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# NATIONAL GEOGRAPHIC

May 1984

IT WAS APPROPRIATE that the largest color print ever made by National Geographic photo labs should be hung in the East Building of the National Gallery of Art in Washington, D. C. From the new building's dramatic concept by architect I. M. Pei to the half-ton Alexander Calder mobile in the central court and through a series of spectacular exhibitions, the gallery has earned a reputation for thinking big.

This winter the gallery put on view Leonardo da Vinci's original studies for the "Last Supper" from Queen Elizabeth's Windsor Castle collection—the first time they have been permitted out of England.

When National Gallery Director J. Carter Brown invited the Geographic to provide a



COURTESY COLLEON

color print of the painting for the exhibit, he noted that there was a wall in the gallery that was within three inches of being as tall as the one on which Leonardo had painted his masterpiece. The challenge of producing this huge print from Vic Boswell's eight-by-ten-inch color transparency was handed to Rex Stucky. Using 50-inch-wide rolls of color-sensitive paper, Rex made 36 separate panels and mosaicked the perfectly matched set into a magnificent 34-by-36-foot mural.

Over the centuries many artists have copied the "Last Supper" but none so successfully. Because the original is dimly lighted to prevent fading, more than 125,000 visitors to the 11-week exhibit had a better look at the "Last Supper" than if they had gone to Milan to see the original.

*Wilbur E. Garrett*

EDITOR

## The Dead Do Tell Tales at Vesuvius 557

*For nearly 2,000 years they lay mute, hidden in a tomb of hardened ash. Today their bones speak volumes to scientists piecing together their lives and fiery deaths. Rick Gore and O. Louis Mazzatenta report on the latest excavations at Herculaneum and Pompeii.*

## A Prayer for Pozzuoli 614

*Pozzuoli, a thriving port when Vesuvius erupted, now waits in terror as its own huge volcano stirs uneasily to life. Rick Gore and O. Louis Mazzatenta find the land rising as magma surges beneath it.*

## Krill: Untapped Bounty? 626

*These tiny crustaceans are whale food today, but they offer man a vast store of protein that just might—and might not—be worth the trouble of harvesting. Biologist William M. Hamner and photographer Flip Nicklin examine a "superb" Antarctic species.*

## The Olympic Peninsula 644

*Giant trees, glaciated peaks, and wild shores dominate Washington State's "green thumb." Bill Richards and Sam Abell give us a vivid look at the land and its people.*

## Indians Cursed by Gold 675

*For villagers of the Amazon Basin, a gold rush on their land means new wealth—along with pollution, invading miners, and many of the headaches of civilization, as Vanessa Lea and Miguel Rio Branco discover.*

**COVER:** *With rings on her fingers and gold bracelets at her side, a Roman lady emerges from Herculaneum's volcanic tomb of A.D. 79. Photograph by O. Louis Mazzatenta.*

THE NATIONAL GEOGRAPHIC MAGAZINE  
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FOUNDED 1888



# AFTER 2,000 YEARS OF SILENCE THE DEAD DO TELL TALES AT VESUVIUS

**O**UT OF A TIMELESS, musty dark, an ancient Roman victim of Mount Vesuvius stares into the 20th century, her teeth clenched in agony. Nearby lie charred and tangled remains of scores of others buried in the wet volcanic earth. The scene is Herculaneum, lesser known sister city of Pompeii. Both cities were destroyed by the A.D. 79 eruption of Vesuvius. The wall painting from Pompeii (right) depicts the wine god, Bacchus, and the mountain's profile that Romans knew before the disaster. Macabre new relics of that eruption were discovered



NATIONAL ARCHAEOLOGICAL MUSEUM, NAPLES

two years ago, as Italian workmen began to excavate a series of seawall chambers that lined ancient Herculaneum's beachfront. Since then many other fragments of lost lives have emerged along the beach: a noble lady with her jewels; a Roman soldier carrying sword and tools; lanterns, coins, and even an intact Roman boat. These discoveries do more than reveal the moving last moments of a terrified population. They bring to the light of science a wealth of new details that already are telling us much more about how people lived, as well as died, in the lost cities of Vesuvius.

By RICK GORE

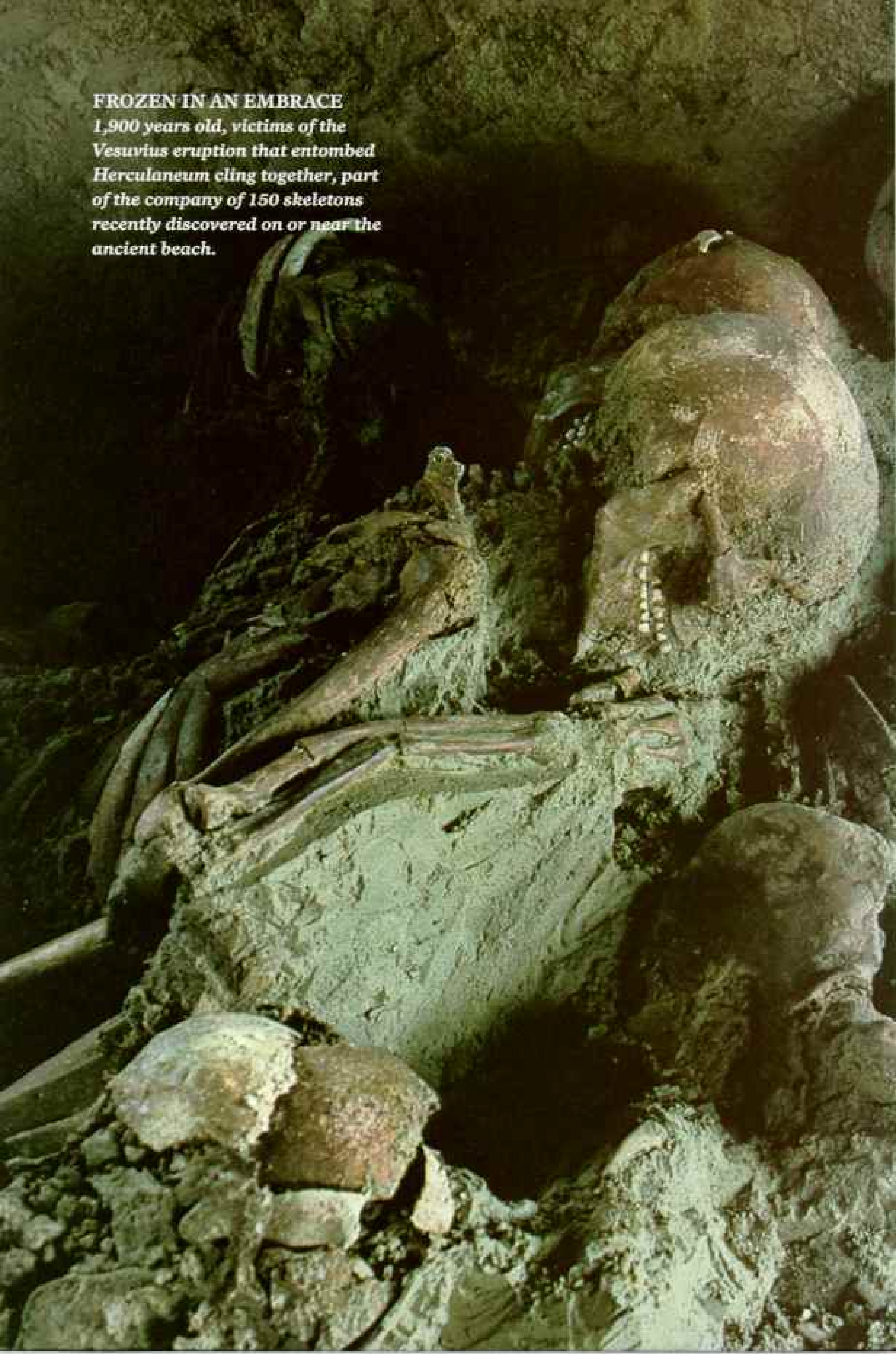
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by O. LOUIS MAZZATENTA

SENIOR ASSISTANT EDITOR

**FROZEN IN AN EMBRACE**

*1,900 years old, victims of the Vesuvius eruption that entombed Herculaneum cling together, part of the company of 150 skeletons recently discovered on or near the ancient beach.*





# AMID DEATH'S SHADES, THE GLINT OF GOLD...

**A**ND THE ECHO of love. "She was certainly homely, but someone cared enough to give her beautiful things," says Dr. Sara Bisel, the physical anthropologist who examined the skeleton of this 45-year-old woman (right), found with a treasure of jewels. A bird struts across the carnelian set in one of her two gold rings (below), while jasper enhances the other. Jasper also gleamed as eyes on the snake heads of her two gold bracelets (facing page). Pearls probably adorned the golden tips of earrings, upper left, made for pierced ears.









## BAUBLES AMONG THE BONES

**A** DESPERATE retreat to the back of a boat chamber (left) proved futile, as lined-up skeletons testify, appearing like souls "floating down the River Styx," in the words of one observer.

Costume jewelry of beads, stones, and amber (right) was found near a skeleton (below). Decoration rare for Roman times, Gorgon heads adorn several beads.



CHERYL NUSS (ABOVE)



## A LIFE SNUFFED OUT BEFORE BIRTH

**B**LOW ON a dead man's embers and a live flame will start." The thought, expressed by poet Robert Graves, holds true for Herculaneum, where the breath of science coaxes flames of knowledge from bare bones. "An attractive young woman," Dr. Bisel judges on studying this skull (left). "A 25-year-old blonde — see the patch of hair on top — and pregnant with her first child." Putting together her seven-month-old fetus, below skull, was like handling broken eggshells — "it was that fragile."

Fragile, too, was the life of a baby whose skeleton was found in the charred crib (right), rocking today as 1,900 years ago. Here displayed in a Herculaneum residence called the House of the Mosaic Atrium, for its beautiful floors, the crib has since been stored for safekeeping.

CHERYL NUSS (LEFT)





**T**HE STAGE HAS BEEN DARK for nearly 2,000 years. Yet enough light shines down through an old well shaft to show me that this buried Roman theater had been grand. Surely it once blazed with spectacles. I close my eyes and see the elegantly marbled proscenium, the acrobats, the preening athletes on exhibit, the bawdy mimes. I hear the lyres, flutes, and cymbals, and the jingling bracelets of dancers. I see a famous actor from Rome, mask in hand and regally clad, waiting to make his entrance.

I open my eyes, and the steady drip of groundwater onto the stage reminds me that I am 30 meters (100 feet) underground. This theater, once the opulent pride of the ancient seaside town of Herculaneum, lies beneath a succession of pyroclastic flows and surges. These glowing avalanches began roaring down the slopes of Mount Vesuvius about midnight of August 25 in A.D. 79, scorching and smothering the countryside, including the neighboring city of Pompeii.

My escort, assistant supervisor Vittorio De Girolamo, takes me down a corridor leading to the costume depository. He points his flashlight upward at the hardened volcanic flow overhead. A haunting face stares back down. It is only an imprint, made by the head of a statue that the glowing avalanche picked up as it invaded the theater. Yet this impassive visage testifies that the last performance on this stage was indeed a tragedy.

One can argue that this stage was also where modern archaeology was born. All traces of Pompeii and Herculaneum had been lost until 1709, when a well digger accidentally struck the stage. Tunnels were dug, and soon the ruling nobility of Naples began to loot the theater. They stripped away its multicolored marble facings for their villas

*The audience roars as masked players in Herculaneum's theater act out a comedy. The white-bearded father catches a young slave with a bag of ill-gotten money as a bejeweled courtesan looks on. A pair of bronze cymbals lies on stage. The theater, seating between 2,500 and 3,000, was discovered and looted in the 1700s.*

PAINTING BY LOUIS S. SLANZMAN







and carted off the bronze and marble statues. These royal treasure hunters used hundreds of laborers, including some prisoners, to dig numerous additional tunnels out from the theater to plunder the rest of buried Herculaneum.

I walk along one of these narrow old corridors and feel as if I am caving back through time. I see the name of an earlier visitor—"Pihan, 1793"—etched into the volcanic wall.

Abruptly the tunnel is blocked by rubble. If I could continue my walk, however, this labyrinth would bring me into the heart of Herculaneum, much of which has been once again exposed to air by archaeologists over the past half century. I could walk past the Trellis House with its graceful balcony. I could continue to the House of the Mosaic Atrium and stand in the elegant triclinium, where a wealthy family took their summer meals overlooking the Bay of Naples.

The bay today is nearly half a kilometer away. The same volcanic flows that buried Herculaneum covered the ancient beach to a depth of 20 meters.

In the past few years a strip of that beach has been excavated, and I could descend the steep stairs to the old coast. There in the seawall of the town are ten recently uncovered chambers, probably once used to store fishing boats. In those chambers today, however, lie some of Herculaneum's most important discoveries since that 18th-century well digger found himself on center stage.

Archaeologists have long held that almost all Herculaneum's population had time to escape Vesuvius's wrath. Only a dozen or so skeletons were found in the town versus the hundreds that were excavated at Pompeii, on the other side of Vesuvius.

Classical scholars had assumed that after Herculaneum's population fled, the town had been embalmed by airtight mud slides. At Pompeii, they concluded, the people were felled over a period of hours by a smothering snow of ash and pumice. These scholars knew nothing about glowing avalanches and their pyroclastic flows. Not until early in this century did scientists actually

observe these phenomena, also called *nuées ardentes*, which are made up of superhot gas and debris and which rush down mountainsides at hurricane speeds. Moreover, the cooled flows at Herculaneum do resemble hardened mud.

In the early 1900s two American volcanologists suggested that glowing avalanches had occurred at Vesuvius. But archaeologists and volcanologists alike continued to



*Haunting and mysterious, a noble face appears on the ceiling of a dank, chilling tunnel (facing page) in Herculaneum's theater. The image was imprinted in the soft volcanic flow by a statue that was toppled from its pedestal.*

*Vittorio De Girolamo, assistant supervisor, stands under the hole (above) made by a well digger who in 1709 accidentally struck Herculaneum's stage beneath the town of Resina, now Ercolano.*



gloss over the question of exactly what killed the people on the slopes of Vesuvius. Then, in 1981, Michael Sheridan of Arizona State University, working with Franco Barberi and a team of Italian volcanologists, corroborated the concept of glowing avalanches.

In early 1982 striking human evidence for these volcanic storms emerged. Under the direction of Giuseppe Maggi, workmen began excavating Herculaneum's seafront chambers. The chambers, they found, were filled with the skeletons of people who obviously had met sudden death.\*

Two years earlier Dr. Maggi's crew had unearthed three skeletons on the beach in front of the chambers. This had led Maggi to speculate that Herculaneum might not have been as thoroughly abandoned as thought. Suddenly, faced with so many new skeletons, he had to ask whether *anyone* in Herculaneum could have had time to escape.

In the summer of 1982 Maggi had led me into the first chamber. As my eyes adapted to the dark, a pitiful cluster of skeletons emerged from the wet volcanic ash at my feet. They seemed to have been huddled together. Maggi is convinced they were a household in flight: seven adults, four children, and a baby lying

cradled beneath one of the adults. The most striking skeleton lay with head buried, as if sobbing into a pillow.

"In this chamber nature has composed a masterpiece of pathos," Dr. Maggi told me. "One is deeply moved by the postures. You can imagine each person trying to find courage next to another."

If that chamber was one of pathos, the next was a chamber of horrors.

A host of tangled, charred skeletons, including that of a horse (above), lay chaotically strewn. "I think these people descended the stairs terrified," said Maggi. "In panic they tried to take refuge in this chamber."

As I entered, I could almost sense a collective groan across the ages. I could almost hear the screaming as the fiery avalanche

struck. It must have been like being trapped in a furnace.

**N**OW IT IS A YEAR LATER, and I have returned for the third time to Herculaneum. Now another chamber has been opened. Its many victims lie inexplicably aligned, as though in orderly streams. "They look like they are floating down the River Styx," says a colleague.

Outside the chambers, on the ancient beach, excavators have been uncovering many more skeletons. A Roman soldier had been found, flattened. Had he been trying to control the panicked flight? Within a young woman's bones, diggers had discovered the tiny skeleton of her seventh-month fetus.

From a yet-to-be-excavated chamber extended the hand of a woman. She had been nicknamed the Ring Lady for her large jeweled rings. Exquisite gold bracelets were found beneath her (cover and page 561).

Perhaps the most significant find was the overturned hull of a Roman boat. Little is known about first-century Roman boat-building, and this craft promises to reveal much to archaeologists. Next to it lay the remains of a man with what appeared to be an oar in his hands. Could he be the helmsman? Was this boat under sail? Could it have been trying to evacuate fearful residents?

Provocative questions, these, fueled by so many new clues. And as I walk the beach on this early summer morning, I see three detectives at work.

Sara Bisel, a physical anthropologist who specializes in the analysis of ancient bones, has been on site since my first visit. She was sent by the National Geographic Society at Dr. Maggi's urgent request to preserve the newfound skeletons.

To Dr. Bisel the beautifully preserved Herculaneum skeletons are as valuable as the treasures excavated here in the 18th-century. Very few other Roman skeletons have survived; the Romans cremated their dead. Suddenly along this ancient beach lay an entire Roman population, democratically distributed among men, women, and children, patricians, freedmen, and slaves.

"Who says dead men don't talk?" Dr.

\*See "A Buried Roman Town Gives Up Its Dead," by Joseph Judge, in the December 1982 *Geographic*.





*Scholars come to see for themselves the boat chambers, at right, where the new finds at Herculaneum have surfaced, including a horse's skeleton (facing page). Dr. Giuseppe Maggi, director of the site, briefs the group from his perch on a railing. He faces a wall raised by Vesuvius's volcanic flows that pushed back the sea.*

Bisel had told me after her first look at the site. "These bones will have a lot to say about who these people were and how they lived."

Meanwhile, University of Rhode Island volcanologist Haraldur Sigurdsson is in a tunnel, sampling the volcanic deposits that cover Herculaneum. Sigurdsson, whose research is also being sponsored by the National Geographic Society, had just co-authored a new interpretation of the timing and nature of the A.D. 79 eruption when the skeletons were revealed. To him these human remains offer a unique opportunity. The way they lie in the ancient strata will help him work out a moment-by-moment scenario of how Vesuvius took those lives.

Then, inside a corrugated metal shed that now protects the Roman boat, I find a third Geographic-sponsored scientist, Richard Steffy of the Institute of Nautical Archaeology at Texas A & M. The boat's blackened hull was severely charred by the glowing avalanches. It will be exquisitely difficult to excavate. Nevertheless, Steffy remains enthusiastic.

"This will be *the* definitive Roman boat," he says. We know more about what fourth-century B.C. Greeks could do than we know about this period.

"It's a good-size boat. More than eight meters [26 feet]. I think it's some kind of utility craft, a harbor tug, or maybe a fishing boat. Except the fancy design indicates it was used for something other than fishing. We'll know soon."

**I** REEMERGE into the bright Mediterranean sunlight and am struck by the sight of Vesuvius, which looms like a blue shadow behind the dig. Although its massive profile dominates the horizon along the Bay of Naples from Capri and Sorrento all the way around to Cape Miseno, nowhere does the volcano seem so inescapable.

I have been sent here as a journalist to piece together the new story developing about this volcano's most famous eruption. Yet I have quickly learned that the story extends beyond this one mountain and that one eruption. In a geologic sense this entire

bay is a stage, Vulcan's amphitheater, on which a long-running series of geo-dramas continue to be played out.

The Bay of Naples is a crucible where the African Continent is crunching into Europe, creating a legacy of earthquakes and volcanoes. Vesuvius itself has been quiet since 1944. But the area remains shell-shocked from a severe earthquake that struck in 1980, paralyzing and demoralizing Naples.

Moreover, in the past year tremors have wracked the nearby town of Pozzuoli. Half its residents have fled, and scientists cannot discount that the eruption of a new volcano, possibly even more violent than Vesuvius,

may be brewing beneath the town (see the article beginning on page 614).

Nor do the residents of modern Herculaneum, known now as Ercolano, trust the slumbering Vesuvius. As Ercolano native Matteo Paparo tells me: "Where we live, there is a fire under our houses."

**T**WO THOUSAND YEARS AGO the people living on the slopes of Vesuvius had no such realization. Most probably did not even suspect that their mountain, peaceful for at least 300 years, was a volcano.

Even the great Roman naturalist Pliny



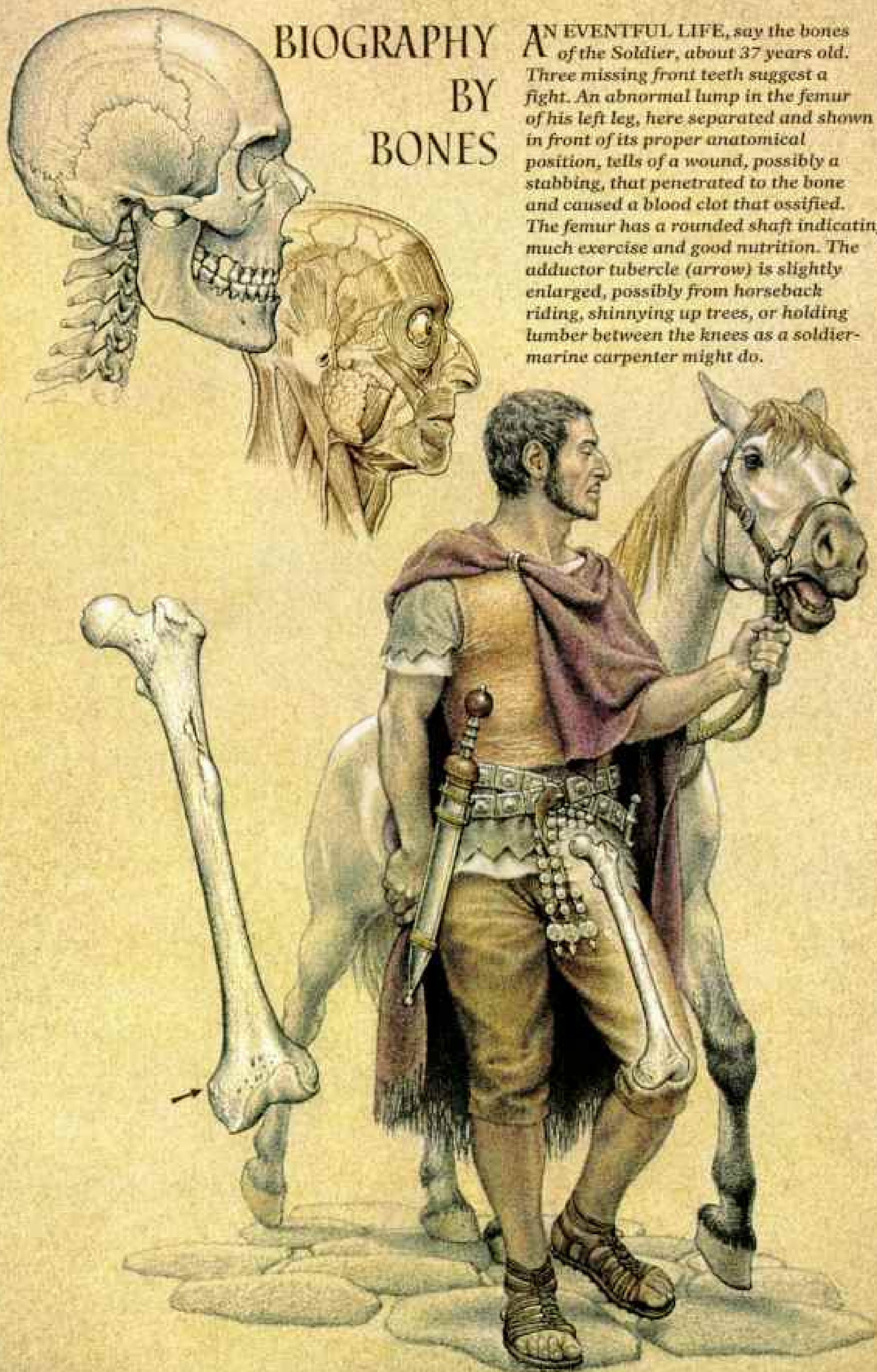
JONATHAN BLAIR (ABOVE); DRAWING BY JAY R. MATTERNEE



*Lying down on the job, Vittorio De Girolamo (above) works to free the Soldier from his volcanic tomb. The skeleton's sword rests by his side, attached to bits of a metal belt. Further excavation brought to light remnants of carpenter tools—an adz and three chisels (left) that appeared to have been slung over the man's back. Roman soldiers were often set to work building when not on military campaigns.*

# BIOGRAPHY BY BONES

**A**N EVENTFUL LIFE, say the bones of the Soldier, about 37 years old. Three missing front teeth suggest a fight. An abnormal lump in the femur of his left leg, here separated and shown in front of its proper anatomical position, tells of a wound, possibly a stabbing, that penetrated to the bone and caused a blood clot that ossified. The femur has a rounded shaft indicating much exercise and good nutrition. The adductor tubercle (arrow) is slightly enlarged, possibly from horseback riding, shinnying up trees, or holding lumber between the knees as a soldier-marine carpenter might do.





Oldest Greek colony on the mainland, Cumae was the home of a renowned sibyl, whose prophecies were consulted by Rome's senate.

Today a sparkling lake, Averno was once a sulfurous crater. The Roman poet Virgil described it as a "foul-breathing" entrance to the underworld.

**ANCIENT CALDERA**  
A score of craters pock this area of boiling mud and sulfuric fumaroles where a massive eruption 36,000 years ago left a 12-km-wide (7.5-mile-wide) caldera. Today 200,000 people live here.

**Naples (Neapolis)**  
Founded by the Greeks on ancient volcanic beds some 26 centuries ago, Naples was badly shaken by a 1980 earthquake that cost 3,000 lives.

