Energy Awareness, P.O. Box 37012(G14), Washington, D.C. 20013. Please allow 6-8 weeks for delivery.

Information about energy America can count on

U.S. COMMITTEE FOR ENERGY AWARENESS

The 1985 Turbo New Yorker. Once you drive it, you'll never go back to a V-8 again.

Chrysler introduces the new technology of driving: Turbopower* in its most advanced luxury sedan.

Here is the confidence of front-wheel drive, the security of advanced electronics and the quiet, smooth ride you expect in a fine luxury car.

And here are the luxuries you demand. Automatic transmission, power windows, power steering, power brakes, power remote mirrors and individual pillow-style reclining seats are all standard.

And finally, here is the new technology of turbopower. More power to move you. To accelerate. To pass. To cruise in serene comfort...yet with remarkable fuel efficiency. 23 hwy. est. mpg 20 city est. mpg.**

Turbo New Yorker merits careful consideration by every luxury car owner. It is backed by a 5-year/50,000-mile Protection Plan covering drivetrain, turbo and outer body rust-through†

The new technology of driving must be experienced. So Chrysler invites you: test drive Turbo New Yorker. Once you drive it, you'll never go back to a V-8 again.

Purchase or lease your 1985 Turbo New Yorker at your Chrysler-Plymouth dealer. And buckle up for safety.

Chrysler. The best built, best backed American cars.††

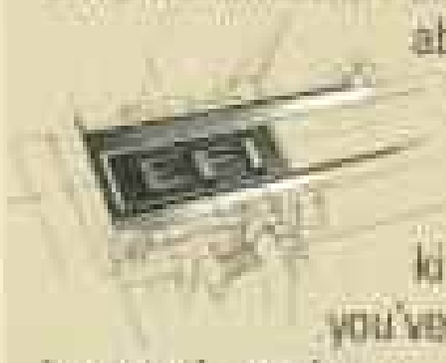
Chrysler
Division of Chrysler Corporation

*Turbo is optional. **Use these EPA ests. to compare. Actual mpg will vary with options, driving conditions and habits and vehicle condition. CA ests. lower. †Whichever comes first. Limited warranty. Deductible applies. Excludes fluid/lenses. Dealer has details. ††Lowest percent of NHTSA safety recalls for '82 and '83 cars designed and built in North America. Best backed based on warranty comparison of competitive vehicles.

Is it too much to ask for space behind the seat so you don't feel cramped? So your tools or sports gear won't need the passenger seat?

The Toyota SR5 XTRACAB doesn't think so. That's why there's extra space behind the seat and, up front, more leg room than in any small truck.

The XTRACAB also has full, rich carpeting, reclining bucket seats and options you wouldn't expect to find in a tough truck. Like an AM/FM/MPX sound system with electronic tuning, cassette and 7-band graphic equalizer that puts others to shame. Like a 4-speed automatic overdrive transmission. Like a 7-way adjustable driver's Sport Seat to indulge you even more.



If this is the kind of equipment you've been looking for in a truck, read on.

XTRACAB's 2.4 liter engine with 116 hp is the *most powerful* ever built for a truck in its class. And its all-new computer-controlled Electronic Fuel Injection system provides the most power while never taking its eye off economy.

These are more of the special extras you'll find here that make driving there as easy as possible.

OH WHAT A FEELING!

TOYOTA

Once you test glide the easy ride of an XTRACAB, you'll wonder why you always thought trucks were only for drivers delivering logs from the mountains and equipment to building sites.

Climb into the world of XTRACAB.

There's extra fun waiting for you here that's just your style. TOYOTA TRUCKS. MOST POWERFUL EVER!

THE 1985 TOYOTA SR5 XTRACAB. BECAUSE YOU SHOULDN'T HAVE YOUR BACK UP AGAINST THE WALL.

XTRA!

On Assignment

RISKY BUSINESS. Photographer ***Fred Ward*** and senior staff writer ***Allen A. Boraiko*** (***right***) donned plastic safety suits, gloves, hard hats, masks, and backpack air tanks before venturing into this abandoned graveyard for hazardous industrial chemicals near Hamilton, Ohio.

"It was a very spooky place," says Boraiko, "with leaking storage tanks, thousands of corroded drums, and puddles of fouled rainwater. Some drums had yellow tags on them to indicate unknown and possibly explosive contents. The air had a bleach-like bite to it." Reports Ward: "A messy, dangerous site."

For our article on hazardous waste, Boraiko and Ward spent ten months visiting chemical dumps, lagoons, storage tank farms, and landfills in the United States, Europe, and Japan.

The pair previously produced GEOGRAPHIC stories on fiber optics, pesticides, and silver. Photojournalist Ward has also written and photographed articles on the Everglades, Cree Indians, Cuba, diamonds, and Tibet.

DONALD BORDA, U. S. ARMY CORPS OF ENGINEERS

MORE HAUNTED than hazardous, catacombs heaped with skulls under a monastery in Kiev gave contract photographer ***Jim Brandenburg*** (***below***) a new insight into medieval Christianity—a faith brought here 1,000 years ago by Vikings. Along the Western Dvina River, once a highway for Viking trade vessels, senior assistant editor ***Robert Paul Jordan*** admired family portraits in the log home of forest ranger Sergei Dedov (***below,*** at right), a Belorussian. "Everything here I have made by hand," said Dedov, expressing the wish that Americans and his people might compete in such peaceful work.

To retrace the Vikings' 250-year presence in the area for this issue, Jordan and Brandenburg traveled from the Baltic to Istanbul. A veteran Soviet watcher, Jordan adds this account of pre-Russia's Scandinavian connection to earlier reports on Soviet Armenia (1978) and the River Ob, a journey that carried him from Mongolia to the Arctic Ocean in 1976.

BOTH BY JIM BRANDENBURG