Pliny's young nephew witnessed the eruption from this naval base 32 kilometers (20 miles) away, saying a "fearful black cloud" split by lightning was "spreading over the earth like a flood."

Half the population has fled this small city to escape constant tremors. The ground here rises and falls with the movement of magma that could someday erupt.

**PLINY'S VOYAGE**  
As commander of the Roman fleet at Misenum—and a dedicated scientist—Pliny the Elder sailed toward the erupting Vesuvius to rescue friends and investigate the phenomenon. He perished at Stabiae in the attempt.

# B A Y O F N A P L E S

## CONTINENTS COLLIDE IN A LAND OF PLENTY

**A CURSE AND A BLESSING:** Throughout history, earthquakes have leveled villages, and volcanoes have paved this land with lava and ash, yet these same powers have given the region a stunning beauty and fertile soil. Then as now, Romans harvested grains, olives, grapes, and as many as four vegetable crops a year. Today two million people inhabit the area, sharing its charms and dangers.

Two continents meet head-on here. The earth's African plate slowly grinds against the Italian peninsula, melting deep rock into magma that rises toward the surface. The process has formed a string of volcanoes (inset) from Sicily to north of Rome and a system of geologic faults that release stress through earthquakes—often disastrously.





**VESUVIUS**  
 This 1,281-meter (4,203-foot) volcano has erupted 80 times since A.D. 79, most violently in 1631 and 1906. It has been quiet since 1944.

Summit before A.D. 79

Summit today

**PYROCLASTIC FLOWS**  
 These ground-hugging slides of superhot gases and debris filled valleys and depressions on the mountain's southwestern and southern flanks in the A.D. 79 eruption.

**Portici Ercolano**  
 (Herculaneum)  
 Built on prehistoric volcanic deposits, this popular Roman resort was buried beneath 20 meters (66 feet) of earth by the A.D. 79 eruption.

**SURGES**  
 Spreading radially from the summit, the turbulent, fast-moving surge from the sixth glowing avalanche was probably the most powerful of the A.D. 79 eruption.

Probably founded by the native Oscans centuries before the eruption of A.D. 79, this busy Roman port was a regional export center for wine.

**ASHFALL**  
 Northwestern winds on August 24, A.D. 79 deposited 2.7 meters of ash and pumice on Pompeii but only a centimeter on Herculaneum.

Scale varies in this perspective view. Ancient names shown in parentheses.  
 A.D. 79 eruption data from *Volcanoes* by William H. Borg, compiled by Linda Drake, National Geographic Cartographic Division.

the Elder, who lived across the bay in Misenum, regarded the large cloud that burst out of Vesuvius on that dreadful August 24 more as a novelty than a danger. As commander of the Roman fleet, Pliny ordered a ship to take him to the site to investigate the phenomenon and evacuate anxious friends.

The elder Pliny met his death in the disaster. But his nephew, Pliny the Younger, watching from his uncle's house, detailed the eruption in elegant, chilling prose. The history of Vesuvius really begins with that description. Only one other account of the cataclysm at Vesuvius has survived the Dark Ages. Indeed, if Pliny's letters had perished, no one in the 18th century would have known that they were unearthing Herculaneum and later Pompeii.

So it seems fitting to seek out the oldest copy of Pliny's Vesuvius letters. I find them in Florence, in the Laurentian Library, which the Medici family established during the Renaissance to house their collection of works that had outlasted the barbarians.

"HERE LIVE Virgil, Tacitus, Dante, everyone. Including Pliny," says the library's director, Dr. Antonietta Morandini, as we enter what must be the ultimate rare-book room. "About 13,000 manuscripts are here. Every one is precious. We keep them only if they are autographed or very special."

An assistant brings her a large maroon leather book.

"We think this volume came from the monastery at Corbie in France," says the dowager *dottoressa*. "A monk copied it, probably in the tenth century, from some earlier version now lost."

She turns the lightly browned parchment pages, searching the Latin calligraphy for the first mention of the infamous name.

"Ah, here it is," she says, reading: "It was not clear from which mountain the cloud was rising. *Vesuvium fuisse postea cognitum est*—Later we knew it was Vesuvius."

Pliny's tale of the catastrophe "which destroyed the loveliest regions of the earth" continues, even though, he writes, "my mind shrinks from remembering." Presumably drawing on reports from survivors who had accompanied the elder Pliny, he recounts how his (Continued on page 584)



PAINTING BY LLOYD K. TORRENDO (RIGHT)

## TWO DAYS WHEN VESUVIUS WENT MAD

AT ABOUT ONE O'CLOCK on the afternoon of August 24, A.D. 79, Vesuvius roared like a monstrous cannon. Its cataclysm is recorded in layers of volcanic deposits at Herculaneum and Pompeii. Examining those deposits, volcanologist Haraldur Sigurdsson of the University of Rhode Island now reconstructs the eruption sequence. For nearly 11 hours, he reports, the volcano hurled a column of pumice 20 kilometers (12 miles) into the stratosphere **A**. Day became night as Pompeii took on more than 15 centimeters (six inches) of ash and pumice an hour. Then, about midnight, the column collapsed for the first time **B**, sending down the mountainside a glowing avalanche of superheated gases, pumice, and rocks. The avalanche separated into a fast-moving surge—which blasted through Herculaneum, killing its residents—and a slower, ground-hugging pyroclastic flow. Not until a fourth avalanche the next morning did a suffocating surge reach Pompeii.



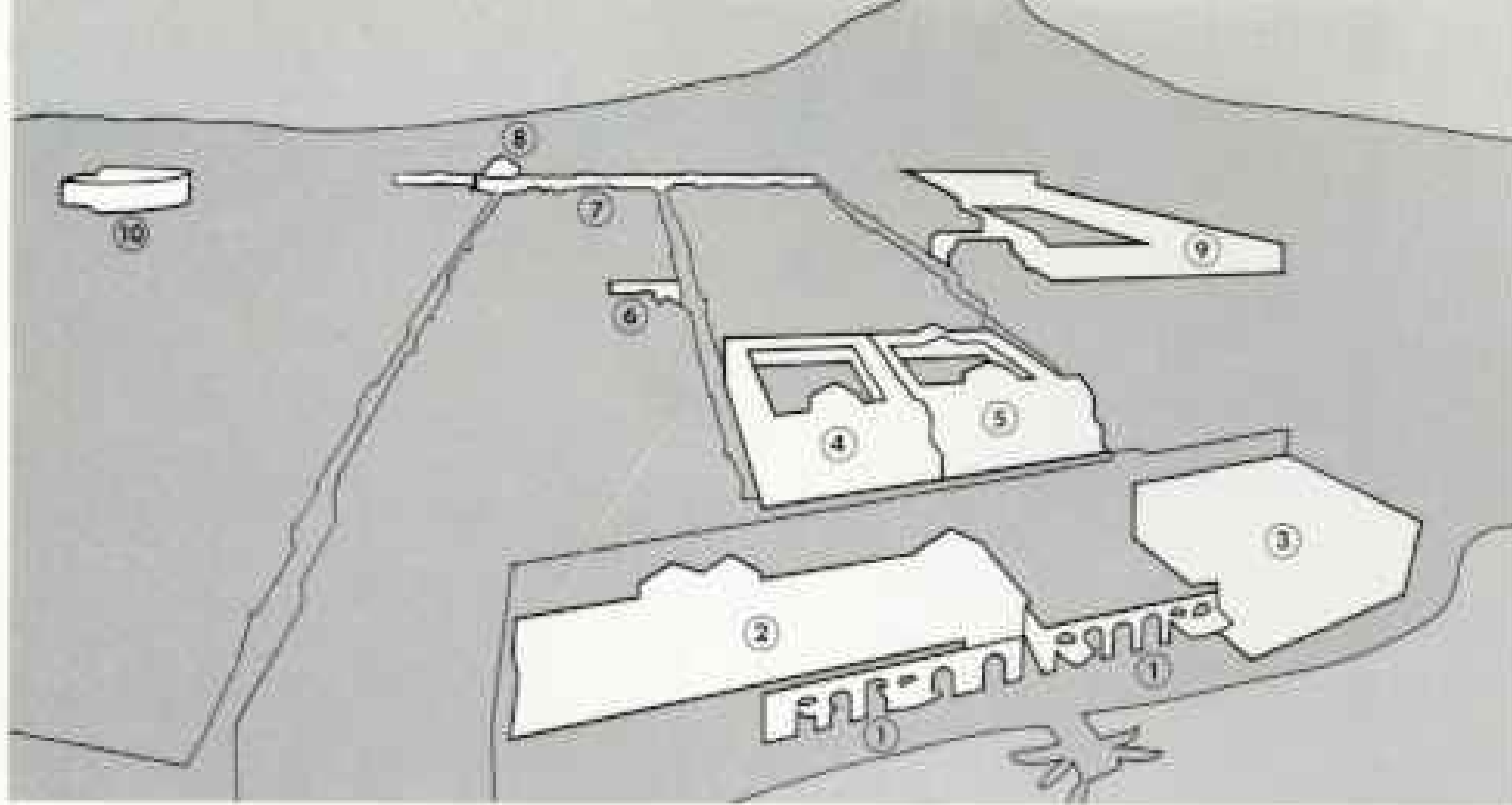
- ① 1:30 p.m., Aug. 24 Pumice begins to fall on Pompeii.
- ② 11:30 p.m. First fiery surge cloud kills Herculaneum victims; pyroclastic flow quickly follows.
- ③ 12:30 a.m., Aug. 25 Second surge and flow.
- ④ 5:30 a.m. Third surge reaches north walls of Pompeii; flow buries Herculaneum.
- ⑤ 6:30 a.m. Fourth surge asphyxiates Pompeii residents; flow follows.
- ⑥ 7:00 a.m. Fifth surge and flow.
- ⑦ 8:30 a.m. Sixth and final surge causes Pliny the Younger to flee Misenum; flow buries Pompeii victims.

As the volcano's chamber emptied and the crater widened, explosive, silica-rich magma (orange) gave way to less volatile, silica-poor magma (red), and the weakened eruption column periodically collapsed. Volcanic deposits found at the beach in Herculaneum, left, are compared in this diagram to deposits from southeastern Pompeii, right.









**T**HE DAY BEFORE the terrifying eruption, Herculaneum enjoys a quiet afternoon in this artist's conception of the wealthy seaside town (*previous pages*). Fishermen pull boats onto the beach near a row of chambers 1, probably used for storage. In the Sacred Area 2 a ceremony is in progress, while patrons of the Suburban Baths 3 relax in several indoor pools.

On the terrace of the lavish House of the Mosaic Atrium 4, guests from Rome could enjoy a view of the sparkling bay. Sea breezes wash through the elegant garden of the House of the Stags 5, where hunting dogs attack deer in a pair of marble statues. Only wealthy patricians could afford seaside homes. Less prominent citizens live away from the beach in smaller quarters like the Trellis House 6. Craftsmen and merchants sleep above their stores on the main street, the Decumanus Maximus 7,

where citizens come to seek justice or do business at the basilica 8. At the spacious palaestra 9 young athletes compete in wrestling, swimming, and foot races, while actors at the 2,500-seat theater 10 rehearse their lines.

Until 1982 few traces of these people had been found, suggesting most had escaped. But now scores are being unearthed at the seafront, where they fled. Some of the most dramatic finds (*below*): **A** a chamber where a group of 12 died together in the ash, **B** a chamber containing a horse and about 40 tangled humans, **C** a chamber where 26 skeletons were eerily lined up in rows, **D** the Ring Lady, **E** the Soldier, **F** a pregnant young woman, **G** a Roman boat, **H** the Helmsman, **I** the Pretty Lady, and **J** the woman called Portia, who may have been hurled down from the town by the force of the volcano's blast.



PHOTOGRAPH BY LOUIS S. BLAZMAN (PREVIOUS PAGES)



City beneath a city, Herculaneum lies 20 meters below the surface of Ercolano, with less than half excavated so far. The old

seawall, once on the waterfront, today stands half a kilometer from the bay. Beyond the excavation and surrounding



*trellised fields the twin peaks of Vesuvius rise against a profile of the volcano as it appeared before it threw six cubic kilometers*

*of ash and pumice into the sky. A museum, at right, built in 1980 to exhibit the ancient city's treasures, has not yet been opened.*

(Continued from page 576) "entirely fearless" uncle hurried toward the volcano, "to the place everyone else was hastily leaving."

His ship was cut off by a fiery ashfall and floating rafts of pumice, but eventually managed to land to the south at Stabiae. That night he tried to allay the fears of his local friends by telling them that the "broad sheets of fire and leaping flames" on Vesuvius were "nothing but bonfires left by the peasants in their terror."

He then slept while his companions sat up all night debating whether to stay in their houses or flee. Finally the buildings began to shake so violently that Pliny and his friends put pillows on their heads to protect themselves from falling rocks and took flight.

Dawn had broken on the morning of August 25, yet Pliny found this dark day "blacker and denser than any ordinary night." Wild waves made escape by sea impossible. Pliny grew tired and repeatedly asked for cold water. Then suddenly the "flames and smell of sulfur" drove his companions to flight. The elder Pliny collapsed, perhaps of a heart attack. Two days later his body was found on the beach at Stabiae.

Meanwhile, Pliny the Younger and his mother, 32 kilometers away, saw a "fearful black cloud . . . rent by forked and quivering bursts of flame" moving across the bay. They fled, along with most other terrified residents of Misenum. As the cloud descended, "many besought the aid of the gods, but still more imagined there were no gods left, and that the universe was plunged into eternal darkness for evermore."

Eventually the cloud lifted and the younger Pliny saw "everything changed, buried deep in ashes like snowdrifts."

"Of course," concludes Pliny, "these details are not important enough for history."

To volcanologist Haraldur Sigurdsson, Pliny's details give remarkable geologic clues as to what was actually happening first at Pompeii and later at Herculaneum. They correlate beautifully with data made possible by new volcanological concepts developed in the 1970s and corroborated since the eruption of Mount St. Helens.

With Sigurdsson I return to Pompeii.

**W**E ENTER the city, like most tourists, through the old Sea Gate, and head toward the forum. We pass a lineup of what in ancient days must have been bars and storefronts in this busy Sarno River port.

In Pompeii's prime, with its population ranging between 10,000 and 20,000, a babble of languages, from Germanic to Hebrew, mingled in the forum. They still do, as innumerable sightseers from America, Germany, Japan, not to mention Italy itself, march uphill and mob the town center.

Pompeii clearly has fallen on hard times again. The 1980 earthquake severely damaged many buildings. Along street after street, scaffolds brace crumbling houses. All but a small percent of the city has been closed to tourists, confining the throngs of visitors to an insufferably cramped area.

Little, if any, attempt is being made to reopen the closed areas. Weeds grow tall.



*The past shapes the present at Piano di Sorrento (left) and Herculaneum (right). Just as in ancient times, fishermen work off a beach lined with arches of boat chambers. From their Ercolano terrace, a family looks across the ruins of Herculaneum. Ever since the discovery of the buried town, some residents living atop it have had cause to fear its rebirth: Homes are at stake with each addition to the excavation area.*



Exposed wall paintings continue to fade and decay. There is, we are told, inadequate money to maintain such a large monument, even though the city generates considerable tourist revenue.

"The great irony of Pompeii," says a visiting scholar, "is that as long as material is buried it remains beautifully preserved. We have to excavate in order to appreciate. But as soon as we excavate something, we assure its destruction."

Largely for that reason, new excavation proceeds extremely slowly. "We are using what poor moneys we have to restore what

we can and save what can be saved," explains Pompeii's director, Stefano De Caro.

**P**OMPEII was probably founded by the aboriginal Oscan people many centuries before the A.D. 79 eruption. Over time the city was conquered by the Greeks, the Etruscans, and by a belligerent Italic race called the Samnites, who greatly expanded it. About 80 B.C. the Romans made Pompeii a colony. They infused it with their culture and turned it into a major agricultural center, specializing in the export of fish sauce and wine.



## SALVAGING THE VICTIMS OF VESUVIUS



Like modern Naples, Pompeii's economy was characterized by small manufacturing businesses, often family run and operating out of the home. A painting outside a former felt-making factory on the heavily commercial Via dell'Abbondanza testifies to Pompeii's mercantile spirit: A winged Mercury alights bearing a bag of money.

When Vesuvius erupted, Pompeii was still recuperating from a devastating earthquake that had struck the region in A.D. 62. The roof of Pompeii's great basilica had collapsed, as had structures throughout the town. Seventeen years later the Pompeians

must have noted with dread the minor earthquakes that probably preceded the imminent eruption. Little did they know that the danger this time would come from the same mountain whose fertility had blessed them with prosperity.

How did the eruption begin? I ask Sigurdsson as we walk through the town.

"Probably the earthquakes became a continuous vibration, or a harmonic tremor," he explains. "Then, I imagine there was a series of small but spectacular steam explosions that opened a crater at the summit.

"In the early afternoon on August 24 the



ALL BY CHERYL WILKES

**J**ET OF WATER excavates a skull (*top left*) that will go to Dr. Sara Biesel (*above*) for treatment. "The skeletons," she says, "come to me so well preserved because they have been kept continuously wet by groundwater percolating through the volcanic soil. Perfectly sealed, they endured no temperature or humidity changes. With exposure comes quick deterioration, and my first job is to stop it."

After washing each bone with a soft toothbrush (*left*), Dr. Biesel allows them to dry on a screen for two days. Then she dips the bones in an acrylic-plastic emulsion and allows another day for them to dry and harden. Thereafter the bones are ready for reconstruction. Behind her work area ranges an expanse of volcanic soil under cultivation. "That soil is so rich," she says, "it would make a dead stick bloom." Before Vesuvius struck, it was part of the sea.



city would have been rocked by a tremendous 'Plinian blast.' It is called that because the blast created the great umbrella-shaped cloud that Pliny saw from Misenum.

"This eruption column, laden with pumice and ash, must have risen 20 kilometers or more. About 30 minutes after the blast the falling pumice began to cover the city. There was no lava in this eruption. The magma was too explosive, too filled with steam and other hot volatiles. Steam turns magma to a froth we call pumice.

"Pumice is too light to hurt anyone, but lots of rocky projectiles, some the size of cannonballs, would have been torn from the sides of the volcano. That's why Pliny the Elder had pillows on his head.

"The pumice accumulated at 15 centimeters [six inches] an hour. After about four hours, or by late afternoon, roofs would have started collapsing from the weight. The eruption created close to total darkness."

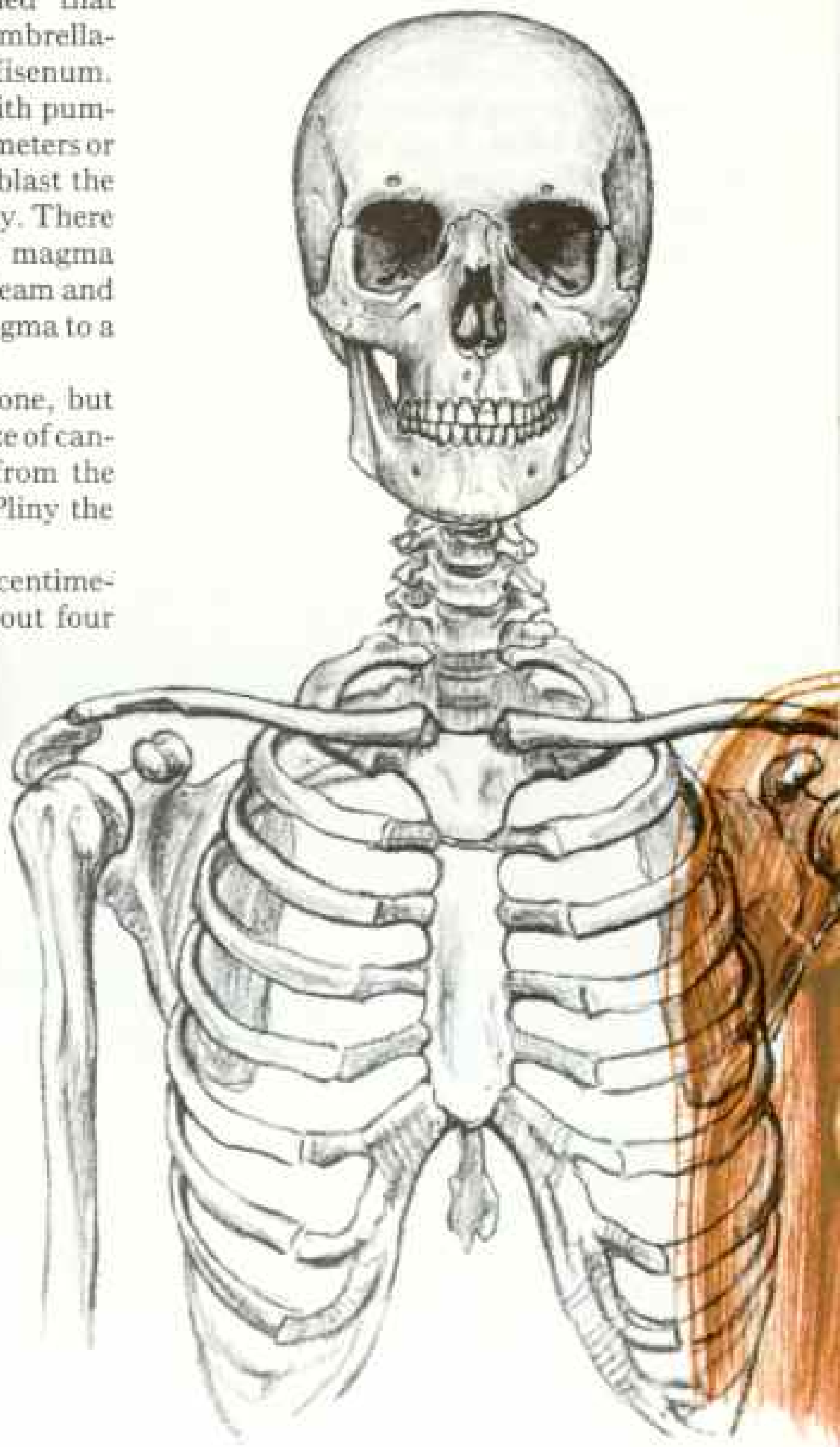
We walk to a cemetery just outside the city walls. There excavators have cut through the volcanic blanket Vesuvius laid down, and have inadvertently revealed a stratigraphic record of the eruption.

Each phase of an eruption, volcanologists have learned, deposits a stratum with a characteristic range of grain sizes. As Sigurdsson puts it, "Grain sizes are the fingerprints of an eruption. They are my bones."

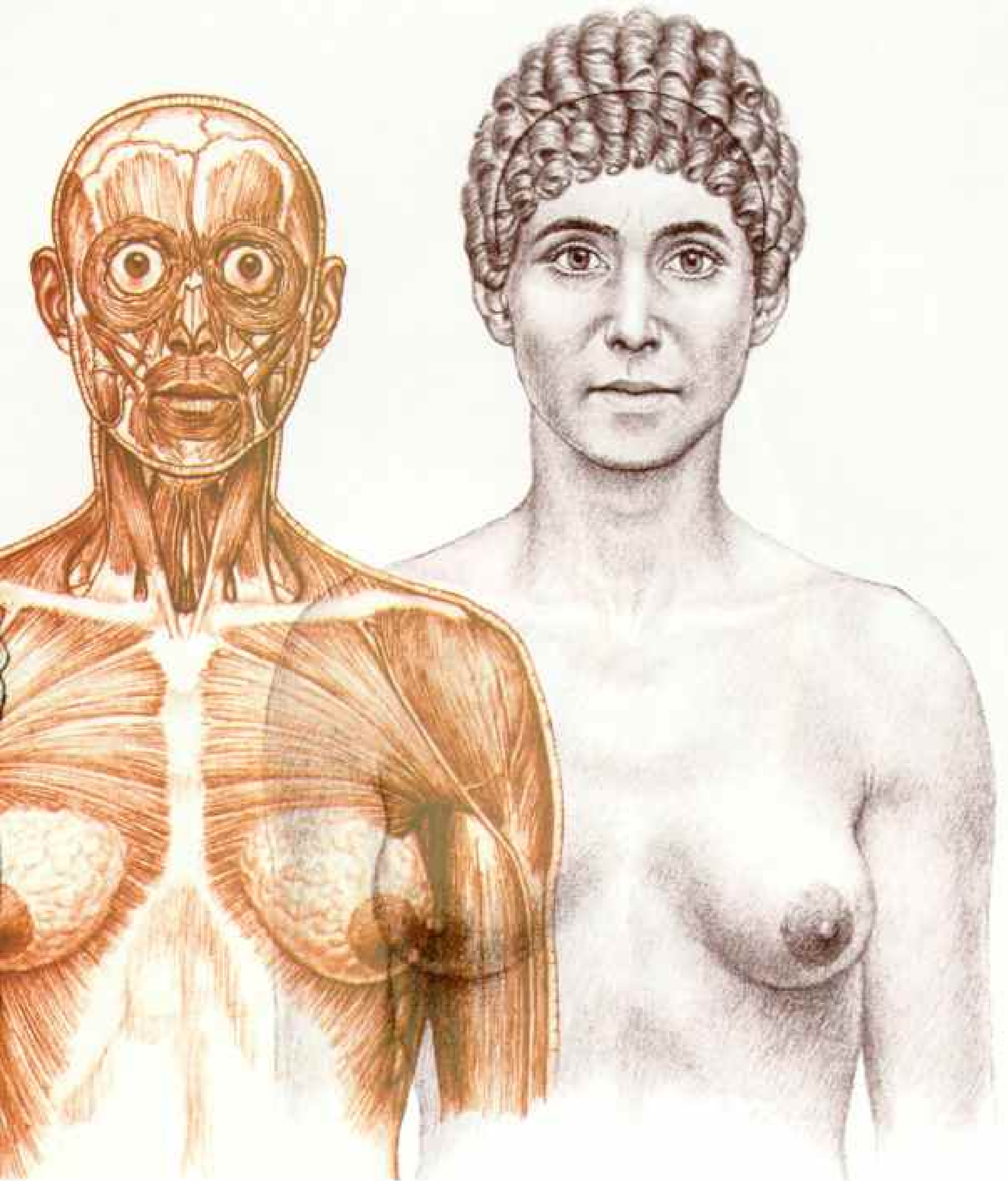
Sigurdsson kicks the bottom of this wall of earth. "This is the ground—the rich, fertile soil of A.D. 79," he says.

I reach down and pull from the bottom a light, airy rock—one of the first pieces of pumice that struck Pompeii. Over 17 hours, 2.7 meters (9 feet) of this pumice rained on the city. The worst was yet to come.

As the volcano's energy abated, it could no longer sustain the 20-kilometer-high eruption column, which began fluctuating like a giant fountain. At the fountain's ebb, enormous quantities of fine ash and pumice collapsed onto the volcano's flanks, becoming those lethal glowing avalanches.



*Beauty more than skin deep* guided artist Jay H. Matternes in the fleshing out of a skeleton found on the beach and called the *Pretty Lady* by Dr. Sara Bisel. "In life she was about 35 years old," says Dr. Bisel, "with a lovely face of rare proportion, perfect teeth, and a dainty nose. Her bones were slender, and she



stood about five feet." Since muscle use affects the shape of the bones, Dr. Bisel thinks that the Pretty Lady probably was not a lady in the aristocratic sense. "Her arms were well exercised, indicating that she worked, perhaps as a weaver."

To develop facial musculature and other anatomical structures, Matternes studied

cadavers at a medical school in Washington, D. C. The diadem hairstyle is typical of the first century A.D. The size of the breasts is a guess, but their shape could have been influenced by whether the Pretty Lady had given birth, an unknown factor since her pelvic bones are missing. The artist has painted her as if she had been childless.



Several of those avalanches, Sigurdsson has recently determined, stopped before reaching Pompeii. One came right up to the walls of the town. These avalanches and the vegetation and buildings they ignited probably created the bonfires Pliny the Elder attributed to peasants. No doubt they triggered panic atop the pumice-covered streets of Pompeii.

Sigurdsson reaches up to touch a thin layer above the pumice in the cemetery strata. "This represents the first glowing avalanche that entered Pompeii," he says. "Clearly that was what killed people here as well as at Herculaneum. I have found roof tiles it blasted off in this stratum. In all we see three avalanches within Pompeii. Each is separated with more ash and pumice."

**W**ANDERING BACK through Pompeii, I can see evidence of those surges everywhere I look. Just above head height, where the protective pumice blanket ended, many walls appear clipped off, as if by some huge scythe.

Then there are the many famous plaster casts of humans and even a chained dog at their anguished moments of death. In the 1860s chief excavator Giuseppe Fiorelli developed a technique of injecting plaster into hollows that his diggers came across in the volcanic earth. These hollows were, in effect, molds created as the bodies of victims decayed. Thus the plaster preserved the forms and postures of people as they fell.

For example, in the so-called Fugitives Garden lie casts made in 1961 of seven adults and six children. They appear to be gasping and choking.

"These people would have been on the run, like those now uncovered at Herculaneum," explains site director De Caro. "Until recently we did not think these deaths were so concentrated into one moment."

Thus, many died at Pompeii because they waited too long inside their houses, where they felt safest. Some were killed when their roofs collapsed. Others found themselves trapped inside by the pumice fall and then sealed in and asphyxiated by the glowing avalanche. The death toll may actually be much higher than the 2,000 previously estimated.

*Glorifying the body, Romans took pleasure in portraying nudes, though clothes were sometimes painted on them. Here Venus (facing page) gets ready for her bath, supported by Priapus, the promoter of fertility, as her son Cupid sits at her feet. The goddess of love wears gilt arm bracelets, a fashion copied by Angela Barrelli (below) of Ercolano, who models jewelry recently recovered.*



FROM POMPEII, NATIONAL ARCHAEOLOGICAL MUSEUM (FACING PAGE)

"I think the majority of Pompeii's victims have not been found," says De Caro. "They are still out there waiting, beyond the city gates. They were in flight."

Who were these people? Several times I return to Pompeii and roam the streets and houses to understand better those who died.

Certainly they could be poetic. Consider a piece of verse written on the walls beside the House of C. Julius Polybius:

*Nothing can last in unending time.  
When the sun has shone brightly, it  
returns to the sea;  
The moon wanes which just now was full.  
So the savagery of love's passions often  
ends up as a gentle breeze.*

They could likewise be brazen. Outside



*Miraculous survivals, many home furnishings weathered Herculaneum's volcanic storms. Curiously, the hurricane-force surges*



*of gas and pumice—a glasslike insulator—that killed the people protected the objects they covered from the thick, superhot*

*flows that followed. The weight of the deposits caused the ground to give way beneath the atrium floor in the House of the*



HOUSE OF THE WOODEN PARTITION (ABOVE); CLOTH MERCHANT SHOP (RIGHT)





*Mosaic Atrium (above), which was graced with a spectacular view of the sea.*

*The heat carbonized a wooden cabinet (above left) in the upper floor of the House of the Bicentenary. An imprint in the wall above it, perhaps of a cross, inspires the belief that Christians lived in the house; if true, it is one of the oldest evidences of the cross as a symbol of Christianity.*

*A wooden bed (far left) still retains the latticework pattern of slats that supported a mattress of fine-spun wool or sweet grasses. Raised panels at the head and one side protected against the chill walls.*

*A carbonized cloth press (left), now covered with glass, utilized the same principle as the printing press, invented 14*

*centuries later, while a bronze bathtub and a marble basin (below) set a style for plumbing fixtures that survives to this day.*



HOUSE OF THE STARS

the Thermopolium (or bar) of Asellina, where bronze cups, lamps, and even petty cash were unearthed, are scrawled the names of three women, who presumably entertained their clients in the upstairs cubicles. Other inscriptions indicate that they were soliciting support for a favored candidate in an upcoming election.

At the Taverna Lusoria, a popular gambling house among young men and women, the owner marked his loans on the walls and offered rooms to amorous customers.

To us the Pompeians might seem immodest. Nudity was regarded as natural, the human body was glorified, and athletes exhibited their physiques with pride at the theater. The House of the Vettii, among others, was adorned with statues and paintings that many people today would label obscene.

It is also clear to anyone who roams Pompeii that residents prized their gardens.

"They lived in their gardens, they ate in them, they made them a major part of their lives," says Wilhelmina Jashemski, who has studied the gardens for decades. "After the A.D. 62 earthquake many people restored their gardens before their houses."

To create an illusion of more and grander space, imaginary garden scenes with elaborate fountains, luxuriant flora, and exotic birds were often painted on the walls of real Roman gardens.

"Sometimes it's difficult," one expert tells me, "to reconcile these people who loved the out-of-doors and growing things with people who took delight in the slaughter of the amphitheater."

**H**UNT SCENES were another motif of the garden wall paintings. With Ian Sutherland, a Duke University graduate student, I see a huge mural in the garden of Marcus Lucretius Fronto. It depicts a bizarre assortment of animals: A lion attacks a bull, a tiger trails a deer. Bears, boars, snakes—all are dramatized.

"This is a mélange of every animal they knew about that might have been vicious or combative," says Sutherland. "That appealed to the Roman taste. They staged these same kinds of combats."

Pompeians also showed a passion for the theater. In the wall paintings that decorated their inner rooms, theatrical themes seem

almost as popular as mythology. As historian Margarete Bieber wrote: "The art of acting was highly developed among the Romans. The Italian natives have always had a special gift for mimicry. They are born improvisators, having lively gestures."

Thus some wall paintings simply recreate the elaborately decorated prosceniums of theaters. Comic and tragic masks, along with mimes and pantomimes, were popular motifs. Also common were scenes from the great Greek myths: Medea drawing a sword to kill her children; Priam kneeling before Achilles; Iphigenia preparing to be sacrificed.

The bath was yet another institution treasured by these people. It was far more than a cleansing experience. It was a social event, wherein one relaxed and met friends. A man like Pliny, for instance, would have regarded his leisurely afternoon hours at the bath as a vital part of his day.

Pompeii had at least three public baths. Yet perhaps the most sumptuous so far unearthed on the Bay of Naples lies on the other side of Vesuvius at Herculaneum.

I well recall my first visit to the Suburban Baths. A skylight in its delightful, atrium-like entry room illuminated a fountain featuring a delicate bust of Apollo. Remnants of wall-to-wall paintings still adorned the *frigidarium*, or cool bath.

Another room featured a swimming pool where patrons could have lounged and gazed out over the bay through panoramic windows. Now out those windows the only vista I had was of a six-story-high wall of solidified pyroclastic earth.

Other reminders of Vesuvius still haunted this bathhouse. A door leading to the *frigidarium* bulged with an invading blob of the hardened avalanche. In the *calidarium*, or hot bath, the window frame was thrust inward where the glowing avalanche had burst through. Glass shards from that window were found in a heavy marble basin the avalanche had flung across the room.

I was visiting the bath that day with Sara Bisel. Just below us was Herculaneum's ancient beach and the chambers with all those bones that had brought her to Herculaneum. Later that day I crouched with her on the beach as she dug out her first skeleton, a female we nicknamed Portia.

**A**LAS, POOR PORTIA. Her skull was smashed, her pelvis crushed, and now Sara Bisel was playing what seemed like a grisly game of pick-up-sticks with her bones. Yet I felt oddly elated to see sunlight striking Portia's battered bones and to watch flies buzz about her for the first time in nearly 2,000 years.

"Portia had a great fall. I'd bet she was flung from up in the town," said Bisel as she worked. "She clearly landed on her face from some distance. There are roof tiles beneath her. Her thigh bone was thrust up to her clavicle. I don't know if I can put her together again, but I'll learn a lot about her.

"I'll determine her height by measuring one of her long bones. The state of her pelvis will tell her age and how many babies, if any, she had. I might even tell you whether she was pretty, but her face is shattered. Her bones should reveal whether she was well nourished, whether she had any of a number of diseases, and whether she had to work hard for a living. And she's just one person. There's a whole town here!"

On this and subsequent visits I wandered the streets of that town, which differs dramatically from Pompeii.

For one thing, the wet burden of earth, moistened by the copious groundwater that flows down Vesuvius, has sealed and preserved Herculaneum far better than the pumice blanket could protect Pompeii. Kept continuously wet and protected from air and climatic changes, many perishable items of everyday life remained intact, albeit often charred. Whole pieces of furniture—beds, cupboards, tables, and chairs—along with fishnets and such foodstuffs as cereals, bread loaves, eggs, vegetables, and even chicken bones, were unearthed much as they were when abruptly abandoned. Herculaneum thus gives us a more intimate look at Roman life.

The wet earth was also what kept Herculaneum's skeletons in such good condition. For as the victims decayed, the conserving mud compressed about the bones, rather than leaving mere hollows as at higher and drier and ash-covered Pompeii.

Herculaneum still greets the visitor with the same unhurried air that one breathes now off-season at nearby Capri or Positano. Like the latter resort, it once descended

steeply to the sea, making heavy commercial traffic impossible. Its vistas must have enchanted the wealthy Romans who came here on retreat.

Idyllic as Herculaneum was, it was more than a resort. Much fishing equipment was unearthed. Therefore, many of its 4,000 to 5,000 inhabitants lived off the sea. Herculaneum lacks the numerous small factories that characterized Pompeii; it seems more a town of craftsmen and artisans. Yet the many refined houses, and indeed the elaborate theater and baths, tell us that a corps of affluent, cultured people also made their home in Herculaneum.

One of these homes, the Villa of the Papyri, yielded to 18th-century treasure hunters numerous bronze busts and statues, including copies of earlier Greek masterpieces that are now lost. This villa's owner, obviously a wealthy and influential Roman, also kept a great library of papyrus scrolls. Many of these charred, but still legible, manuscripts were recovered. Others, however, may still remain buried in this grand villa. Toxic gases forced the early excavators to abandon the site and seal the tunnels leading to it. The villa's reopening and complete excavation, says Attilio Stazio, director of Naples' Institute of Archaeology, is perhaps Italian archaeologists' highest priority. But the project will take many years.

More immediate discoveries continue on the beach at Herculaneum. Three months after Sara Bisel's arrival I return to the site to find her well into her analysis of the skeletons—the skulls, tibias, fibulas, and other osteal remnants of twenty men, eight women, and nine children—each in its own yellow box and lined up against a wall in her laboratory. The first 12 are the so-called household in flight.

"In that chamber there were three adult males and four females," Dr. Bisel tells me. "I estimate the men were 35, 31, and 25, and the women 42, 38, 16, and 14. There were five children, but I can't tell people's sex before they reach puberty. The three-year-old was wearing gold-and-pearl earrings. The five-year-old had cavities and an abscess. There were also a nine- and a ten-year-old; the latter had an iron house key near him, along with a seven-month-old baby.

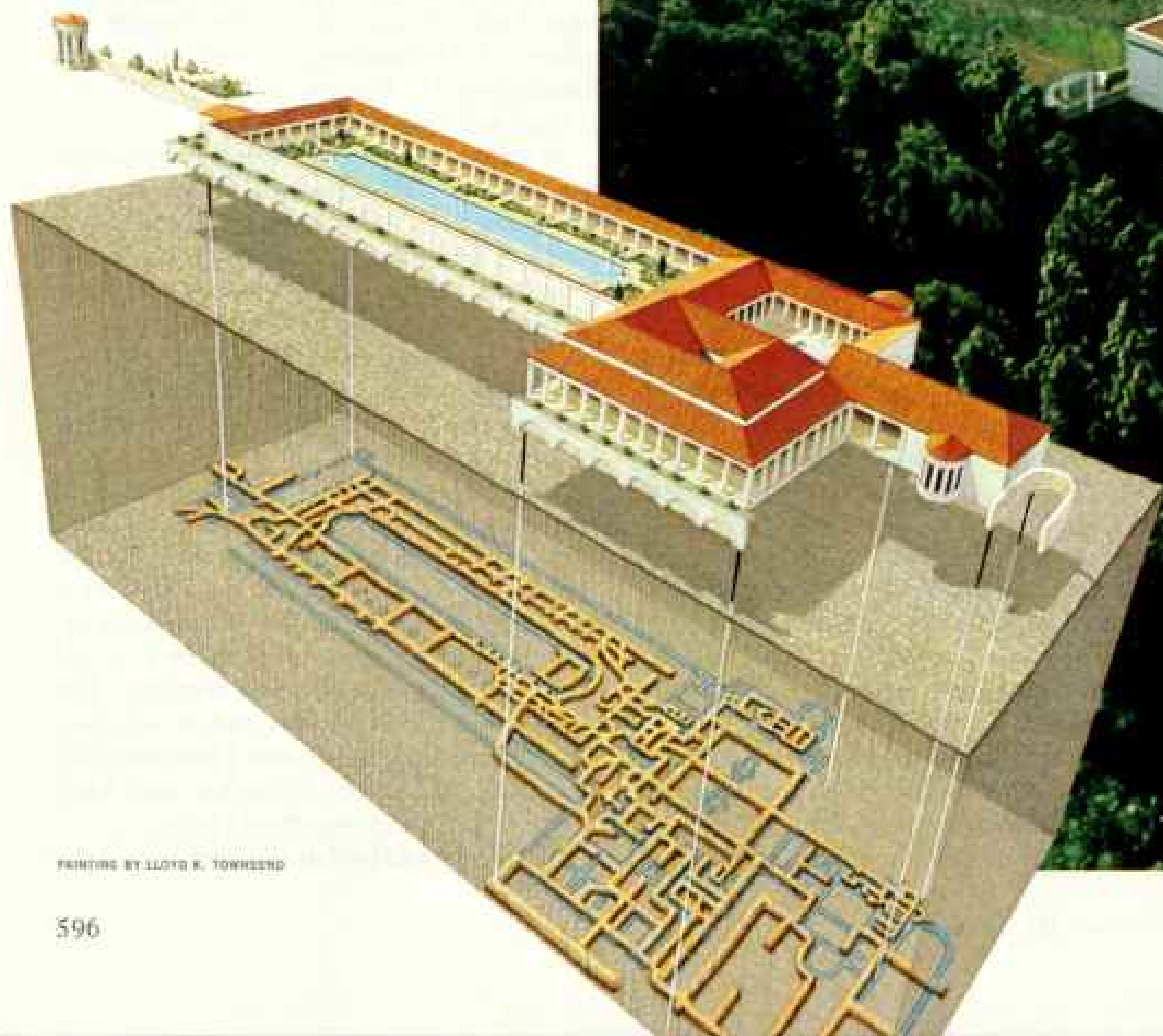
"The baby was probably upper class," she



# A VILLA REBORN

**W**ITH THE DISCOVERY in the 18th century of an enormous private villa overlooking the sea, hundreds of laborers, including some prisoners, were ordered underground to dig out the works of art, precious books written on papyrus scrolls, and rare marbles that were the glory of the fabulous home. Then toxic gas made the work deadly, and the tunnels were sealed. The Villa of the Papyri was “lost”—and remains so to this day. But, luckily, a Swiss engineer and one of the site’s excavators, Karl Weber, drew its plan, making this artistic rendering possible (below). Italian authorities dream of complete excavation.

Incredibly, the villa’s plan also provided the blueprint for an actual reconstruction, another seaside villa (right) filled with works of art—the J. Paul Getty Museum at Malibu, California. Here, within sight of the Pacific, the replicated building has been placed among gardens similar to those beloved by the Romans. Galleries display sculptures and mosaics from ancient Greece and Rome, just as did Herculaneum’s villa.



PRINTING BY LLOYD K. TOWNSEND





continues. "It wore jewelry and was being cradled by the 14-year-old, who I suspect was a slave. I say that because there are scars on the upper shafts of her humeri, where the pectoralis major joins the bone. That means she used those muscles for heavier work than she should have."

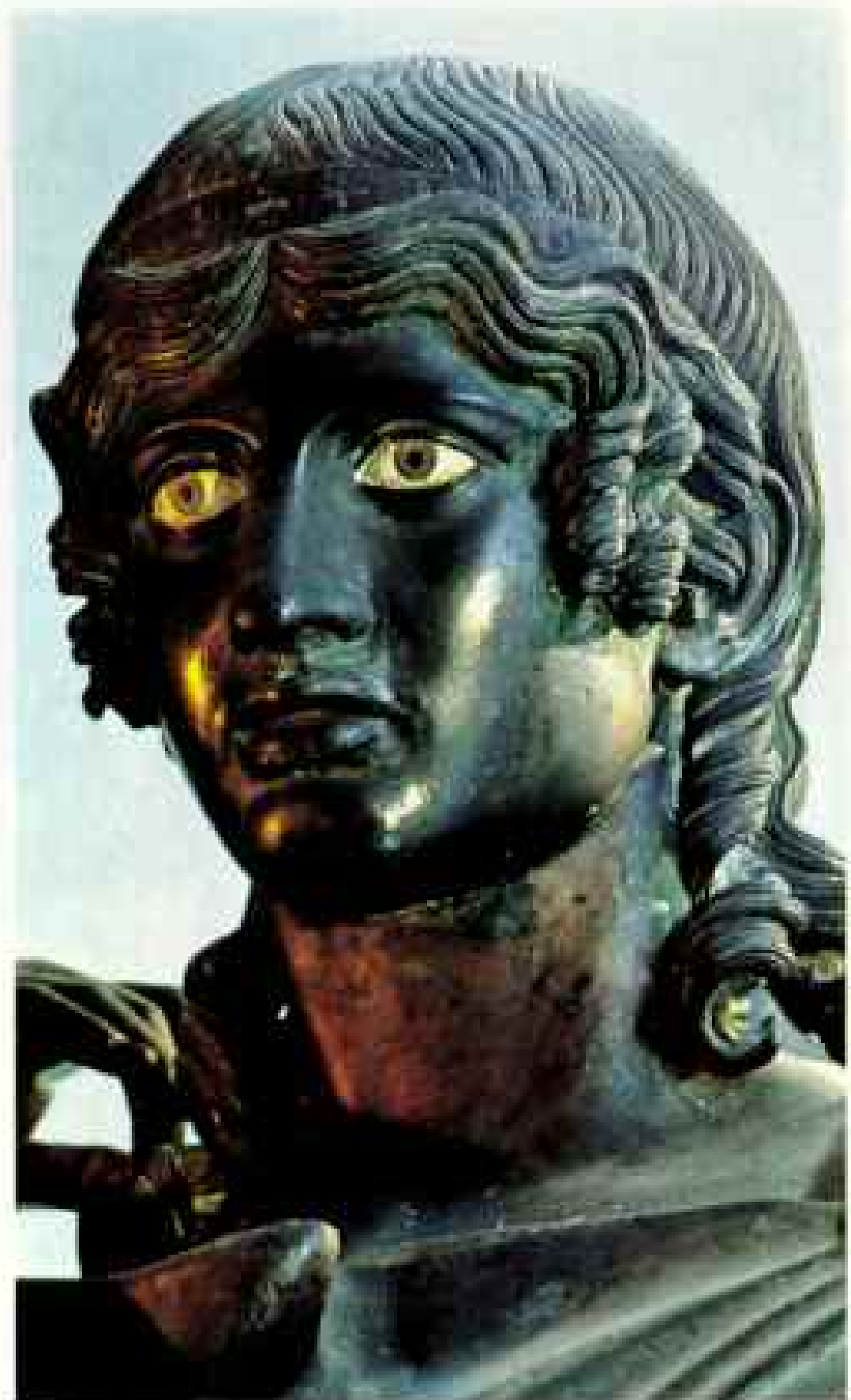
Dr. Bisel picks up the girl's skull. "See these grooves on her teeth? They indicate that she didn't get enough to eat when she was about 11 months old. She almost died

either from illness or starvation. She was a very good-looking girl. That probably complicated her life if she was a slave."

**A**NOTHER seven months pass, and Dr. Bisel has now analyzed the bones of 45 adults and 10 children. "Except for the slaves, these people are very healthy," she says. "There are few signs of anemia. They had enough to eat. Many of the presumed slaves, however, appear



*Lifelike in grace and size, and all in bronze, young athletes stand before a line of Grecian ladies and a Roman bust—part of the rich harvest from the Villa of the Papyri, now in the Naples National Archaeological Museum. Eyes of glass paste (below) enhance the facial expressions of the young women who were found in the villa's garden. They have been called dancers, but possibly represent water carriers.*



to have been dreadfully overworked.”

She rummages through the bones in yellow box number 27. “This man we call the Helmsman, because he was found next to the boat. He was about 46 and probably a slave. He did not have good treatment, good food, good anything. I don’t think anyone who had any choice would look like this. A free man would stop when his body hurt as much as this man’s must have.”

Dr. Bisel picks out his upper arm bones.

“See these large crests on the bones? That’s where the deltoid muscles attach. They indicate he did heavy labor.

“It seems safe to say this guy did not have *la dolce vita*,” she says, while digging out a piece of the Helmsman’s spine. “Six of his middle thoracic vertebrae are fused. You can see the strain put on his arms and back.”

She leads me to another box, number 46. “This is my Pretty Lady,” she says, picking up a skull. “Just look at her profile and that



delicate nose. In your mind's eye, spread a little flesh over these bones. She was lovely! I think she was a middle-class housewife. The way she used her arm muscles makes me suspect she was a weaver."

Next Dr. Bisel goes to a skull most dentists would like to exhibit. It belongs to the celebrated, bejeweled Ring Lady.

"The Ring Lady was special," site director Maggi had told me earlier. "The quality of her objects shows that she came from a class or family that had taste. She is really something!"

"The Ring Lady was a relatively tall, well-nourished woman of about 45," Dr. Bisel explains, skull in hand. "Her teeth had no cavities or abscesses. These people didn't use sugar. *But* she did have periodontal disease. Look!"

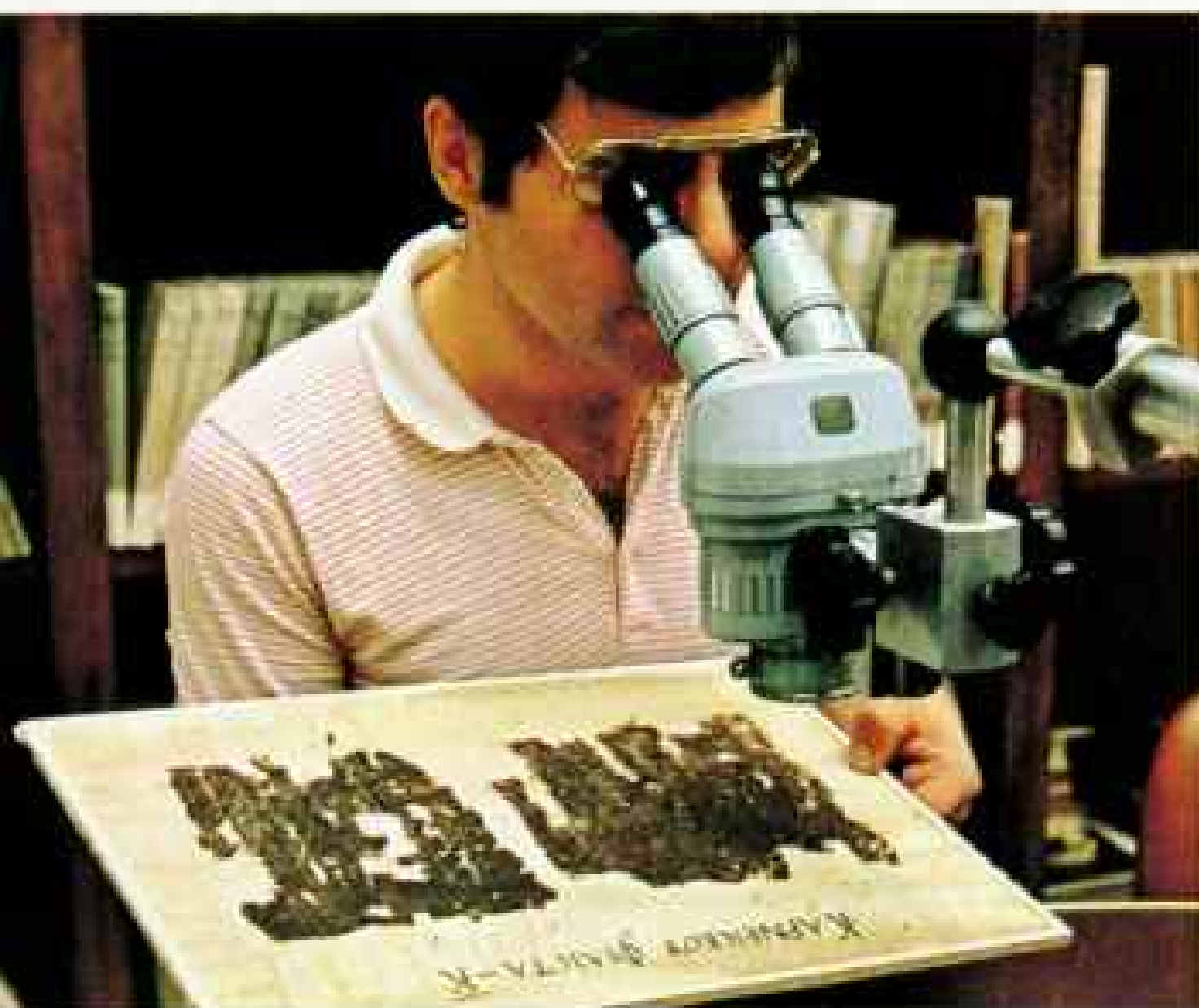
She points to numerous little pits on the bone along the Ring Lady's gum line. "This is why you floss every day."

I ask about Portia, the first skeleton Bisel had unearthed. "Portia was about 48, certainly *not* good-looking," she replies. "She had extreme buck teeth. Also, certain of her pelvic bones show rather unusual and unexpected changes. I do not like to make accusations across 2,000 years, but Portia's pelvic bones resemble those I once saw from a modern prostitute."

A less speculative finding is an extremely high, probably pathological, level of lead in Portia's bones.

Scholars have long debated, often furiously, whether lead poisoning could have been widespread among the Romans. Lead can cause

*(Continued on page 606)*



*From the villa's library, a scroll of papyrus (above)—words sharply recorded in black ink—is among the 1,800 carbonized scrolls recovered. Science has unrolled a thousand, which scholars are studying with meticulous scrutiny (left). The writings are largely those of the Epicurean philosopher Philodemus, thought to have lived at the villa under the patronage of its presumed owner, L. Calpurnius Piso, father-in-law of Julius Caesar. This scroll expresses Epicurus's own philosophy, since it begins by saying "... god is not the world," a reflection of his belief that the gods have nothing to do with government nor do they feel anger or love toward men.*





## PRECIOUS PRIZE— A ROMAN BOAT

**L**IKE A DETECTIVE, Richard Steffy, a nautical archaeologist from Texas A & M, collects clues to piece together the story of this upended, carbonized boat, discovered on the beach of Herculaneum. "This boat is unique," says Professor Steffy; "the inverted hull covers and preserves important information about its use and the steering techniques of small first-century Roman craft, of which we know little. Since most ancient wrecks have been discovered upright on the seabed, only the lower hulls were preserved." But

raising the boat to uncover its secrets, scheduled for sometime this year, will be tricky, since the charcoal crumbles easily.

A fresco from ruins of the ancient port of Ostia depicts a boat (top) reminiscent of the one at Herculaneum. The Ostia vessel, known as Isis Geminiana, is shown being loaded with grain, probably to be hauled from the port up the Tiber River to Rome. An iron remnant of an ancient anchor found on Herculaneum's beach provides a model for an excavator's drawing (below).



VATICAN LIBRARY, ROME (TOP); CHERYL NUSS (ABOVE)

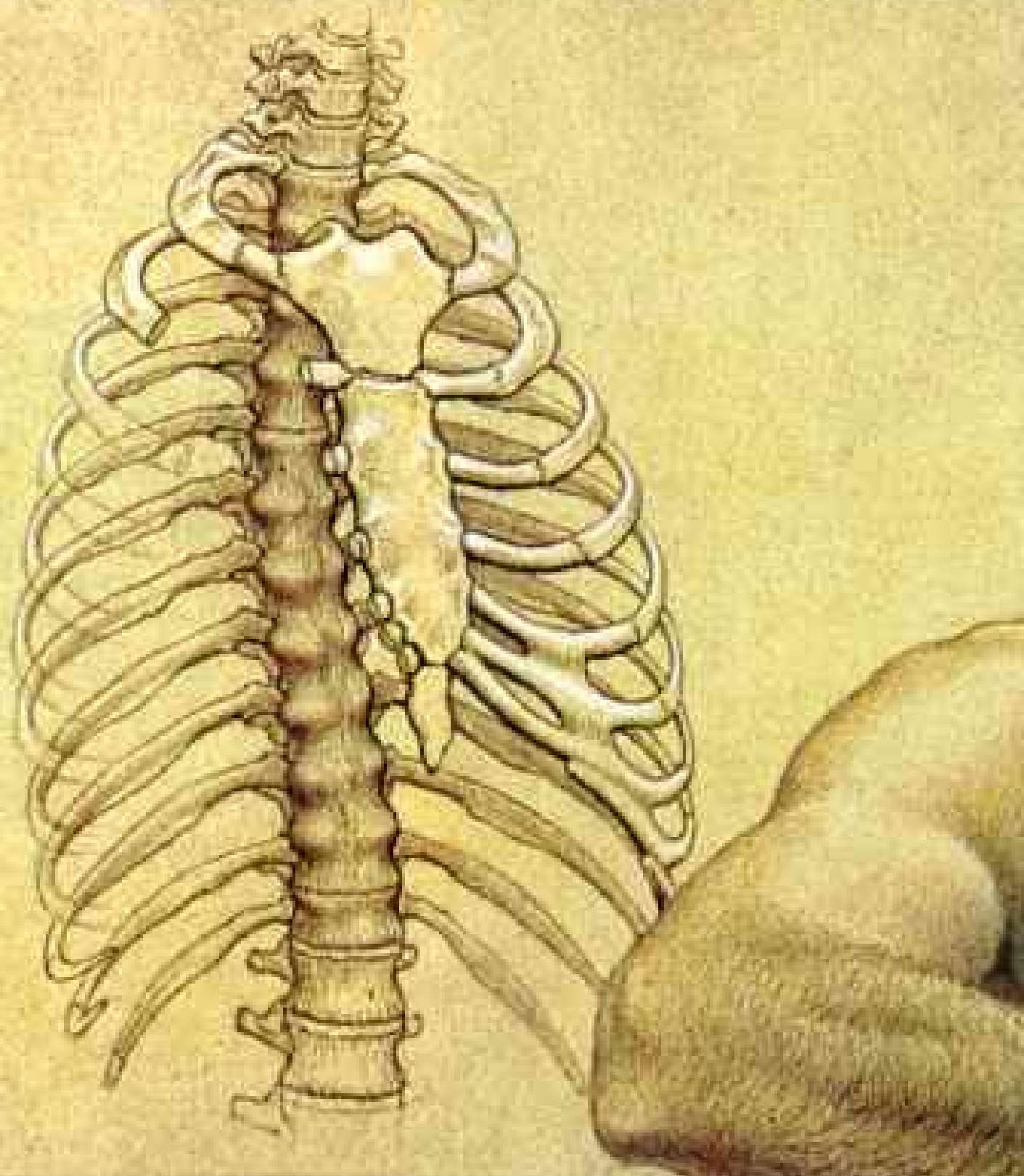


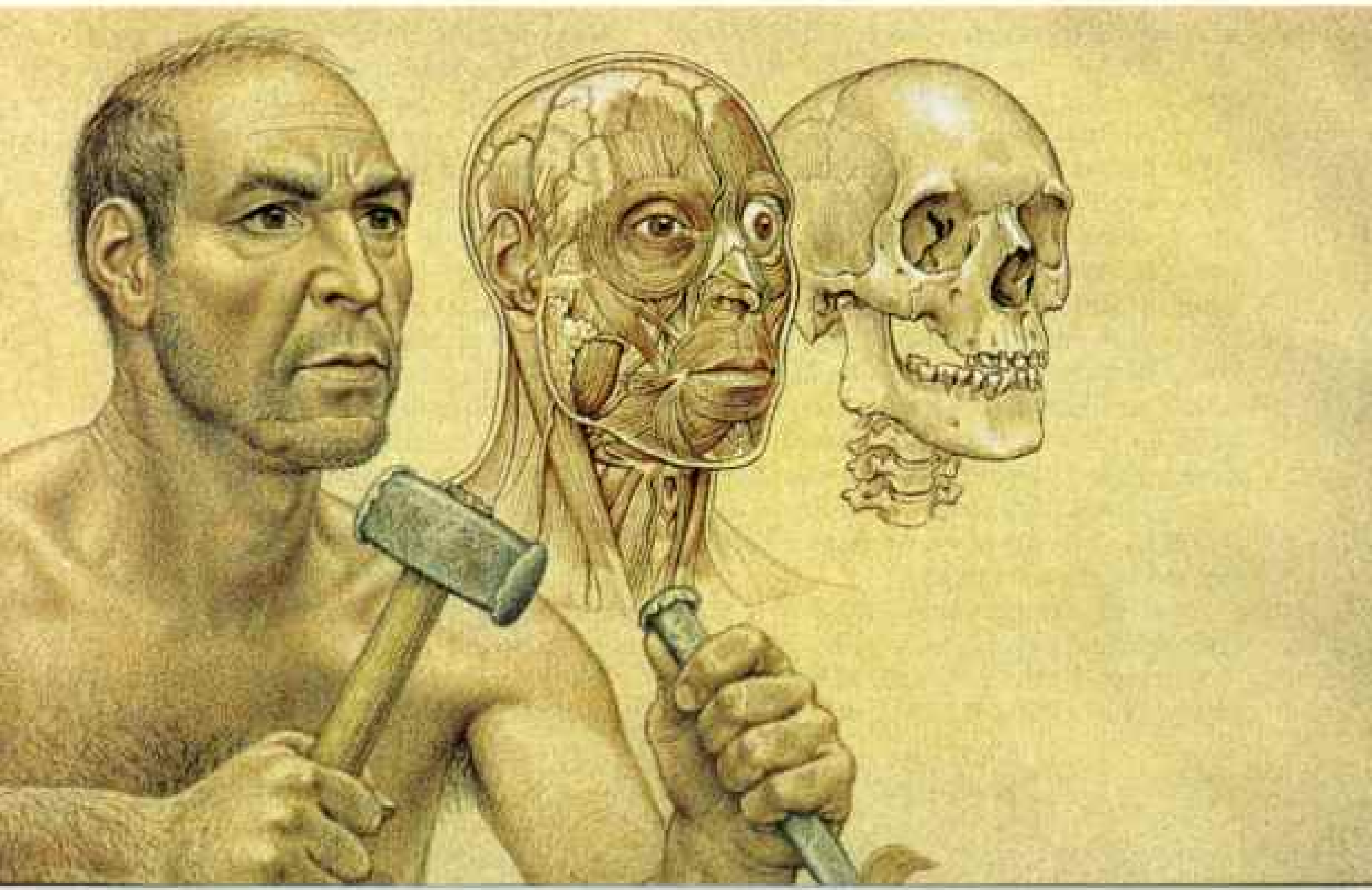


*"A poor slave with nothing going for him," decided Dr. Biesel of the man whose skeleton (above) was found near the boat. He has been called the Helmsman, although his body did not arrive on the beach with the boat. Dr. Biesel's analysis: "A short man, about 45 years old, with bones flattened from overwork and poor nutrition. A slightly-crooked back and fused vertebrae (drawing, near right) could have been caused by years of slave labor. He probably never had enough to eat, and his rotting teeth kept him in continual pain."*

*A finished timber near the seemingly new boat and other timbers on the beach lead Steffy to speculate that there was a boatyard nearby.*

DRAWING BY JAY H. MATTHEWS





brain damage. It has been suggested that the mad emperors Nero and Caligula suffered from lead poisoning. Now Dr. Bisel's chemical analysis of 45 skeletons shows that Portia and one other person had lead levels high enough to have certainly caused them some problems. Six more people had significantly elevated levels.

The most plausible way these people would have ingested lead is via wine. Grape juice was often boiled down in lead vessels to make the thick syrup used to sweeten some wines. Stirring the boiling syrup would have scraped lead from the pots. Thus, heavy drinkers risked heavy lead intake.

"This is the first hard evidence that the Romans may indeed have had trouble with excess lead," says Dr. Bisel. "In no way does it indicate that lead poisoning brought about the fall of the Roman Empire, but it does raise many questions that cannot yet be answered."

**U**NANSWERED QUESTIONS are everywhere. They also still surround that overturned Roman boat, and during the summer of 1983 Dick Steffy's problems seem to mount with each passing day.

Most important, the boat has proved to be fragile charcoal. If excavators try simply to lift it, Steffy estimates the boat will crumble into thousands of pieces. "I've never confronted a charcoal boat before," says Steffy on the beach. "Obviously, we're going to have to invent something."

For the time being, so much of the boat remains buried that Steffy cannot tell the bow from the stern for certain. Moreover, until the craft can be lifted, its interior remains invisible. And the interior, explains Steffy, holds most of the boat's secrets.

"It won't take me five seconds to tell you what this boat was all about once I see its insides," says Steffy. "I can tell you how it was built, how it was steered, how repairs were made, where the mast was, whether the sail was square, and probably what it was used for. Right now I'd guess we have a harbor tug or a local wine carrier."

From its exterior alone, however, the Herculaneum boat is proving important.

"It's longer than I thought at first," says Steffy. "I'm calling it a 30-footer. It has a

beautiful, sweeping hull, with much painstaking carving. The workmanship is on a par with the Greeks', and their shipbuilders were as meticulous as cabinetmakers. I didn't expect to find that in the Romans."

Steffy also suspects that a long tapered timber lying near the boat could be its mast. That would indicate that the hull belonged to a boat that was built for both sailing and rowing. He is also intrigued by another timber found close by. That one is especially thick, 70 centimeters in diameter. It might be a building timber. But it might also be a mast belonging to a very large vessel.

"There could be many fascinating ships out there," he says. "We know, for instance, that the Romans had highly decorated grain ships that were more than 140 feet long. What a dream to find one of those!"

Both Steffy and Haraldur Sigurdsson note that the beach is littered with finished timbers. These could be part of a pier that led out from the stair that descends from the town. Sigurdsson has determined that the ancient shoreline came right up to the city walls. Herculaneum thus had the narrowest of beaches. Waves must have lapped beneath the windows of the Suburban Baths.

The vast number of timbers, however, leads Steffy to wonder whether Herculaneum could have been a shipbuilding center. If so, the money it generated could explain the town's obvious but mysterious wealth.

Many of these timbers are aligned, as if driven by a great wave that roared around the corner of the bathhouse. Sigurdsson believes that not only the timbers but perhaps the boat as well were swept down from an unexcavated site not far away, possibly a shipyard.

Herculaneum, Sigurdsson notes, was built on a promontory, a tongue of land formed by a prehistoric eruption of Vesuvius. Small rivers flowed to the bay on both sides of the town. These river mouths could have served as small harbors.

Also, Steffy can find no teredo worm holes in the boat. Every other Mediterranean ship he has studied has been riddled with these borings. So the Herculaneum boat may have been newly built or hauled out of the water when not in use.

Could the boat have been trying to evacuate fearful residents? Sigurdsson's work

now makes that doubtful. The boat and its so-called Helmsman lie in different layers of the glowing avalanches that swept the town. So the Helmsman clearly was not in the boat when he died. The boat was deposited—perhaps from an adjacent shipyard—anywhere from moments to minutes after the Helmsman died from the first lethal surge.

We can thus only speculate now who this insignificant, overworked man we call the Helmsman really was. We can, however, do much more than guess about how he and his fellow townspeople died. By the time Haraldur Sigurdsson leaves Italy, his weeks of stratigraphic sampling on the slopes of Vesuvius will have created a detailed geologic post mortem.

In Herculaneum, Sigurdsson has found only a dusting of the early ash and pumice that barraged Pompeii. Being upwind from the mountain, Herculaneum was spared that first assault, even though it was in fact much closer to Vesuvius's summit. Nevertheless, earthquakes and fireworks from this volcano, whose crater lay a mere seven kilometers (four miles) away, must have alarmed Herculaneum's population. No vessels have been found in the boat chambers where the people took refuge, suggesting that at least some residents had fled by sea.

Examining exposed strata at quarries above Pompeii, Sigurdsson has found evidence that three major glowing avalanches roared down Vesuvius's slopes before one finally reached into Pompeii. Herculaneum was within their range, and thus it died seven hours before Pompeii.

Pompeii was hit, Sigurdsson says, in early morning on August 25. So Herculaneum was buried in the middle of the previous night. That explains why a lamp was found with the household in flight.

As a glowing avalanche descends a

mountain, gravity segregates it into two phases that Sigurdsson terms "surges" and "flows." Both phases, which scientists have described well only in the past decade, leave distinctive stratigraphic fingerprints.

The surge strikes first. This turbulent, ash-charged torrent forms a high, billowing cloud as it steams down the slope at speeds of 100 to 300 kilometers an hour and temperatures of 100° Celsius (212°F) or higher. Composed of air along with ash and the finer debris, the surge is made almost frothy by convection.

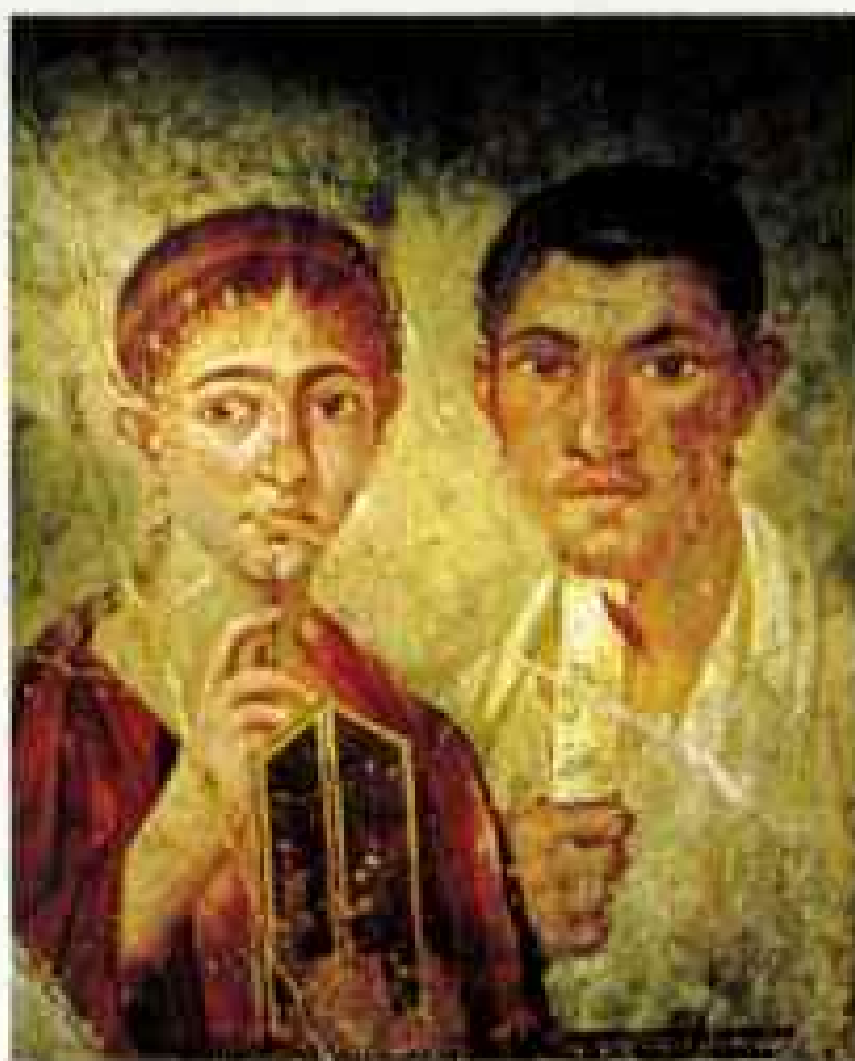
The denser, ground-hugging flow follows the surge, bearing the larger rock fragments and pumice both made fluid by temperatures as high as 400°C. Like a glowing river, the flow follows topographical features, such as streambeds, at slower speeds of 20 to 50 kilometers an hour.

Sigurdsson suspects that during the night the residents of Herculaneum may have been alarmed, like those at Pompeii, by several small glowing avalanches that did not quite reach the town.

"Seeing fiery tongues cascading down the mountainside would

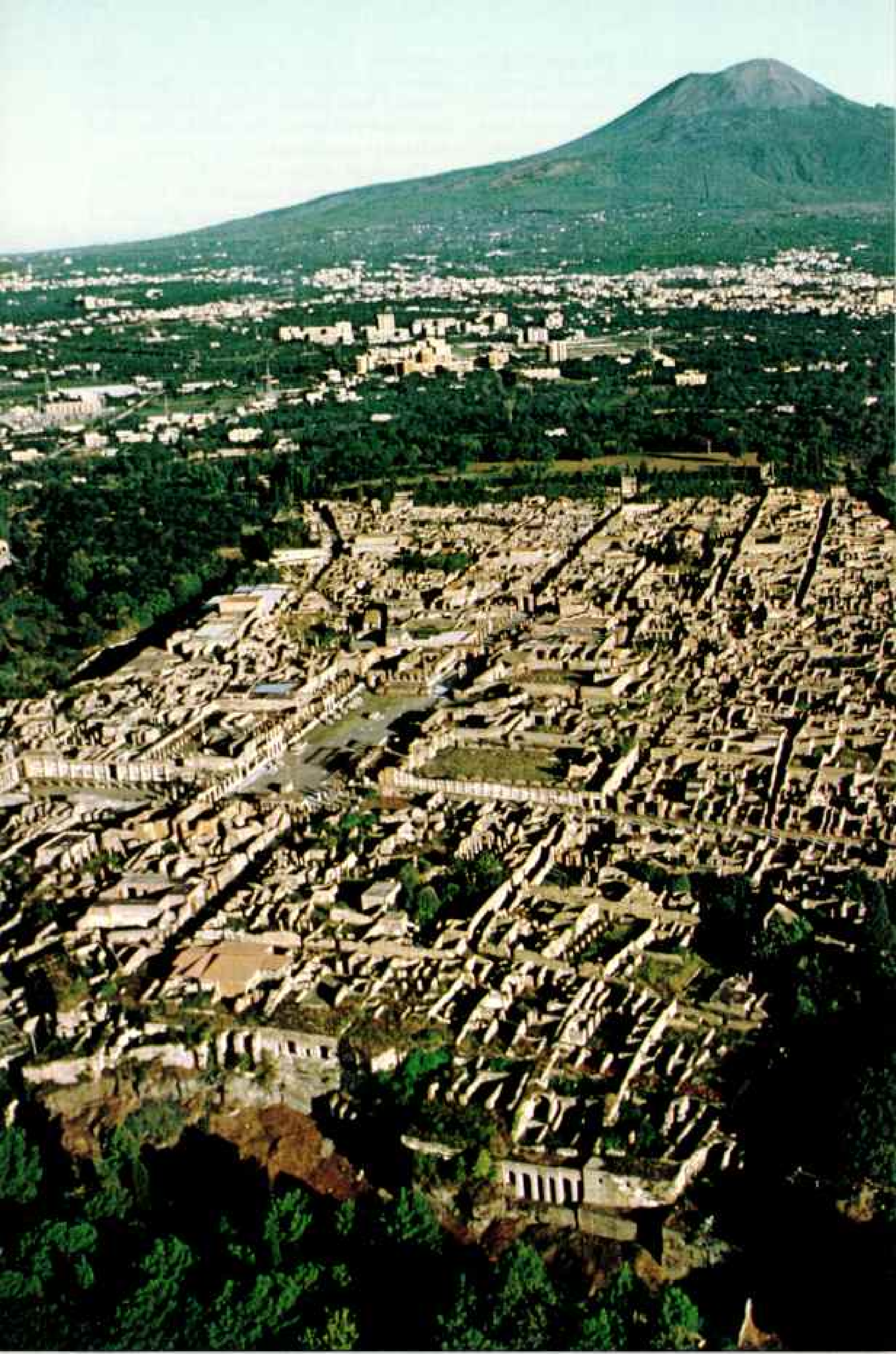
have gotten the people running to the edge of town," he says. "But I don't think they were in the streets long. One skeleton the early excavators found in the town was a baby in a crib. Another appeared to be a sickly, bedbound child. If the parents had had much time, these children would not have been abandoned."

The first surge to roll over Herculaneum would have killed everyone. As autopsies of surge victims at Mount St. Helens indicate, this dense ash cloud was the most lethal agent. It would have blasted down like a blinding sand storm, flattening people and forcing them to hold their breath to keep ash-saturated air from their lungs. The heat of the surge may not have been high enough



FROM POMPEII, NATIONAL ARCHAEOLOGICAL MUSEUM

*Portrait of success, a young Pompeii couple pose holding a papyrus roll and waxed tablet to establish their importance.*



UNDER THE EYE of its killer,  
Vesuvius, ancient Pompeii lies dead,  
its 160 acres in ruins, tattered  
reminders of once vibrant life — in  
homes, shops, marketplaces, baths,  
and theaters.





*Illustrious citizen, Marcus Nonius Balbus repaired Herculaneum's basilica after an A.D. 62 earthquake. His equestrian statue in the Naples museum, where scaffolding testifies to today's earthquakes, lost its head, and his father's now sits in its place.*



to kill, but once the people had to gasp for air, ash would have formed plugs in their windpipes, suffocating them. Other victims could have died as they were thrown down to the beach or struck by flying debris.

No more than minutes after the first surge struck, the dense superhot flow hit the town. This first flow apparently was diverted around many upper parts of the city, but swept onto the beach just below the Suburban Baths. It was what washed the boat into its resting-place beside the Helmsman. Its intense heat charred whatever limbs stuck above the surge layer and turned the boat to charcoal.

Other surges and flows over the next few hours finished the burial of Herculaneum. In all, Sigurdsson finds that Vesuvius produced at least six glowing avalanches. The last one, he suspects, was the volcano's grand finale. It became the mammoth, sun-extinguishing black cloud that raced across the bay, leading Pliny the Younger, his mother, and other terrified residents of Misenum, 32 kilometers away, to suspect the world was ending.

Vesuvius has since erupted often, but seldom with such devastating glowing avalanches. Typically, it throws out spectacular but rarely lethal lava flows. Glowing avalanches, however, did accompany an almost unknown eruption in 472. They struck again in 1631, killing at least 4,000 people. Scientists feel confident that another Plinian eruption will occur in the coming centuries.

"Vesuvius certainly ended a cycle with its last eruption in 1944," says geologist Pio Di Girolamo of the Institute of Mineralogy in



Naples. "Now it is in its longest interval of repose in modern history. It's impossible to forecast the next eruption. We do not think it will be soon."

**I**T IS LATE SEPTEMBER 1983 and my last day in Naples. Excavation at Herculaneum has slowed. For months site director Maggi has worried that the pathetic scenes uncovered in the chambers will be forever lost if the skeletons are even temporarily removed for cleaning and preservation. Although the chamber with the household in flight has been cleared and many beach skeletons exhumed for Bisel, Maggi has resisted full excavation of the remaining chambers while he tests a chemical spray that he hopes will fix the bones in situ. It has failed. Skeletons in the unopened chambers, however, still lie safe from the destructive atmosphere.

Also, the government of Italy has just changed, and new political forces are being exerted at Herculaneum. A new archaeologist is in charge of the boat, and its excavation has been delayed into 1984. Although the archaeological program and its funding at Herculaneum is proceeding, it awaits a more certain future.

On this last day I have walked through bumptious Neapolitan streets to the National Archaeological Museum, which houses most of the art treasures recovered from the buried cities of Vesuvius. It offers unequaled glimpses into Roman times.

The museum's voluptuous statues of Venus, Apollo, and Hercules, which must have towered over the citizenry in public places,

*Horses and riders topple at Pompeii's Temple of Jupiter, part of an ancient marble relief (above) commemorating the A.D. 62 quake. Wooden beams bracing walls of the House of the Vettii (below) recall the 1980 earthquake that damaged many structures in Pompeii.*







*On the way to a new life, Ercolano newlyweds Anna Taccogna and Pirro Giovanni, with her sister assisting, pose before Herculaneum's ruins to reaffirm*



*the importance of their heritage—life amid the splendors of a long-ago age.*

*The Dead Do Tell Tales at Vesuvius*

in many ways speak more of ancient Romans than do those skeletons. Herculaneum and Pompeii lived with these gods and goddesses, and their images personify Roman concepts of physical beauty, strength, wisdom, libido, and pleasure.

I especially admire the equestrian statues of proconsul Marcus Nonius Balbus that must have dominated Herculaneum's basilica. The head of one has been lost and replaced with a likeness of his father. These aristocrats were the city's foremost citizens.

The younger Balbus, with his strong and youthful build and Apollonian face and bearing, is the idealized Roman youth. His father's face across the hall shows the same regally handsome features, except lines of age and the beginnings of jowls speak of the passage of generations, the connections between family, and the ultimate erosion of time. It is through these statues and the surrounding art that I can reach these people and identify with them as inhabitants of the same planet.

Upstairs hang the wall paintings and mosaics that reveal many of the moments that created the texture of life on the flanks of Vesuvius. A teacher disciplines a student with a beating, a rough-cut man and his wife sit for a portrait, two men and a boy receive a dole of bread, a couple drinking wine recline erotically on a couch, a tragic actor sits exhausted after a performance.

**T**HE ACTOR takes my thoughts back to Herculaneum's buried theater, and for a moment I sense the thrill that must have greeted those early excavators. Imagine such vivid images emerging as you are scraping in the dark deep underground!

Did the excavators, I wonder, notice the eyes in these paintings, busts, and statues? So many stare vacantly ahead. They remind me of that impassive face imprinted in the pyroclastic flow in the theater. These faces do not express much joy. Often they seem to be asking whatever gods are listening why there must be such sorrow in the world. From those eyes flows a sadness that sums up the fate of this "loveliest region of the earth," that makes me want to say, "Alas poor Portia, alas Pompeii, alas Herculaneum." □



*Uprooted by the terror of earth tremors, people from Pozzuoli draw comfort from a Mass in the safety of a nearby tent village. The town, only 17 kilometers*



(10.5 miles) from Herculaneum,  
trembles within a volcanic caldera.

# A PRAYER FOR POZZUOLI

By RICK GORE

NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by

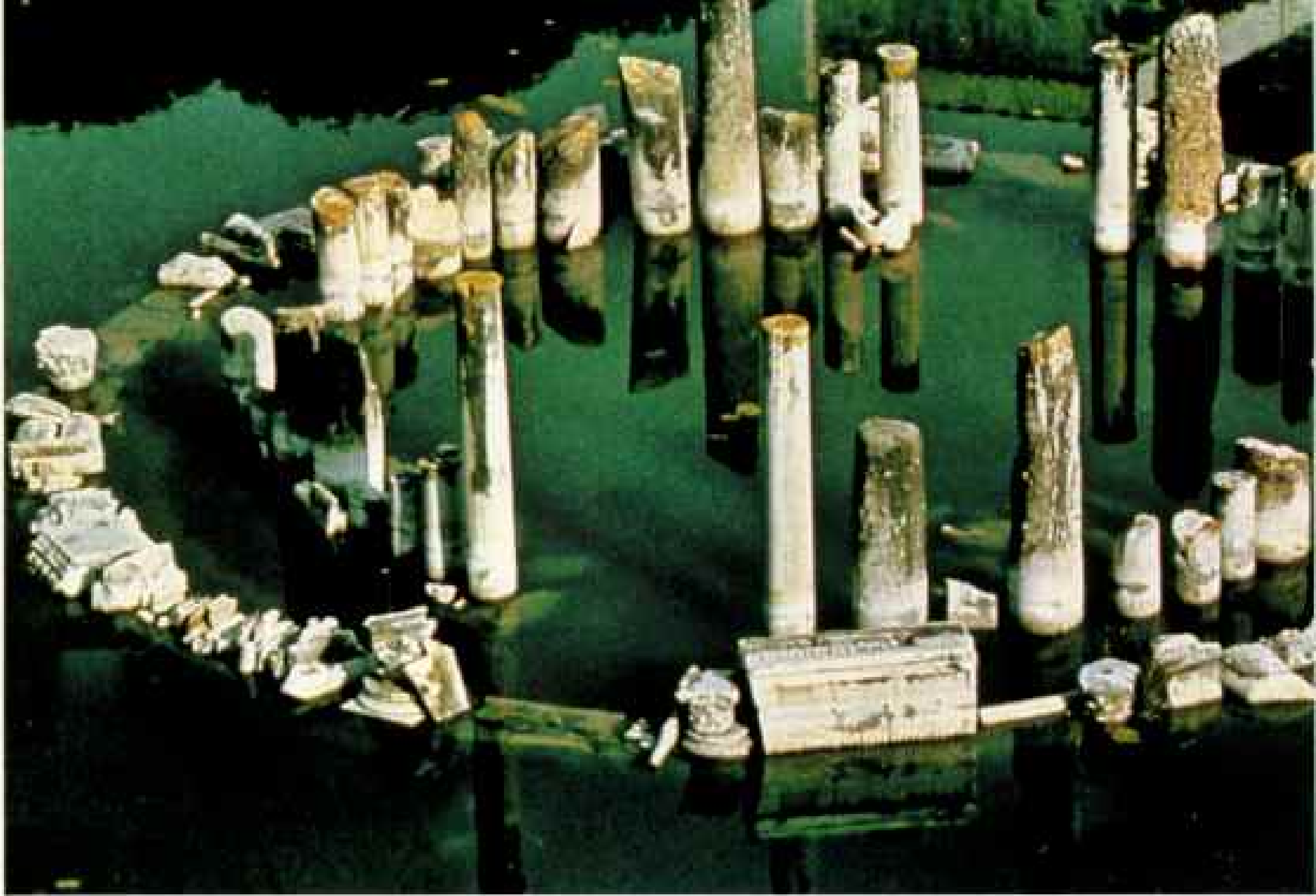
O. LOUIS MAZZATENTA

SENIOR ASSISTANT EDITOR

**N**OT FOR THREE CENTURIES had San Gennaro's people so needed his help. For months the earth beneath Pozzuoli, a 2,500-year-old working-class town just west of Naples, had been rising. At first the people had taken the uplift with bemusement; this geologic phenomenon, caused by magma moving beneath the area, has been part of the life and lore of Pozzuoli since antiquity, when this town on the Bay of Naples was a thriving Roman port. As local fisherman Carmine Carannante had told me in 1981 on my first visit, "Pozzuoli, she is like a ballerina. She is always going up and down."

Carannante was much less jocular when I met him again on the docks in May of 1983. "Pozzuoli is becoming a very big ballerina now," he said. "We are very afraid."

The rising earth beneath Pozzuoli had pushed the docks up so high that Carannante had to climb down to, rather than step into, his boat. More ominously, earthquakes by the thousands had begun jarring Pozzuoli's 80,000 residents.





*Seesaw of pressures from deep in the earth lifts the ruins of the Roman market (below) at Pozzuoli; eight years ago they were inundated (left). Here the ancients venerated the god Serapis, sacred to merchants, in tribute to the fame and fortune he had brought to the port then known as Puteoli. But Serapis is not responsible for the fate of Puteoli/Pozzuoli or the marbled cities that long ago sank beneath the sea. Pozzuoli lies in an enormous caldera, named for the Campi Flegrei, or "Fiery Fields," region, which is reawakening. As magma moves below, it forces the land surface up and down in an earthquake-triggering action. Today's fear comes from a speedup of this activity.*

MARIO DE BIASE, EPOCA (LEFT)



"Almost every night the buildings shake and we hear explosions," the fisherman told me. "They sound like bombs going off underwater, like something trying to get out of the earth. People wake up and scream. We pull on our clothes and run into the streets. We are very tired. We can't live like this much longer."

Pozzuoli sits within the Phlegraean Fields Caldera, an ancient volcanic explosion pit some 12 kilometers (7.5 miles) across. Scientists were beginning to fear that a new eruption of unpredictable magnitude was brewing beneath Pozzuoli.

Then, on September 4, the town was hit by a strong earthquake. Panic ensued. Massive traffic jams clogged all roads as the population fled the city.

Two weeks later, on the eve of the feast of San Gennaro, the fourth-century martyred bishop who traditionally has protected the towns along the Bay of Naples, I returned to a tense, troubled metropolis.

The next morning the faithful of Naples were expecting a miracle from San Gennaro. Two vials said to contain his blood are stored in the cathedral of Naples, the Duomo. On his feast day for at least the past 595 years these relics have been taken from a vault to the altar in a procession. There a powdery dark solid in the vials gradually changes into a liquid. Scientists have no explanation for this phenomenon and the Roman Catholic Church has never let the substance be chemically analyzed.

Occasionally the blood has not liquefied. Over the centuries, numerous natural catastrophes have been blamed on failures of the miracle.

According to legend, San Gennaro has saved Naples from plague and cholera. But his most famous interventions have involved volcanoes. In 1631, for instance, as the flaming Mount Vesuvius spewed ash and what one observer called "a stinking fog of hell" over the city, his relic blood was paraded through the streets. Within a few hours the wind changed, delivering Naples from the volcano's fury.

Traditionally, it was near Pozzuoli that San Gennaro was beheaded, after bravely entering the city to comfort frightened Christians. And Pozzuoli was clearly on many minds on September 19, 1983,



*Miracle of the blood of San Gennaro, patron saint of Naples, inspires awe each year at the city's cathedral (left). On his feast day the saint's blood liquefies, the faithful believe, sustaining their conviction that San Gennaro, martyred near Pozzuoli, protects them against the ravages of volcanoes. One that now bears continual watching is La Solfatara (right), a door to the underworld in Roman myth, where increasing steam has been escaping. This is a sign of mounting pressure that could blow rocks and mud sky-high, raining devastation on Pozzuoli.*

when the vault at the Duomo was opened.

To everyone's surprise San Gennaro's blood had already liquefied. In the past some had considered this rare occurrence a bad omen. But this time the throng at the Duomo regarded the premature liquefaction as a special blessing. Women in the front pews wept and clutched their rosaries. Fireworks exploded outside. "We hope," pronounced Corrado Cardinal Ursi, "this is a good sign for Pozzuoli."

**E**VEN AS THE cardinal spoke, however, a new swarm of 80 earthquakes struck Pozzuoli.

"There was a roar from the earth at the time of the miracle," Michele Rinnovato, a Pozzuoli priest and journalist, told me later that day. "Some say that was a sign that the crisis has passed. I don't believe it."

Father Rinnovato took me to one of the six tent communities set up for Pozzuoli refugees. Morale was low among the several hundred bivouacked there. Their tents were stifling by day, damp and chilly at night. Theft, rats, and riots over the sporadic food rations plagued these so-called *tendopoli*.

"We are dying like mice," complained an irate woman, Italia Aracri, who until the previous night had been living with six other

family members in one tent. The tent had caught fire, and all the family's possessions were lost. But would she return to her home in Pozzuoli?

"Never!" she cried. "It's too frightening."

Many Pozzuolians, however, could not bring themselves to abandon their town, even if they did have to flee their cracked and dangerous homes. They were building shacks and setting up tents on the Via Napoli, the main street along Pozzuoli's waterfront. It looked like wartime.

Tents even fronted the famed market known as the Temple of Serapis, whose rising and sinking columns have in the past been reliable barometers of the changing ground levels. The columns are marked by the burrows of marine mollusks, indicators of past levels of submergence. Since my first visit to Pozzuoli two years earlier, these columns had risen more than half my height.

More than a hundred shops and most schools had closed in recent weeks. Ancient art treasures were being moved out of town. Ferryboats from the island of Ischia had difficulty docking at the elevated wharf. Pozzuoli's celebrated fish market, which had always lured crowds to the town, was struggling to survive.

At lunchtime on Saturday, when the fish



market and restaurants are usually crowded, I found Giuseppe Carnevale, the young manager of the once flourishing *Ristorante Il Pirata*, sitting in his empty dining room. He was depressed.

"Yesterday we had just one customer," he said. "We cannot continue this way." He held out both hands; they were shaking. "I don't know what I'm going to do."

Yet all this has happened before to Pozzuoli.

In the early 1970s the ground rose 1.7 meters (5.5 feet) over three years, before leveling off and subsiding a bit. The oldest part of town was evacuated then. Scientists believe that the present rise is a continuation of that earlier uplift. What disturbs everyone this time are the frequent, jarring earthquakes—more than 4,000 in the past year. They indicate a crisis may be closer.

In 1538 a crisis did occur in *Tripergole*, a town that used to sit beside Pozzuoli. The ground rose seven meters (23 feet) over several years. Stone blocks from *Port Julius*, the submerged ancient Roman seaport, emerged offshore. Earthquakes forced residents to flee.

Then abruptly, wrote one eyewitness, "the earth showed an awful mouth from which poured out smoke, fire and ashes,

making a thunderous terrible noise. . . . Even Naples heard the roar, as if artillery were shooting. . . . Ash covered Naples to the depth of two hands."

Three days later a new 140-meter-high volcano, named *Monte Nuovo*, stood where *Tripergole* had been. Then for the next four centuries, the region slowly subsided.

Historically, the ground around Pozzuoli was highest in Roman times. Much of the bustling ancient metropolis, including the entire port, Nero's imperial palace, and many grand villas and baths, now lies submerged in the Gulf of Pozzuoli. No records exist to date the sinking of these structures. They simply disappeared, possibly in a series of undocumented catastrophes, during the Dark and Middle Ages.

**I**S ANOTHER *Monte Nuovo* lurking beneath Pozzuoli today?

"We can't say. We don't understand the geology deep beneath this region very well," said Dr. Lorenzo Mirabile of Naples' Institute of Oceanography. "Personally, I would not sleep in Pozzuoli."

Dr. Mirabile's remark did not comfort me a few hours later as I descended 28 meters to the seafloor off Pozzuoli in a submersible his group operates. He wanted me to see one





## FIERY FIELDS AND SUNKEN CITIES

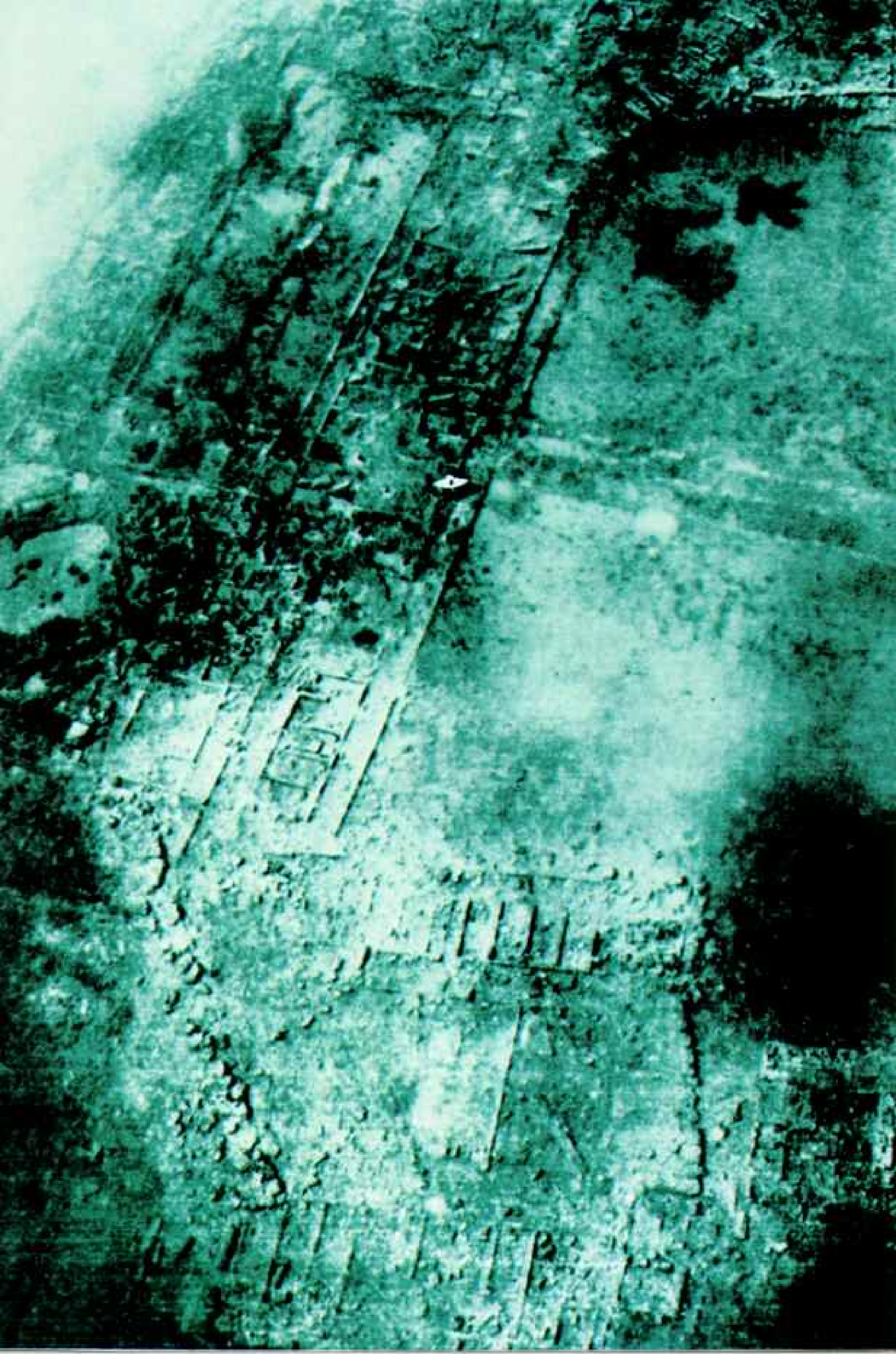
WITH THE DOCK getting higher, a Pozzuoli fisherman must jump down into his boat (left). Magma beneath the Gulf of Pozzuoli heats groundwater to activate fumaroles (below left). And in the silence of doom the Roman Port Julius (right) lies mired beneath the surface of the sea, its heritage lost in myth. Along this fabled coast Circe revealed to Ulysses the way to Hades, and the Sibyl foretold to Aeneas the future of Rome. Cicero loved the Fiery Fields—"delightful, a most desirable place, despite the crowds of bores that almost make one want to flee." Illustrious Romans made the gulf their playground, bathing in the hot waters and feasting on "a thousand and one beauties," as Goethe found it centuries later.



MARIO ROSIELLO



CAPRONI AERONAUTIC MUSEUM, ROME (OPPOSITE)





*Head almost lost to rock-boring mollusks, the marble figure of a slave with a wineskin is raised from the Gulf of Pozzuoli by underwater archaeologists off Point Epitaph. Mud protected the rest of his body. "A sea of statues," wrote author Mario Sirpettino of the waters that drowned so many ancient works of art when the land subsided. The treasure remains largely untapped, but the Italian government now offers divers a percentage of the value of the finds they salvage.*



BOTH BY CLAUDIO BIFFI

of two giant underwater fumarole fields that had just been discovered. This field, some 50 meters across, indicated that the magma moving beneath Pozzuoli was also heating the groundwater offshore. As we approached the field, countless bubbles wafted up through the murky water. The muddy bottom seemed to be boiling.

Dr. Mirabile believes the fields are actually a good sign. "They show that the pressure building beneath the town is being at least partially released," he said.

Other scientists contend that is only wishful thinking.

If too much pressure builds, the most likely result would be mud explosions. With that kind of eruption, the heat from below would vaporize groundwater, blowing out a crater and ejecting devastating bursts of steam, mud, and rock over an area as much as two kilometers wide.

If some of the rising magma mixes with the steam, the consequences could become even more serious. Another Monte Nuovo—or worse—could burst to life.

In fact, compared to the other volcanoes that the Phlegraean Fields Caldera has produced, Monte Nuovo was a minor event. These volcanoes, which pock the region west of Naples, are but individual vents within the caldera of the mammoth parent volcano that erupted some 36,000 years ago. Civilization has never known the likes of that eruption. Burying the immediate area in ash more than 50 meters thick, it was on an order of magnitude greater than any explosion in historic times.

Could such an eruption recur in the Phlegraean Fields? "We do hope not," said Dr. Roberto Scandone of the nearby Vesuvius Observatory. "But we know nothing about the precursors to such eruptions. So we prefer to forget about that prospect."

Dr. Scandone does worry that a steam eruption might open a pathway for the rising magma. That happened at Mount St. Helens in 1980, as well as in the Phlegraean Fields 3,800 years ago, when the volcano Astroni came to life. Astroni's relatively recent birth rivaled the A.D. 79 eruption of Vesuvius. It surely was accompanied by glowing avalanches like those that obliterated Pompeii and Herculaneum.

However, Italian volcanologists believe

(and pray) that the Phlegraean Fields system has been losing energy over the past few millennia. If so, any eruption would be about the size of Monte Nuovo's. They do not exclude a far more serious explosion. But even the least dangerous possibility, apart from a pause in the uplift like that in 1973, could be a disaster far beyond the center of the activity at Pozzuoli. Some 200,000 people live within the caldera.

"An American volcanologist asked me why I do not urge that everyone in Pozzuoli be evacuated," said Dr. Giuseppe Luongo, director of the Vesuvius Observatory. "But

this is not Mount St. Helens. We have thousands of people, not hundreds, to evacuate. Most have nowhere to go. We must wait as long as possible."

Pozzuoli continued to rise throughout last fall and winter. By February it had risen 1.1 meters (3.5 feet) in two years. As many as 100 tremors a day were hitting the area. After dark the place was a ghost town.

The earlier panic in the region, however, has ebbed. As volcanologist Roberto Scandone put it: "Twenty-seven centuries of catastrophes, invasions, and instability have taught us how vain it is to believe in the



mercy of nature. We have learned to live by the day. It is the only possibility when you live with a potential apocalypse.”

Meanwhile the government had closed down some of the tendopoli, found new temporary housing for some of the refugees, and promised to build a “new Pozzuoli” on a less precarious site. But southern Italians have learned to take politicians’ promises skeptically. So far little has been done even to house the victims of the 1980 earthquake.

And on nearby Ischia I visited the descendants of refugees from an earthquake there a hundred years ago. They were still living

in the one-room “temporary” shacks their great-grandparents were given.

As the family of Vincenzo Maltese gathered for lunch, his eight-year-old son said excitedly, “Maybe these visitors can help us get a new house.” His 16-year-old sister looked at him and said bluntly, “You’re going to die here.”

Perhaps the people of Pozzuoli will fare better. Perhaps their pleas to San Gennaro will help. But as Father Rinnovato pointed out on the saint’s most recent feast day: “If San Gennaro wanted to help the town, he could have done it before this.” □



GIANNI TURTOLI

*Moving out of a town of collapsing walls and weakened balconies, a Pozzuoli family flees to safety (left). Night after night of successive shocks, inflicting such damage as that suffered by the Church of Purgatory (above), have now made Pozzuoli a ghost town. But only during the hours of darkness. Many residents return for work during the day, hoping that the town will survive—and revive.*

# Krill—Untapped

By WILLIAM M. HAMNER



# Bounty From the Sea?

Photographs by FLIP NICKLIN



“WAKE UP! Krill at the surface!” The words ring an alarm at 4:30 a.m. Peggy and I scramble from our bunks. Pulling on thermal underwear, we hurry on deck and peer over the rail. In the lights of the ship, dense schools of *Euphausia superba* mill at the surface. The ocean around the research vessel *Hero*, cruising close to the icy Antarctic shores, swarms with the reddish, thumb-length crustaceans that compose the predominant krill species of south polar seas.

Dawn is breaking as my wife and I don neoprene dry suits and scuba gear and launch the inflatable boat; within 15 minutes of the call to action we are falling backward through frigid water into the midst of myriad schooling krill. Each cubic meter of ocean holds tens of thousands of them, all of a size, all oriented like marching soldiers, all surging forward in their disciplined legions.

We charge through a mass of these euphausiid “shrimp,” waving our arms, blowing bubbles, and shouting into our air regulators. We stop, the school hovering before us. Puzzling! Instead of darting away, the swarm is gradually sinking. I touch one animal. It doesn’t move. Slowly it drops away, upside down. Peggy plucks another from the horde that is falling into the depths like soft rain. It is not a live euphausiid at all! In her hand Peggy holds an exoskeleton, a complete and perfect cast-off shell.

We have literally scared the krill out of their skins. In defense against our intrusion, they instantaneously molted before they fled, leaving behind as decoys their empty husks, a ghost school in an empty sea. . . .

*Afloat in a soup of diatoms, a krill shrimp traps the minute plants with thoracic legs and ingests them. Staple food for a reduced population of whales and other Antarctic wildlife, protein-rich Euphausia superba, a thumb-length crustacean, now faces a new predator: man.*







**SCHOOLING FOR PROTECTION,**  
*krill swarm in Antarctic waters,*  
*often in enormous masses. One*  
*school recently reported extended*  
*across several square miles.*

**C**ONGREGATING in the millions, krill can stain the seas as if with blood. The name "krill" derives from *kril*, an old Norwegian word once applied to tiny creepy-crawly things, lively vermin, and larval fish. Today krill means whale food, and a number of species of euphausiid shrimp, as well as other very small planktonic animals, feed the biggest creatures of all, the great baleen whales. Krill also are harvested by man and processed into feed for livestock, poultry, and farmed fish. Their swarms constitute the oceans' richest source—as yet barely tapped—of protein.

Supported by the National Science Foundation, Peggy and I, with Ron Gilmer of the Woods Hole Oceanographic Institution, were in Antarctica to learn about *Euphausia superba*, the world's most abundant euphausiid and perhaps the most important of all plankton species. Accompanying us were ichthyologist Steven Strand of the University of California at Los Angeles and photographer Flip Nicklin.

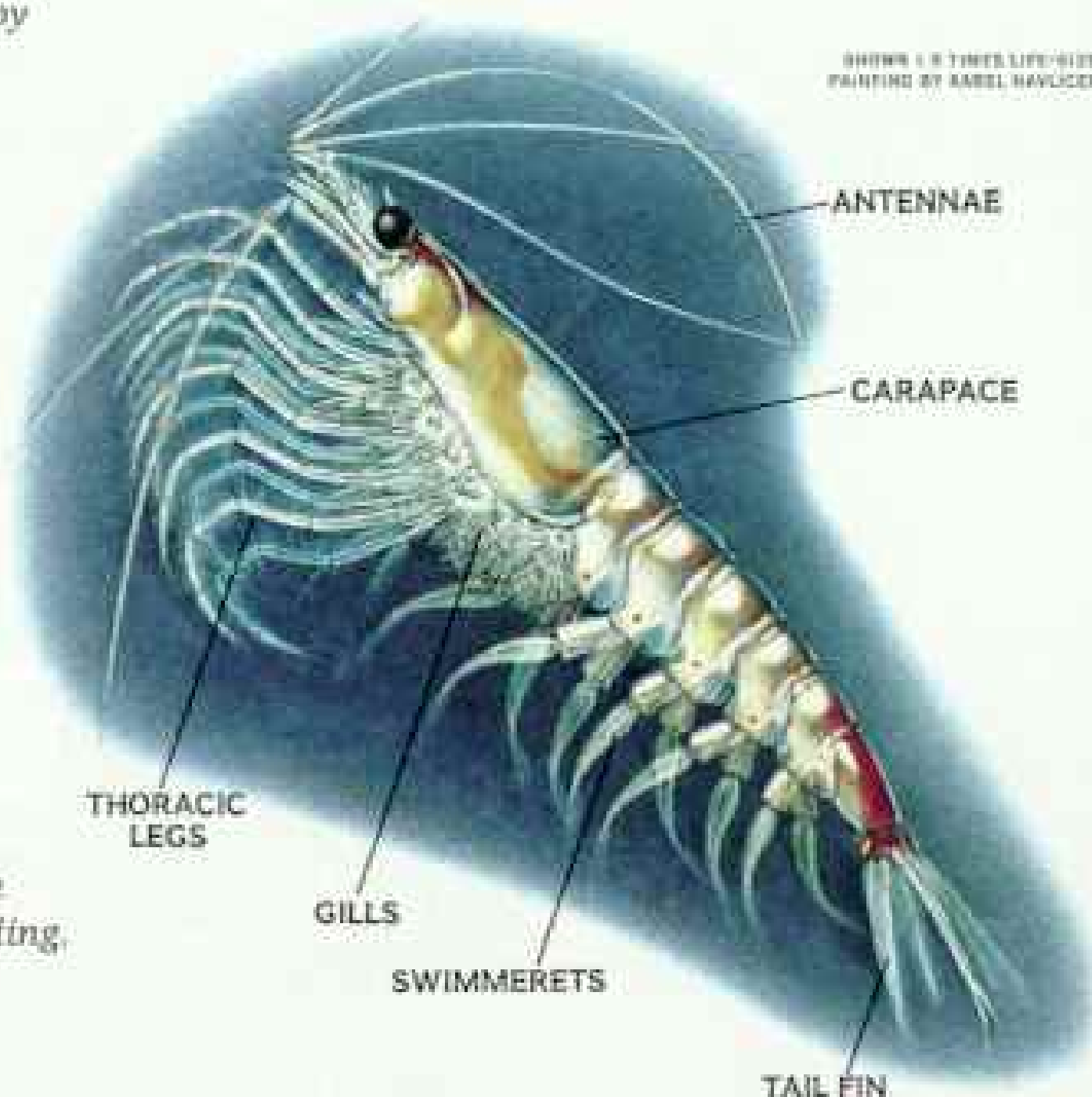
*E. superba* is the almost exclusive food of the southern baleen whales, some species of which are now pushed to the edge of extinction. Today, because of the depletion of



Now you see 'em. . . . Frightened by the author and his wife, krill molt en masse and vanish, leaving a phantom school of empty exoskeletons (above) sinking upside down.

In an aquarium (facing page) at the National Science Foundation's Palmer Station, Antarctica, where many of the pictures in this article were made, krill orient themselves to light coming in from the right. In the sea, where light comes from above, they swim horizontally.

*Euphausia superba* (right) propels itself with swimmerets and uses a tail fin as a rudder. The thoracic legs form a basket for feeding.



Antarctic whales, the shrimp that nourished them are much more numerous than 50 years ago. Experts calculate that the potential annual yield of this "unutilized whale food" could exceed the present world harvest of all other edible marine species combined. It is estimated that 50 to 150 million metric tons of krill (330 billion pounds!) conceivably could be taken by humans each year, a shrimp cocktail the size of a city block and piled five miles high.

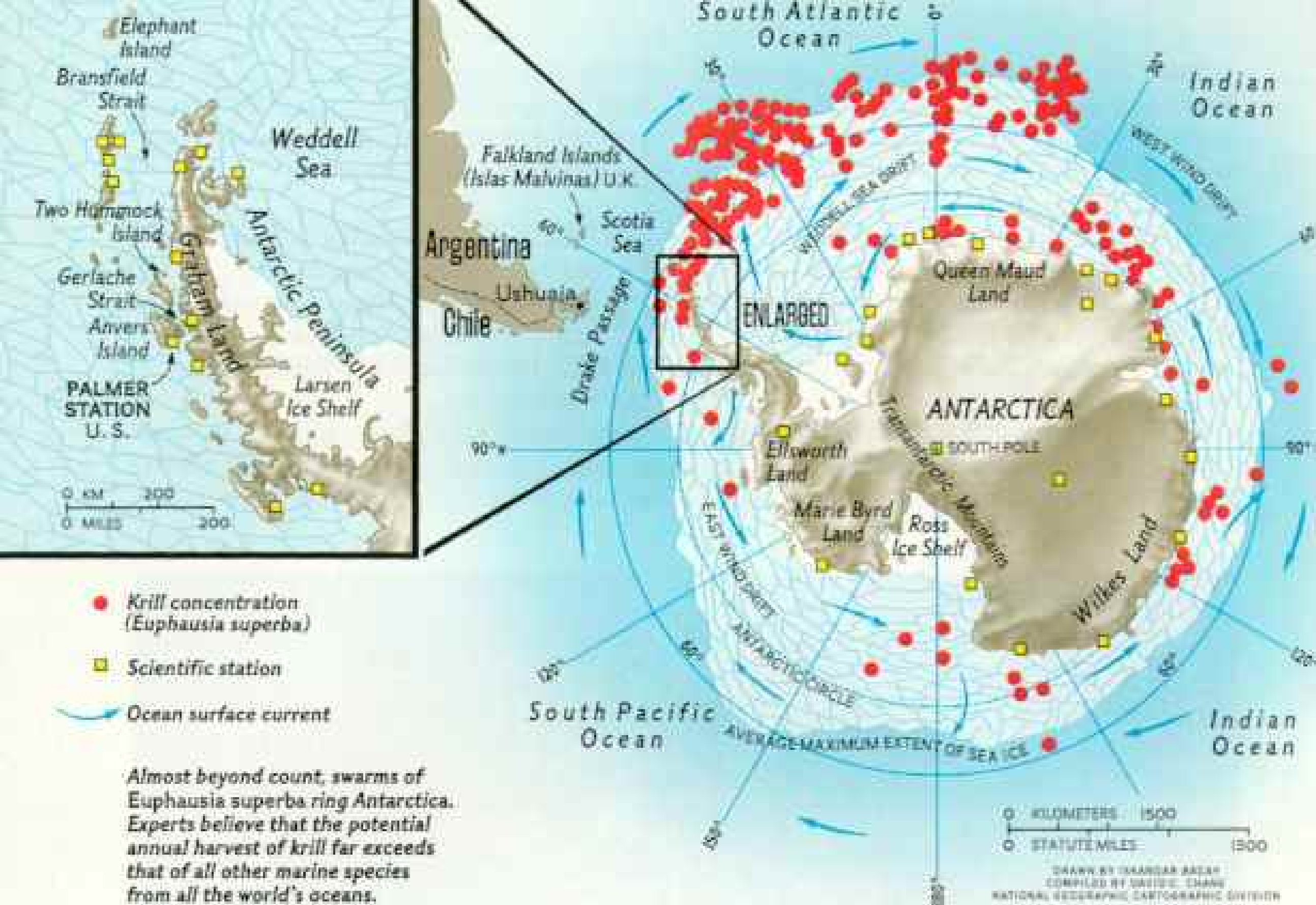
Talk of such a vast harvest alarms marine biologists. Many animal resources historically thought inexhaustible—species

like the passenger pigeon, the bison, and even the great whales themselves—have proved the most susceptible to overexploitation or outright extinction.

**A**S PART OF A RECENT intensive international effort to acquire more knowledge about this resource, we embarked from Ushuaia, Argentina, in December 1981, bound for the "whale pastures" of the Antarctic seas.

Our sturdy ship, *Hero*, a 125-foot wooden, sail-equipped trawler, had the world's best Antarctic skipper, Capt. Pieter Lenie.





History accompanied us, for the original *Hero*, a sloop only 47 feet long, entered Antarctic waters 164 years ago. Our destination, Palmer Station, commemorates her captain, Connecticut-born Nathaniel Palmer, who at age 21 in 1820 sailed south hunting seals. Palmer may have been the first ever to sight the Antarctic Continent.

It was midsummer, the season of endless daylight, as we cruised along the Antarctic Peninsula, and the sea ice was beginning to break up. From the mountainous coasts, glaciers cracked and avalanched into the ocean. On Christmas Eve, when the ship docked at Palmer Station, cheers greeted us from station personnel and scientists who had arrived a month earlier.

**T**HE NATIONAL Science Foundation operates Palmer Station on Anvers Island, latitude 64° 46' S, to support research in the biologically rich lands and waters of the Antarctic Peninsula. The modern, functional buildings, with space for 36 scientists and support personnel, stand on the naked rock of Gamage Point below

a glacial tongue of the Marr Ice Piedmont.

This was a new chapter in a quest for krill that had led us to many diverse habitats. We had traveled from northern Japan to British Columbia and the fjords of southern Chile, and from the Bering Sea to the oceans of Antarctica. Everywhere we were impressed by the complexity of krill behavior.

Although in Antarctic waters the term "krill" refers specifically to *E. superba* shrimp, in different areas of the world's oceans it designates a variety of animals, depending upon what a particular species of whale consumes in a certain region. Off Vancouver Island, krill means the vast shoals of mysid shrimp, the prey of gray whales. In the Chilean fjords, a thumbnail-size pelagic red crab of the genus *Munida*, the lobster krill, forms immense swarms and is a favorite food of sei whales. In the North Atlantic and North Pacific Oceans, krill includes schooling small fish. But in Antarctic waters, *E. superba* so abounds that the

UCLA biologist Dr. William M. Hamner reported on "The Strange World of Palau's Salt Lakes," in the February 1982 *GEOGRAPHIC*.

**Like a harpooned whale,** a net containing some 12 metric tons of krill is winched aboard a Soviet trawler off Elephant Island (right). Employing huge nets as wide as 80 meters and perhaps 50 meters in depth, the Soviet Antarctic fleet harvested almost 500,000 tons during the 1981-82 season. The krill are dried and ground into meal to feed farm animals in winter.

Although the present harvest of krill is minimal, the author questions whether such a vast resource, the oceans' largest single source of protein, will remain unexploited. Significantly expanded krill fishing could pose a threat to protected baleen whales and indeed have repercussions on the entire Antarctic ecosystem. The krill are a key link in the food chain that supports

Antarctic marine life.

In Antarctic waters, "krill" refers to the ubiquitous *Euphausia superba*. But it is also a generic term for various animals fed upon by baleen

whales: pelagic red crabs in Chilean fjords, mysid shrimp off Vancouver Island in the North Pacific, larval fish in the North Atlantic, and copepods in the Bay of Fundy.



baleen whales feed on it almost exclusively.

All the planktonic animals called krill congregate in enormous schools, primarily in polar and subpolar seas. While this behavior well serves the appetites of whales, such schooling nevertheless helps protect the crustaceans from other predators such as fish and seals. Schools of krill, widely scattered, are often simply hard to locate. They enjoy another built-in advantage: A given predator can eat only so many at one time.

Still, baleen whales—the Mysticeti, or "mustached sea monsters"—can cut a big swath through a mass of krill. These whales are distinguished from the toothed whales by having baleen, or whalebone, as part of the mouth structure. Baleen is a plastic material the consistency of horny fingernails that grows downward from the whale's upper jaw.

The whale, like a giant pelican, gulps huge mouthfuls of seawater together with masses of small schooling shrimp and fish. Through the comblike bristles of its baleen filter, it squirts out the seawater, entrapping krill by the bushel.

**A**LTHOUGH MUCH is known about how baleen whales feed, the same can't be said for their principal prey. So at Palmer Station we stocked the aquariums with krill, hoping to shed some light on this problem.

*E. superba* shrimp have 11 pairs of legs. They swim with the five posterior pairs, which are broadly paddle-shaped, and they feed with the six forward pairs. Each feeding leg, split into two branches, carries stiff bristles and feathery setae. In the large aquarium the darting shrimp moved their legs so fast that all we saw was a blur. How did the euphausiids capture food with such complicated structures?

Euphausiid shrimp are essentially herbivores, eating diatoms, the tiny, single-celled plants, or phytoplankton, that float in great abundance in polar areas. Peggy collected live phytoplankton with fine-mesh nets to feed our captives.

We had expected that the krill would select food according to its physical properties, the size and shape of the particles. But here in the laboratory, to our astonishment,



*Net full of krill, a northern variety called *Euphausia pacifica*, comes aboard the Fumi Maru No. 18 (right), operating from Onagawa, Japan. Though *E. pacifica* makes an attractive dish (below), its bland taste has failed to titillate Japanese palates.*

*Much of that country's krill harvest goes back into the water at fish farms. A worker at the Toishi Fishery Cooperative (above), near Nagasaki, prepares to defrost blocks of frozen krill to fatten up sea bream, red snapper, and yellowtail.*

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ALL BY PAUL CHEVLEY







they were responding eagerly to a variety of chemicals, even to diluted orange juice!

In the sea the krill schools probably use their highly developed sensory receptors to find food. Encountering an enticing taste or smell, they feed, as they did in our tanks, by repeatedly throwing wide their legs to enfold a packet of seawater that smells edible and presumably contains food. The krill then squirt the seawater sideways through their setal filters, entrapping algae in a feeding pattern much like that of baleen whales!

Eager as we were to observe the behavior of krill underwater, on our early cruises out of Palmer Station we failed. Though that summer of 1981-82 was moderate by Antarctic standards, two blizzards struck us, with winds that reached 70 knots. Even after the seas calmed, weeks followed when the krill did not rise to our diving depth. We knew krill were in the vicinity, because Captain Lenie kept locating dense schools with the ship's echo sounder.

Then, finally, one snowy midnight the mate woke us with the cry, "Whales ahead!" Around the ship rolled several groups of feeding humpback whales, and we knew there must be krill at the surface.

We put on our diving gear and entered the sea, but now it was too dark underwater to see without artificial illumination. Shoals of krill encircled our lights. For us, this first view of Antarctic krill in their own element combined awe with disappointment. Against the watery blackness we could see little of their behavior.

**T**HEREAFTER we kept alert for whales, whose feeding would pinpoint schools of krill. Our best luck came on the last morning of the last cruise, events that I partially described at the start of this story.

That day, dawn broke on a fine flat sea as we toddled across the ice-slicked deck, each weighted down with a hundred pounds of gear—weights, lights, scuba tanks—to climb down to the Zodiac rubber boat.

Early sunlight danced on the glacier face of nearby Two Hummock Island and glinted off krill that popped out of the water like bouncing raindrops. We dropped into ice-calmed waters and instantly were immersed in shimmering clouds of krill, millions upon millions of shrimp sweeping past

in response to the secret signals that command the unison of schooling creatures.

One linear school, a foot across and a foot thick, stretched beyond my vision in the crystal water, flowing uninterrupted like a band of army ants hugging the undersurface of the sea. Another school spooked when we waved our hands. The shrimp fled backward at blinding speed, with powerful flicks of their tails. Each individual swam rapidly, as if lost, until it found another isolated shrimp. They then swam as a pair. The two became four, and then more and more came together, as the scattered shrimp regrouped into the cohesive security of the school.

The life cycle of *E. superba* is attuned to the seasons in Antarctic seas. These shrimp mate in the austral spring, October and November. As with most crustaceans, because of their rigid exoskeletons the male must wait to implant his sperm until a female has molted her old shell.

Robin Ross and Langdon Quetin from the University of California at Santa Barbara raised krill at Palmer Station and showed that a female *E. superba* produces many sets of thousands of fertile eggs throughout the summer spawning season. Released into the sea, these eggs sink hundreds of meters to depths where few predators dwell. There the eggs hatch and the larvae, or nauplii, looking nothing at all like the adults, develop in relative safety. Eventually, however, their yolk-sac reserves are depleted and the nauplii must swim toward the surface to find the phytoplankton on which they will feed.

*E. superba* develops slowly in the icy Antarctic waters, passing through many molts and five life stages from nauplius to adult. Growth to a mature length of about six centimeters may take three to four years. All this time the krill stay together in enormous schools, coursing great distances at sea and beneath the ice in search of food while avoiding their many foes.

**I**N ITS VAST SWARMS the Antarctic's *E. superba* without question represents a potential source of food for humans.

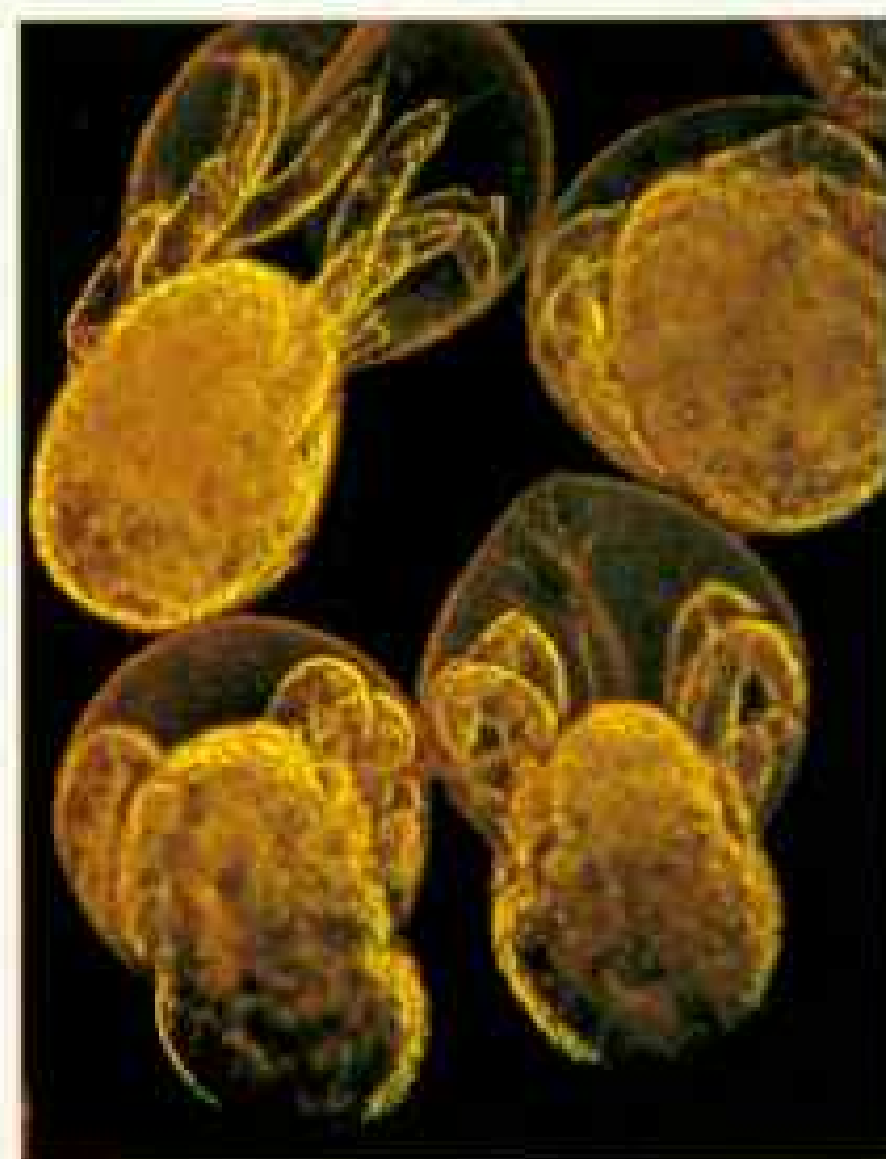
Dried krill are more than half protein and are rich in vitamins, especially vitamin A. Japan and the Soviet Union already harvest heavily in south polar waters. In the austral



*A deluge of eggs, perhaps 2,000 in all, issues from a gravid female in a jar (left) outside the laboratory at Palmer Station. A screen prevents the mother from eating her own eggs.*

*A female stores the male's sperm and releases it to fertilize her eggs, which appear as small bubbles in her feeding basket (below). Colleagues of the author discovered that a female can produce many sets of eggs—totaling more than 20,000—during the summer spawning season.*

*Krill larvae emerge from their shells (bottom). In nature this occurs at depths of several hundred meters, where, safe from predators, the larvae subsist on yolky materials.*







*Passengers on an iceberg, chin-strap penguins (above) drift in Bransfield Strait near the Antarctic Peninsula, secure from their chief marine predator, the leopard seal. Thus the penguins can pick their own good time to dive (left) for their chief prey, krill.*

*Krill occupy the prime spot on the menus of nearly all Antarctic creatures: penguins and other seabirds, seals, fish, squid, and a reduced population of baleen whales.*

*With the decline of whales as predators, krill numbers have increased, benefiting other species. Marine biologists have noted increasing populations of southern fur seals, crabeater seals, and various species of penguins.*

To catch a krill shrimp that ventures too near, a starfish first grasps the antennae with the pedicellariae—tiny pincers with teeth—on its arms. Then the starfish uses another arm to secure a firm hold prior to ingestion.

summer of 1981-82 they took as much as 500,000 metric tons, with the U.S.S.R. catching the bulk, principally for dry meal to feed domestic livestock and poultry.

In the populous Orient, with protein at a premium, Japan conducts two krill fisheries, one in Antarctic waters for *E. superba* and one along the coasts of the home island of Honshu for the smaller *E. pacifica*. Neither species enjoys much popularity as a food item in the Tokyo fish market. Fresh, uncooked euphausiids have almost no taste. Frozen or dried krill develop a strong, rather discouraging flavor.

While culinary uses falter, the krill fishery is prospering in Japan because of a market for frozen euphausiids to feed trout, salmon, sea bream, red snapper, and yellowtail in extensive fish-farming operations. Vitamin A carotenoids in the shrimp enhance the tone and pigment of fish flesh. Sport fishermen also buy frozen krill to use as chum; most fish find euphausiids delectable.

The Japanese north coast fishery, operating out of Miyagi Prefecture, exploits the peculiarity that in spring, from first light to about 10 a. m., compact schools of *E. pacifica* rise to the surface close to the coast. The schools are small and hard to find; they move quickly when disturbed.

The boats used for this fishery are narrow, maneuverable, and fast. Long before dawn the fleet is at sea, scattered and waiting. At sunrise the fishermen watch for the reddening of the water that betrays a surfacing school, for feeding seabirds, and particularly for signs that another boat has spotted krill. When a school is sighted, the boats close in, recklessly jockeying for position. The foredeck of each vessel is bare except for two giant poles set forward across the bow bulwarks, a surprisingly small net slung between them.

We are aboard *Fumi Maru No. 18*. As the early sun brightens, we see a school! Diesels roar as we speed toward the russet patch.



The two poles slide forward like probing antennae. The captain shouts. The booms tilt and plunge, and the net spreads open beneath the bow. *Fumi Maru* pushes the net slowly through the school and engulfs the krill. The cod end—the collecting bag of the net—fills, and the crew winches it aboard, the catch cascading onto the deck. Sunlight sparkles on water droplets spangling the net. The sea is blue, the mounds of krill shine wet and red, the captain smiles.

**T**HIS SIMPLE TECHNOLOGY and the small ships used to catch *E. pacifica* contrast sharply with the modern Antarctic *E. superba* fishery. Antarctic schools are huge, and often swarm at depths as great as 150 to 200 meters. The bigger southern krill swim faster than other species and readily avoid small nets. Fishing vessels



are designed to counter these capabilities.

The Soviet ships I saw in Antarctica, like similar vessels from Japan and Poland, are big stern trawlers towing enormous mid-water nets as wide as 80 meters and perhaps 50 meters deep at the mouth. Otter boards, wooden slabs the size of barn doors, slip sideways through the water away from the ship to spread wide the mouth of the net, which sweeps an area almost equal to a football field on edge pulled through the sea. A haul of 8 to 12 tons of krill is common.

Late one foggy afternoon in January we sighted a Soviet fleet sheltering in the lee of Elephant Island. We stumbled first on the support vessels—a fuel tanker and a factory ship, as well as freighters to carry home the dried krill. Early next morning we found the trawlers, first four, then six, then nine glowing blips on the radar screen. Three trawlers

loomed close by, pulling their immense nets along parallel tracks through a massive patch of krill at some hundred meters' depth.

Captain Lenie maneuvered the *Hero* close to the stern of one trawler as it winched its net aboard. The cod end was so heavy and swollen that it caricatured a harpooned whale, dwarfing the Soviet seamen as it inched up the sloping sternway. Crewmen hooked the end of the net to an overhead hoist, and the krill poured into the hold. From there, processing would transform them into food for people and animals in the U.S.S.R., 10,000 miles away.

The Russians operate about a hundred and the Japanese 14 of these giant trawlers in the Antarctic krill fishery.

As man competes for krill with whales and other marine mammals, with fish and seabirds, serious questions arise. If the krill

fishery expands, even the protected southern whales, as their populations attempt to recover, may not survive. They could become extinct, not because hunters harpoon them but because they starve. Indeed, excessive krill fishing could be disastrous for the entire fragile Antarctic ecosystem, because almost every animal there depends for survival directly or indirectly on *E. superba*.

Perhaps such overfishing will not occur. Costs and distance may curtail the harvest. The Antarctic waters are remote from the countries best able to exploit their resources, so it is difficult to operate a cost-effective fishery there.

Only the Soviet Union is presently engaged in large-scale fishing for Antarctic krill. Several of the nations that raced each other to exploit krill are now reining in their efforts. West Germany and several South American countries tried krill fishing but gave it up as uneconomical. Poland, after fielding a strong fleet, now is following suit. The United States has shown little interest in the krill fishery.

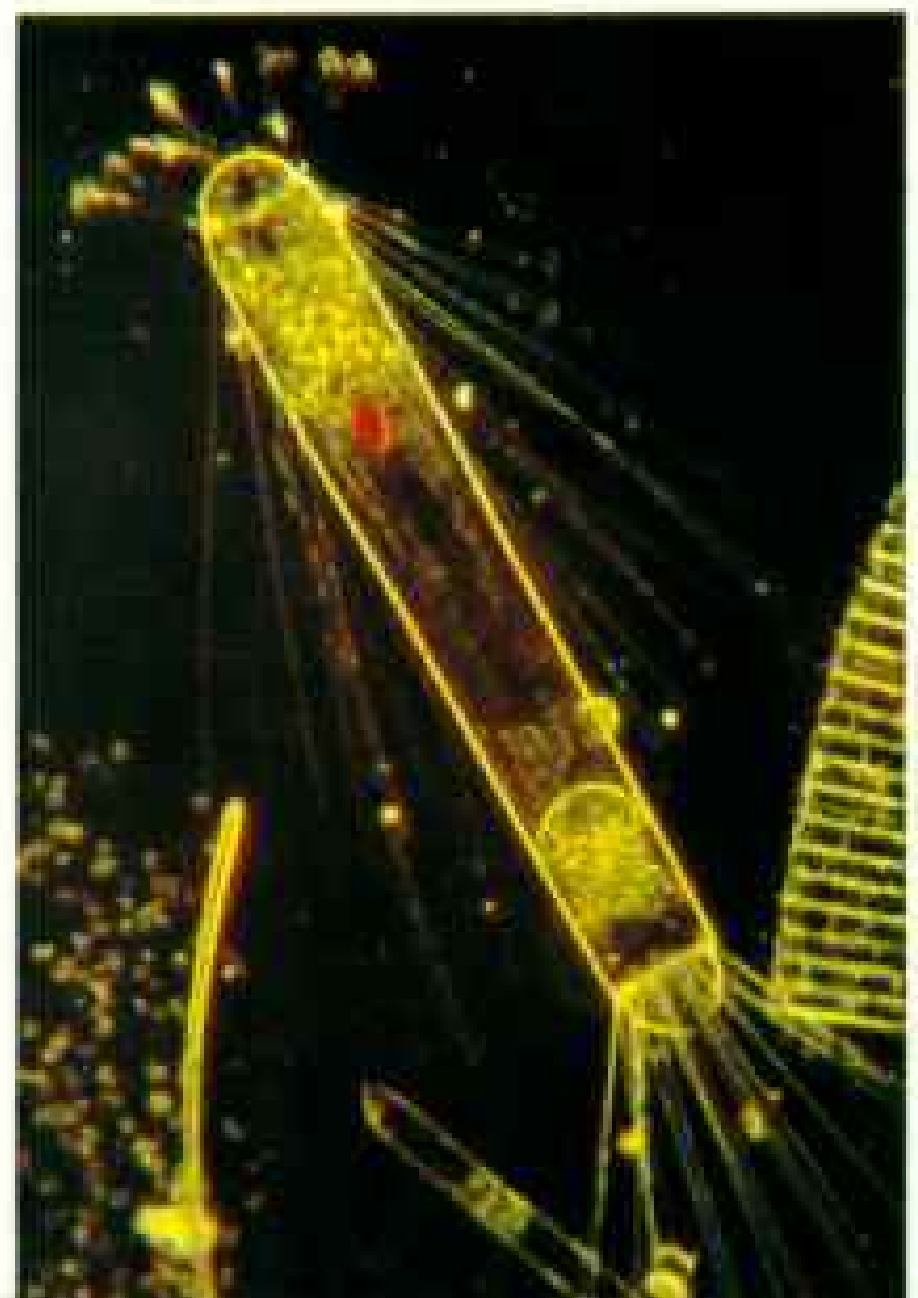
**Y**ET KRILL surely is a sleeper as a protein source for man, and its fuller utilization seems inevitable. The Antarctic Treaty, signed in 1959, assures peaceful international sharing of Antarctica for the pursuit of science, but it avoided the controversial issues of marine and mineral resources. Concern for conservation led the major maritime nations to ratify, in April 1982, the Marine Living Resources Convention to manage not only krill but also the entire marine ecosystem.

What quantities of krill do the Antarctic seas support? Estimates vary from 125 million metric tons to 6 billion metric tons. Obviously the upper limit of a safe harvest hinges on which estimate is closer to the truth. The fishing season is also the krill breeding season. How many millions of egg-bearing females can safely be removed from the population each year?

Can an international treaty protect such distant and disputed waters? Cooperation, patience, and goodwill are required. Needed, too, is much more knowledge of that overwhelmingly important krill species, the bountiful, elegant, clever little shrimp, well-named *Euphausia superba*. □



*Frozen dinner, algae growing on the underside of Antarctic ice in an aquarium at Palmer Station elicit dramatic feeding behavior from krill (right). "They scrape and grate rapidly," says the author, who suspects that such ice algae may be a valuable food source during Antarctic winters. Diver Steve Strand (above) collects diatoms. The tiny plants (below) are the chief summer fare for krill.*









# *The Olympic Peninsula*

By BILL RICHARDS

Photographs by SAM ABELL



Point of Arches, Olympic National Park

*Awesome and remote, Washington State's northwest corner resounds with the primeval energy of wilderness untamed. From the pounding surf of Pacific beaches to lush rain forests, profound respect for nature reigns.*



*Where no ax has been raised in the luxuriance  
of the Olympic rain forest, wind-toppled*

*National Geographic, May 1984*



Hoh River Valley, Olympic National Park

*trees provide nourishment for saplings,  
while moss and ferns feed on the very air.*



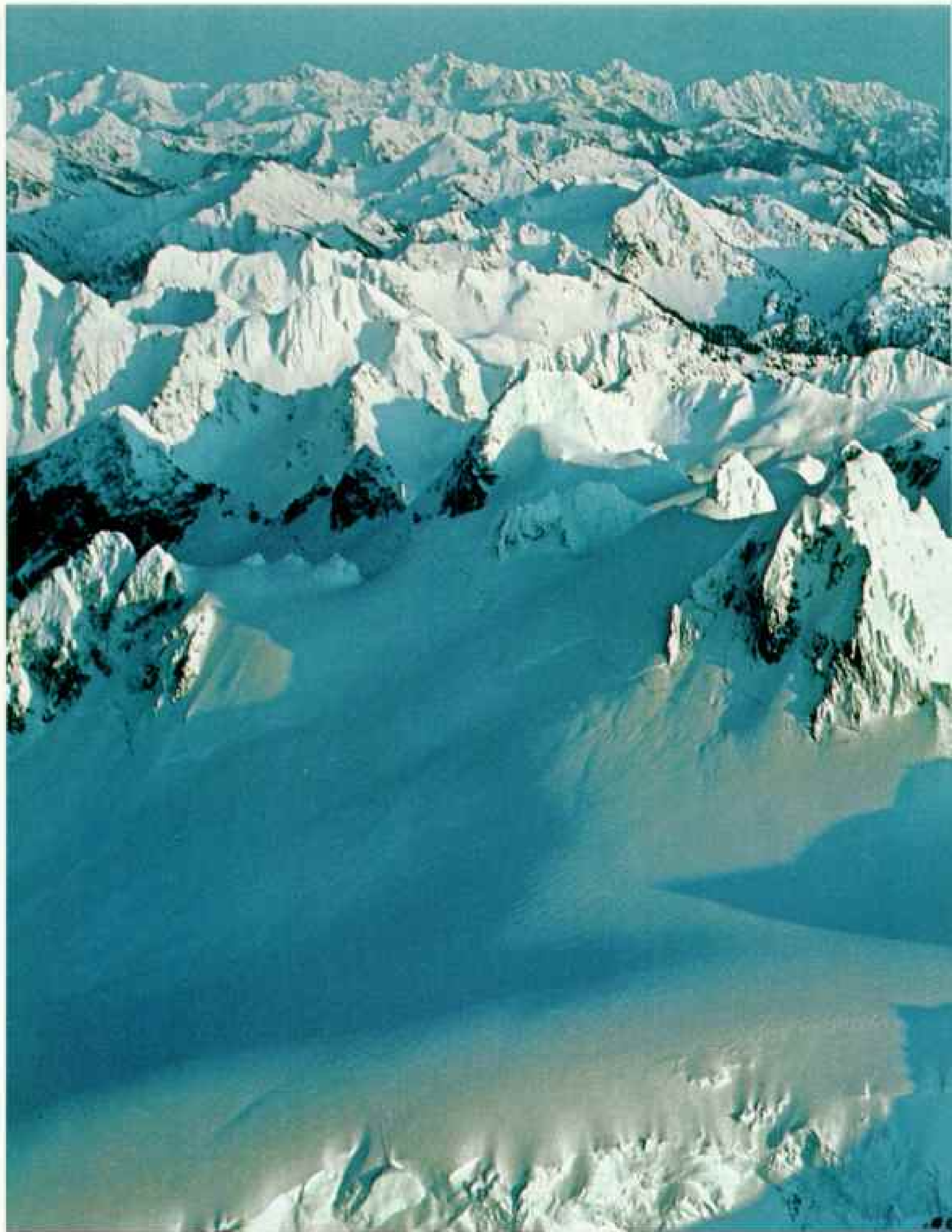
Hurricane Ridge (above and below), Queets River (right), Olympic National Park

*Far above the rich valleys, where subalpine firs dot the timberline, deer and elk range free while Olympic marmots fatten on wildflowers for winter hibernation.*

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*Frigid home for the gods, jagged peaks of Mount Olympus rising in the foreground cap*

*National Geographic, May 1984*



*a glacier-mantled host of ramparts visible  
from Seattle, 40 miles to the east.*



**T**HE DOUGLAS FIR was the kind of tree that makes your hat fall off when you throw back your head to see the top. Within the deep wrinkles in the bark on its mighty trunk, tiny spiderwebs glistened like rainbows in the light of early morning.

Tom Smith, who has logged big timber on Washington State's Olympic Peninsula for 47 years, guessed the tree to be 230 feet high at the tip. There was enough lumber in the old giant to build two houses.

"How old do you figure that tree is?" I asked. "Maybe 600 years, maybe 700," Tom answered. "How long will it take you to cut it down?"

In the grove's stillness Tom spat on his hands and yanked his snarling power saw to life. "I can take 'er down in 30 minutes," he shouted. And he did.

There is a swagger of self-confidence here on the peninsula. It comes from besting nature in her wildest exuberance. This thumb of land, nudging into the Pacific Ocean from the edge of the continent, is a living catalog of natural superlatives.

Here, beneath the Pacific fog that shrouds coast and forest, can be found some of the world's biggest trees, fattest salmon, most exotic coastline, wettest weather, and mountains so rugged that less than a century ago they inflamed speculation in the yellow press that those trackless peaks might be hiding a tribe of man-eating savages.

The peninsula is no longer mysterious: nearly three million visitors made their way here in 1983. Still, there is wilderness enough. A logger offered this backhanded compliment as we stood deep in the backwoods of the Olympic National Forest.

"It's a known fact," he said, "that when God finished with the rest of the world He dumped the leftovers here. But then, praise be, He gave us all these big trees to cover the whole thing up."

By dodging between the huge logging trucks, Kenworths and Peterbilts grinding along the two-lane track of the Olympic Loop Highway, it is possible to make a

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Author Bill Richards has covered other out-of-the-way regions for the *GEOGRAPHIC*, including Alaska's Southeast and Hudson Bay. Contract photographer Sam Abell has contributed to many Society publications.

complete circuit of this 6,500-square-mile peninsula in a single day (map, page 654).

In its northwest corner, locally called the West End, I passed through remote timber towns—the elegantly named Sappho and the not so elegantly named Forks. The West End is wild, remote, woodsy, thinly settled. The road runs down hushed aisles of lofty Douglas fir, hemlock, and Sitka spruce and passes through deadened stretches of clear-cut forest, forlorn as battlefields.

From every side of the peninsula its crown jewel, the mountainous 900,000-acre Olympic National Park, is visible, veined with snow and glacier ice even in July. Along the edges of the glaciers, a patchwork of alpine wildflowers bloom: avalanche lilies, pasqueflowers, blue-eyed grass.

Off the west coast the Pacific breathes in mammoth swells. Due north, Vancouver Island, blue and mysterious, lies ten miles across the Strait of Juan de Fuca. To the east glitters Hood Canal (a fjord, dug deep by glaciers, not men), Puget Sound, and a cluster of quiet inlets, breeding grounds for some of the world's rarest and tastiest oysters.

**M**ISSING ALTOGETHER from this flying tour are the critical elements that set the Olympic Peninsula apart from nearby bustling Seattle or Tacoma—solitude and the almost stubborn adherence of some of its people to nature's more deliberate rhythms.

Pearlie Sewell explains: "You get to thinking in different ways here. You don't think of July or November, you think of berry time or oyster time."

Pearlie is a buoyantly cheerful woman of 62 with a tight cap of gray hair and the flat twang in speech of her native Oklahoma. She happily traded her native state 36 years ago for her home on the peninsula. Pearlie was amused when I asked her how she made her living. "Depends on what time of year you want to talk about," she said.

In the spring Pearlie joins a small army of brush pickers who fan out through the peninsula's forests, plucking the leaves of salal, huckleberry, and sword fern. These greens are shipped to florists throughout the world. When summer comes, there are blackberries to gather for local dealers. In autumn

Pearlie is a wild-mushroom picker. Winter is the time to collect pinecones, which she sells for seed to local nurseries.

Each spring and fall Pearlie takes time out from forest chores to shuck the chunky Pacific oysters that are grown commercially in lower Puget Sound near her home in Kamilche. Oyster shucking is hard, gritty work. I watched one morning as she deftly pried open oyster shells the size of softballs.

"There's plenty to do around here if you know where to look," Pearlie said. There was, in fact, just one complaint: "Sometimes the year goes by so fast, it seems you hardly have time to catch up."

**A** CENTURY AGO another oyster—the Olympia, tiny and coppery to the taste, flourished hereabouts. In the gilded dining rooms of San Francisco, gold-rush gourmets paid up to \$20 for a serving of nugget-size "Olys."

Like California gold, the Olympia oyster is mostly a delicious memory now, a victim of predators, pollution, and greed. In the past half century the Oly harvest has dropped steadily, from more than 35,000 gallons in 1935 to a mere 300 gallons in 1983. Faced with the extermination of their Olympia crop, oystermen here turned to importing bigger, hardier—but blander—Pacific oysters from Japan and seeding them in local waters. The few Olys left now come almost entirely from two inlets near Shelton.

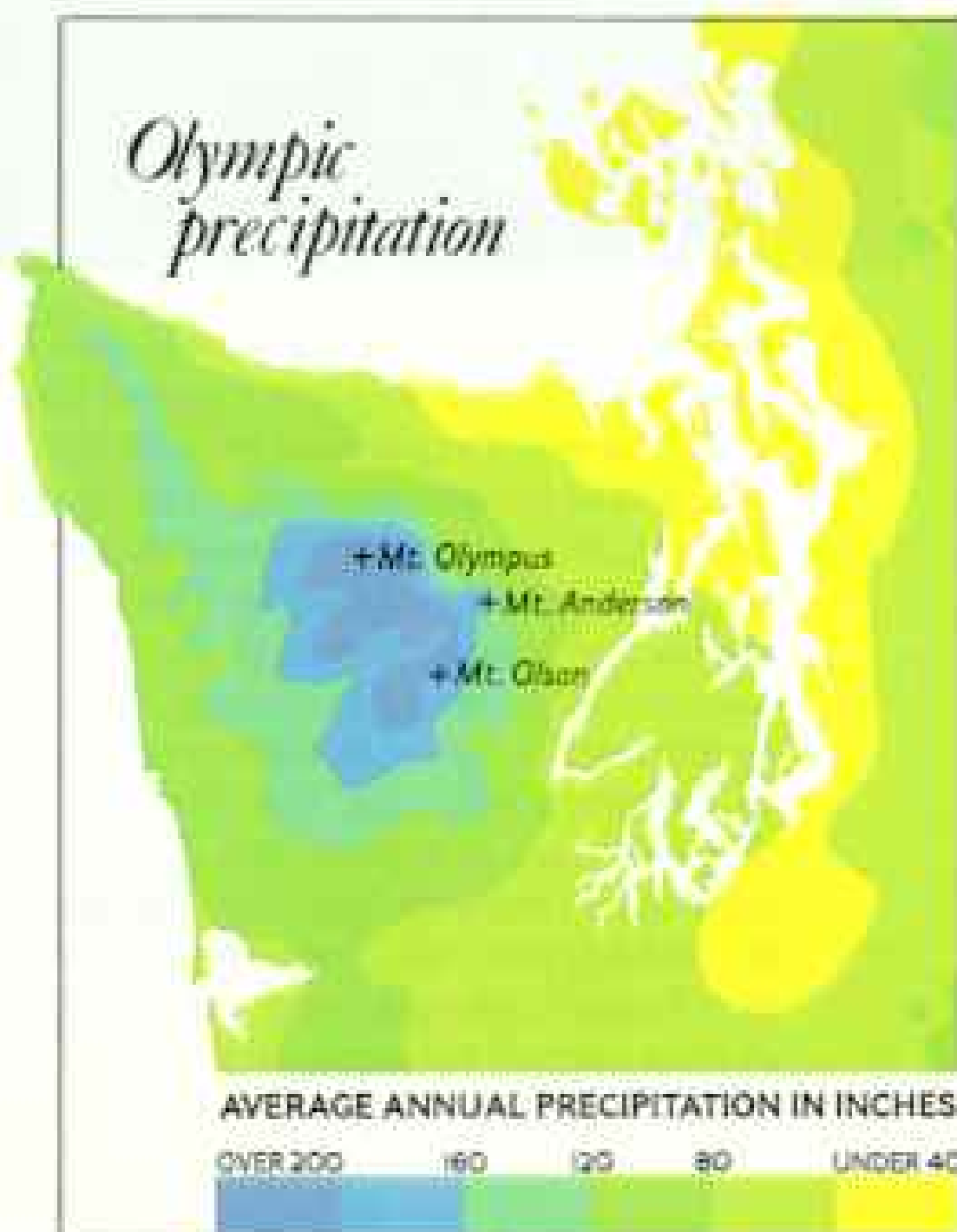
One cool June morning, with the last shreds of fog disappearing into the hemlocks, I drove down a narrow road paved with crushed oyster shells to visit the final holdout of the Olympia oyster.

Dave McMillin, manager of the Olympia Oyster Company, met me at the firm's packing shed on Totten Inlet. A tall, barrel-chested man, Dave is a marine biologist-turned-businessman who has spent 34 years scrambling to save the delicate Olys from paper-mill waste, parasites such as flatworms and Japanese oyster drills, and other threats. So finely attuned has he become to the ways of oysters that when he tastes one he can tell exactly where it grew.

On a swiftly falling tide we crossed the inlet in a small aluminum skiff. There were signs, Dave said, that Olys may be making a



*Before the fall of a centuries-old tree, logger Tom Smith employs a plumb line and 47 years of experience to calculate the path of the giant's earth-shaking descent. In the nation's second ranking timber-producing state, after Oregon, the lumber business remains the peninsula's economic mainstay, despite a nationwide building slowdown caused by the recent recession. But after a hundred years of exploitation, the peninsula's majestic stands of Douglas fir, Sitka spruce, and western varieties of red cedar and hemlock are in steady decline outside the sanctuary of Olympic National Park.*



**A**N IMMENSE RAIN TRAP for the moist Pacific winds that buffet their windward slopes, the Olympic Mountains divide the 6,500-square-mile peninsula into contrasting zones. While rainfall in excess of 140 inches a year nourishes luxuriant temperate rain forest along the valleys of the Hoh, Queets, and Quinault Rivers, a rain shadow casts the northeast side into relative dryness, demanding occasional irrigation of area farms.

Wilderness centerpiece of the peninsula, Olympic National Park is traversed by 600 miles of hiking trails. The interior is accessible primarily by foot. Set aside in 1938 by Congress, the 900,000-acre park includes a 50-mile-long stretch of wild and scenic coastline acquired in 1953. Nine Indian reservations control an additional 162,000 acres.

comeback: The latest crop was unusually firm and meaty. Dave was puzzled by this turn of events. Nature, he said, seemed to be solving the problem on her own.

"I'm a scientist, and I like to know why things happen," said Dave. "The flatworm population is decreasing, and I don't know why. But it seems to be great for the Olys."

We stopped at a shack moored near the edge of the inlet. A few sacks of oysters and clams drifted in the current on a line hung beneath the float. Dave took a couple of oysters from a sack, pried them open with his pocketknife, and offered me one.

It sat, plump and healthy, on its purple-rimmed shell, no larger than a quarter. Restaurants as far away as New York City were begging to pay \$180 for a gallon of these little delicacies. A gallon of "quarters," of course, is a lot of Olys. I had come 3,000 miles to this lonely spot to try one.

I popped the Oly into my mouth, savored, and swallowed. It was a bit briny but not too sharp, slightly sweet but not too much so. It was, yes, the best oyster I had ever tasted.

**O** THER BOOMS besides the Oly craze have ebbed and flowed on the Olympic Peninsula. There is always timber (on the bust side of the cycle during my visit, now recovering). But perhaps no craze has run on such undiluted dreams as the one that swept the peninsula's oldest town, Port Townsend, for the railroad that never was.

Port Townsend, originally built on tideland in the northeast corner of the peninsula, settled by sea captains and merchants from New England, has the look of the East about it: vast Victorian houses and gracious inns, turreted and gingerbreaded. The chief support of its 6,100 people is tourism.

For a brief time near the end of the last century, when there were great plans to build a rail spur to join the Union Pacific at Portland, it looked like Port Townsend just might be *the* premier port of the Northwest.

Local citizens raised enough cash to build a mile of track and secure promises from the railroad to finish the line. Stone warehouses, commercial buildings, and those fine Victorian homes were built. Fired by the prospect of a transcontinental railhead with a connection to sea-lanes to the Orient, the

town's population doubled and redoubled.

But the deal collapsed. The established line linking Seattle and Tacoma on the east side of Puget Sound took the traffic. In Port Townsend, banks closed, streetcar companies tore up their tracks, and a large contingent of townsfolk left by steamer for Seattle.

Nearly 90 years later there are still a few people here who cast envious glances across Puget Sound at Tacoma and Seattle. The town that once boasted seven foreign consulates along its unpaved streets now has a single traffic light in its business district—and it is usually flashing.

"We were going to be the New York City of the West," one Port Townsener told me sorrowfully. "We were just on the wrong side of the sound."

Perhaps. Port Townsend will never challenge Seattle as a center of commerce; it has set its course in another direction. Artists, writers, musicians, and others, happy to be away from the urban rush, have moved in.

"This town is full of unconventional people," said Barney McClure. "If you live here, it's because you've chosen not to be someplace else."

That description fits the 43-year-old former mayor (now a state representative) to a T. Ten years ago he was a successful jazz pianist living in the freeway culture of Los Angeles. "I was tired of the smog and the city life," Barney told me. "One day I climbed in my van and headed north. When I reached Port Townsend, I knew I'd found a home."

Barney still plays jazz piano. Residents of Port Townsend were not startled to see their mayor, after a late night gig in Seattle and a long drive home, stroll into City Hall attired in a rumpled tuxedo.

Another unconventional wanderer, Jack London, is reputed to have spent a night here—in a cell, said Barney. He had walked me to the Jefferson County Historical Society Museum, located in City Hall. Peering down from her office—a chair behind a judge's bench—the museum's historian, Helen Burns, issued a judicious note of caution. "We can't find his name in the records," she said, "so we're not sure."

Barney sat down at a battered old saloon piano at the far end of the courtroom and filled the museum with a rickety rendition of "My Funny Valentine." If Jack London



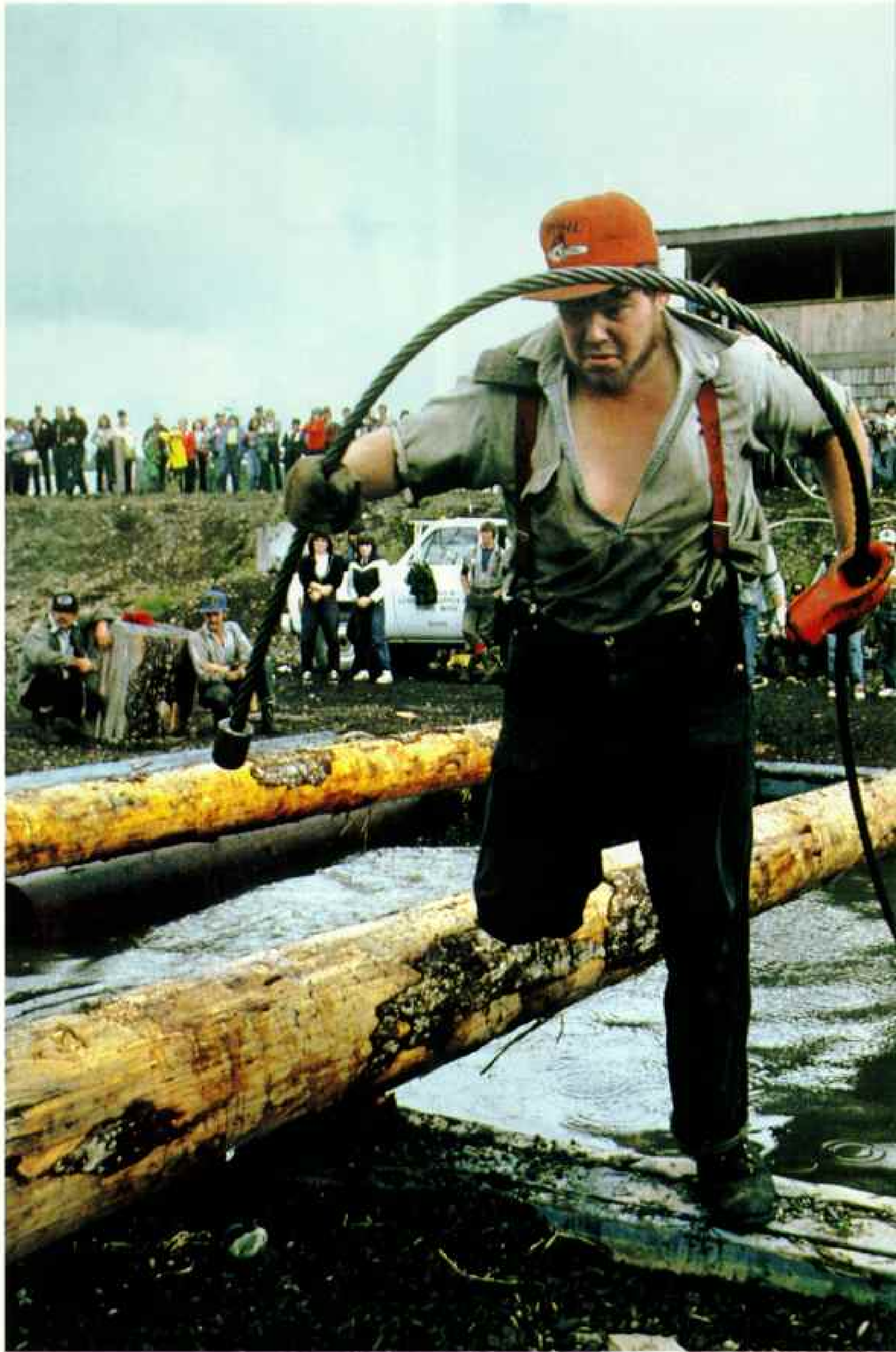
*Laid-back and mellowed-out, the people of historic Port Townsend view a small traveling circus near the ferry pier (above). Many such summer events and music festivals draw crowds to the peninsula's oldest town.*

*Once a thriving seaport, Port Townsend was a serious contender for the railroad terminus and subsequent fortune that destiny had in store for Tacoma and Seattle. Following the collapse of the rail scheme in 1891, the town's population plummeted, while banks and brothels near its notorious waterfront closed their doors. Now a*

*national historic district and Northwest magnet for artists, the gentrified town boasts dozens of Victorian houses, many now bed-and-breakfast inns.*

*"The amount of creative energy here is amazing," says artist and innkeeper Mariii Lockwood (top right), dressed to host a celebration of Italian culture at the Quimper Inn. The town was so admired by out-of-staters Dede Moore (right, at cake) and Marc Liverman, that their guests traveled all the way from California and Oregon for an outdoor wedding, followed by a reception at the 95-year-old Starret House.*







were around today, I thought, he would have loved it.

In at least one respect Port Townsend clings to its past. At the edge of town, at the Northwest School of Wooden Boatbuilding, I found some thirty students hard at work under the keen eye of the school's founder, Bob Prothero. Before setting up his non-profit school in 1981, Bob had spent 67 of his 74 years as a boatbuilder. Lured by his reputation, students have come from as far away as New Zealand and Saudi Arabia to learn how to craft seagoing speed and beauty from a pile of raw lumber.

"We study craftsmanship here, not just boatbuilding," said Bob. He tapped on the 400-pound Honduras mahogany transom that was being given a few final touches with a hand adz before being lifted into place on the stern of a 50-foot ketch. The students hoisted it; it fit beautifully.

One of Bob's students, Ed Louchard, surveyed the job with satisfaction. "Sometimes we row around the harbor, looking at transoms on factory-made boats," Ed told me with a craftsman's pride. "They look like *toys* compared to what we're doing here."

**F**ROM Port Townsend west, the Strait of Juan de Fuca cuts a broad, blue-green channel nearly a hundred miles to the Pacific. It is a magnificent waterway, 14 miles wide at the mouth and deep enough to allow the U. S. Navy's big Trident submarines easy access to their seven-year-old base on the Hood Canal. Yet some historians say that the Strait of Juan de Fuca bears the name of a nautical faker.

In 1592 de Fuca, a Greek sailing under the Spanish flag, believed that he had discovered the Strait of Anian—the fabled Northwest Passage—at the latitude of the Olympic Peninsula. He told of his travels up the strait all the way to the "northern sea."

In the absence of evidence to support his

*Latter-day Paul Bunyan, David Roark runs a gantlet of tests to demonstrate his prowess at old-time logging. Such feats of strength and skill are celebrated each July Fourth in Forks, a peninsula logging center.*







*"Grandfather of all the trades," Bob Prothero calls the ancient art that he has spent a lifetime preserving. Near Port Townsend, which bills itself as the wooden-boat capital of the world, the master boatbuilder works with New Zealander Jim Ferris (far left), one of many foreign students who enroll in his Northwest School of Wooden Boatbuilding each year.*

*"It takes the knowledge of many crafts to make a master boatbuilder," says the Seattle native, who has been building and repairing wooden boats for most of his life. "If you can design and build a wooden boat, you can make anything."*

*Students are exposed to many phases of construction while working on a variety of boats—like the 50-foot ketch whose new propeller makes a convenient prop for student whimsy (left).*

*Many of the students who come to the peninsula for the six-month course end up staying. Former biochemistry professor Frank Reithel and his wife, Kitty (above), not only graduated from the school but also commissioned it to design and build a 34-foot English cutter. "Once we finish the interior," says Mrs. Reithel, "we plan to explore all the beautiful sailing grounds around the Pacific Northwest." The Reithels have even hand built their dream house near Port Townsend. "We enjoy an active outdoor life," says Mrs. Reithel, "and we can have it here."*



claim, most contemporaries dismissed de Fuca's "discovery" as so much dockside yarn spinning. But when the first Spanish and English explorers made their way up the strait nearly two centuries later, they gave de Fuca credit for being in the region and the passage was named for him.

There are still discoveries to be made on the shores of the Strait of Juan de Fuca. The Pacific, streaming into the strait, throws everything from whales to World War II mines onto the beach. Wandering through these mementos from Davy Jones's locker, I came upon a curious gift from the sea—hundreds of logs, scoured by the waves, bleached by the sun.

Joe Faires, a cheerful, white-haired peninsula native, explained. The logs are escapees from the booms—big floating islands of timber en route from forest to market—that are towed by boats. In the Olympic's rowdy past, log rustlers sometimes helped matters along by freeing the chains from the booms and letting the logs float away.

Since the 1920s the State of Washington has allowed log patrols to round up the strays, check the timber company brand on them, and turn them over to the state. Joe Faires is one of the last of these seagoing cowboys. When a beached or drifting log is reported, he hitches up the *Hemlock*, his stubby, 26-foot towboat, and heads out after it. After capture, the log is sold by the state, which keeps 40 percent of the sale price; Joe gets half, and the remainder goes to the original owner. "In the old days," said Joe, tapping the ash from his cigar into a seashell ashtray, "a man could do all right for himself." No longer—nowadays logs are usually shipped by truck, and the beached timber I had seen is too rotten to salvage.

While the peninsula's coast was being slowly settled, the interior remained a region of mystery and imaginative speculation. Not until 1890 did explorers—led by a party dispatched by the *Seattle Press*—make their way deep into the wilderness.

What the explorers found dashed expectations that a Shangri-la or a tribe of cannibals might be hidden somewhere among the cloudy peaks of the Olympic Mountains. "The interior of the Olympics is useless for all practical purposes," reported Army Lt. Joseph O'Neil, the plainspoken leader of

a later trek through the mountains. But O'Neil was also foresighted and suggested that the unpeopled interior might someday make a good national park.

In 1938 President Franklin D. Roosevelt signed a bill creating the park and drew heated protests from timber companies, which saw the peninsula's interior not as "useless" but as a promised land of big timber waiting for the saw.

Nearly half a century after Roosevelt's decision, this controversy persists. "We've got 25 billion board feet of prime timber within our boundaries, which makes us the only remaining forest with that kind of quality left in the country," Roger Contor, then superintendent, told me at park headquarters in Port Angeles on the shores of Juan de Fuca Strait. "The business interests didn't want to lose this timber, and I worry that they'd still like to get a piece of it."

**G**EOLOGISTS have shown a different sort of interest in the Olympics. In geologic terms, the peninsula is "exotic"—of a different origin than the rest of North America. Experts differ, but many believe that the peninsula was born as part of an offshore oceanic ridge, then swiveled into its present position during a massive tectonic shift.

Glaciers carving the channels of the Strait of Juan de Fuca and Puget Sound apparently cut the peninsula off from the migratory path of many animals. There are few snakes here. Also missing are grizzly bears, Wolverines, bighorn sheep, and other animals found in upland habitats in nearby Canada or other parts of the West.

But the Olympics are hospitable to newcomers. A dozen mountain goats were transplanted into the Olympics from Canada and Alaska in the 1920s; the herd now numbers 1,200. Worried that the voracious goats may be altering the distribution of native plants, the Park Service is trying to control or even remove the goat herd and restore the mountains to what has been called "a vignette of primitive America."

At dawn photographer Sam Abell and I climbed the park's steep-sided Klahhane Ridge to watch a roundup of mountain goats. Park Service biologist Bruce Moorhead told us that spotters had counted more

than 200 goats nearby, making the ridge one of the most crowded mountain goat habitats in North America.

Bruce outlined the roundup plan: A 40-foot net had been strung over salt blocks on the ridgetop. When a goat approached the salt, the net would drop, the animal would be bundled into a wooden crate, and a helicopter would fly the captured goats off the ridge, to be relocated in goat habitats in several other western states.

It sounded simple, but the first goat to shoulder his way up to the salt was a 250-pound male with muscles rippling under his shaggy white coat. The net fell, and the billy dropped his head, ready to charge. Gingerly, Moorhead and his ten-man crew moved in. For a moment the scene resembled a football scrimmage, with arms, legs, dust, and goat hair flying in all directions.

"That's about as big a goat as you will find in the Olympics in the summertime," said Moorhead in a tone of relief after the billy was hobbled and blindfolded and his horns were shielded with lengths of rubber hose.

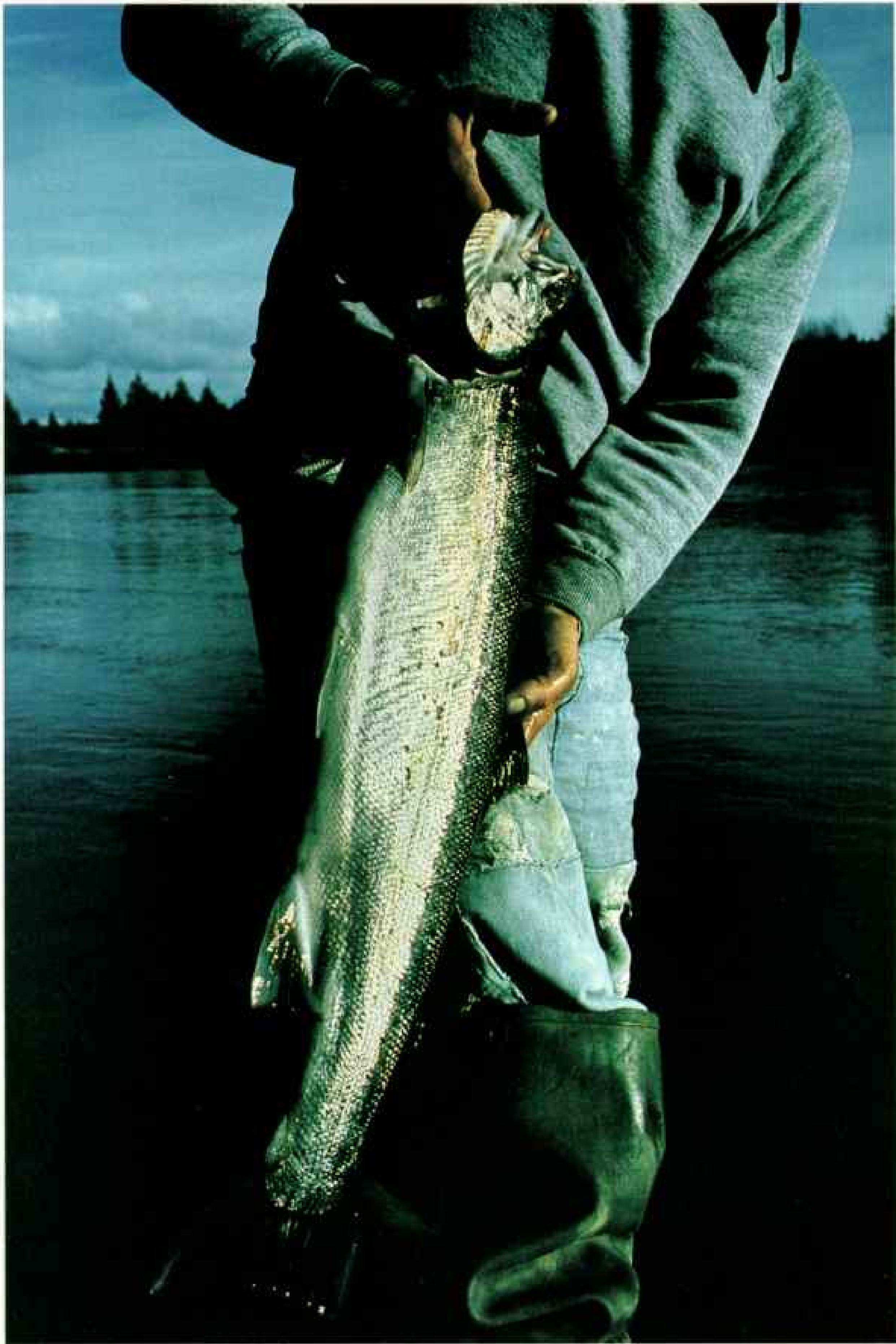
**O**N A CLEAR DAY the Olympics, rising out of their fogbank, are easily visible from the streets of Seattle, 40 miles to the east. But when one looks back toward Seattle from this wild country, the metropolis seems very distant. The solitude should last a while longer. Park officials estimate it will be at least twenty years before they are faced with the visitor overload in the Olympics that is already straining other national parks.

Meanwhile, it is still possible to walk through a rain forest, as I did one day along the Hoh River on the park's western border, where the pages of life and death are turned by another hand than man's. Shrouded choirs of fir and spruce stood around me in the Pacific fogbank. Fallen trees, still part of the forest's hardy life, nourished saplings that sprouted on their decaying trunks.

It is a quirk of nature that while the Hoh rain forest receives upwards of 140 inches of rain annually from the Pacific, farmers in the rain shadow of the Olympics just 40 miles over the mountains must irrigate to survive. The peninsula's ocean winds, cleansed by their long run across the sea and by the rainfall, contain some of the nation's



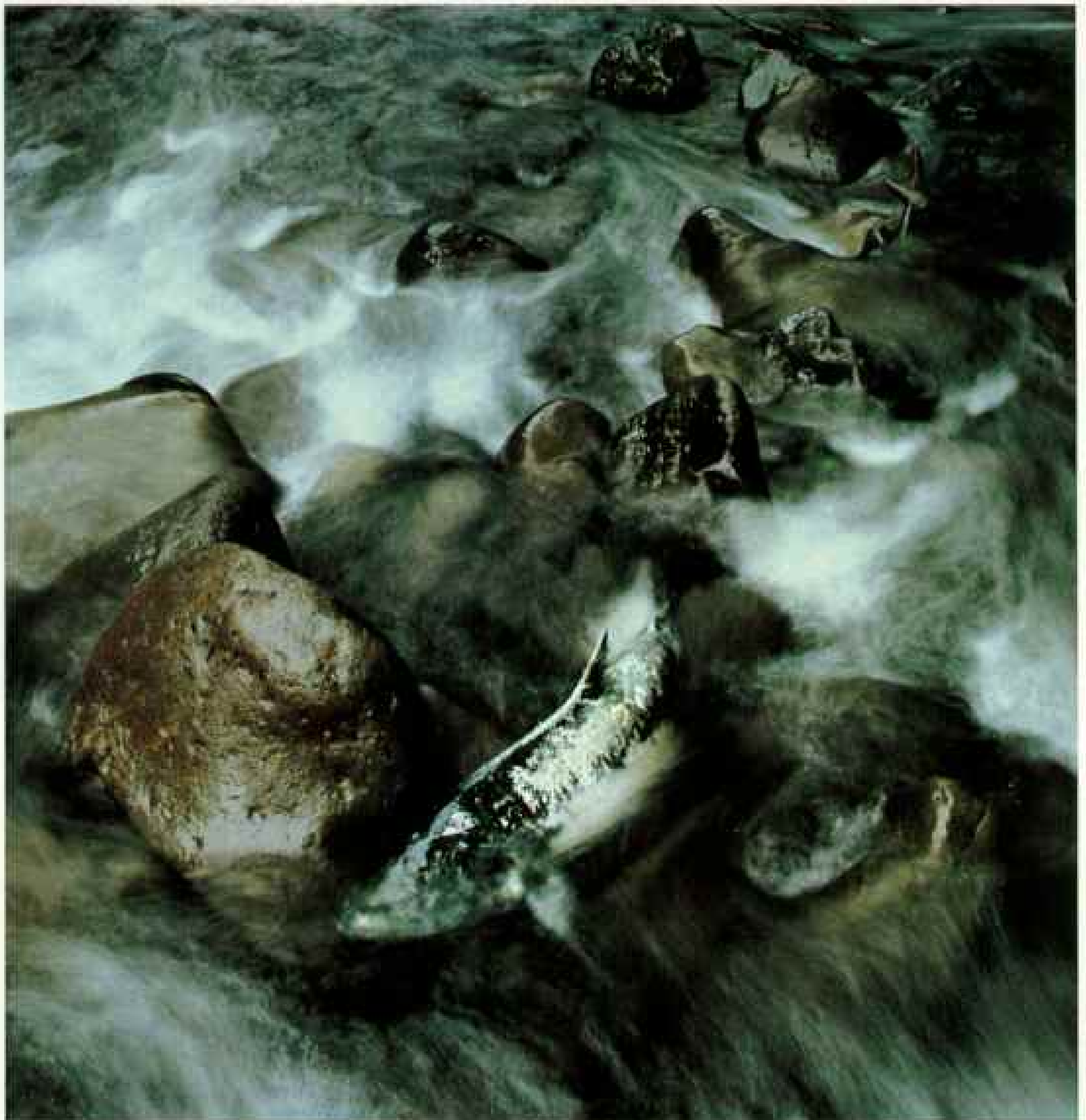
*Guardian of a family trust, Robin McCarty of Neah Bay dresses backstage for a Makah Indian wedding ceremony, during which he will perform a dance passed down through the generations. Heirs to one of North America's richest Indian cultures, Native Americans outnumber whites along most of the Olympic Peninsula's Pacific shore.*





*Battling uphill, a spawning chinook salmon (below) negotiates rapids to reach the headwaters of the Soleduck River, where it will lay its eggs and die. Though they find ideal habitat in these pristine waters, salmon are in decline partially because of overharvesting by commercial fishermen, including area Indians who enjoy traditional feasts of planked salmon (left). Fabled fighter, the steelhead (opposite page) is another oceangoing fish that spawns in peninsula streams.*

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*Big new fish in salmon country, the U.S.S. Ohio, first completed of the new Trident class of nuclear submarines, passes through the Strait of Juan de Fuca after leaving its home port at Bangor. After a decade of development and sporadic controversy, the 6,000-acre, 1.2-billion-dollar Trident base is now firmly entrenched at the north end of the 60-mile Hood Canal, which threads the peninsula's eastern woodlands.*

*When the Ohio, equipped to carry 24 long-range nuclear missiles, first arrived here in 1982, it was met by a flotilla of protest boats—some manned by out-of-staters. With 25,000 new jobs attributable to the new base, most local residents remain staunch Navy supporters.*



purest air. Air similarly free of pollution is found in few places outside Antarctica.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has listed Olympic National Park as one of its 165 World Heritage sites, together with the Pyramids, the Galapagos Islands, and the Taj Mahal. But there are others who view the park and its federal managers more darkly. I saw bumper stickers that said Stop

the Federal Land Grab and talked to people who angrily described the National Park Service as a land-hungry Goliath, gobbling up everything in its path.

"My first mistake when I got here was to tell a logger in a bar who I worked for," a Park Service naturalist told me in Forks, the West End's rough-and-tumble logging hub. The logger directed a dark stream of tobacco juice at the naturalist's boots, then knocked



him flat and stalked off without a word.

In the 46 years since the park was created in 1938, the Park Service has increased its size by a quarter of a million acres; some of these acres are prized land gained by shrewd and aggressive bargaining. "The old bitterness on the West End was not altogether unjustified," conceded Superintendent Contor. "But the tourism the park generates is the bank account for the entire peninsula

now that the timber industry has problems."

Despite cycles of boom and bust, timber is clearly the ridgepole of the economy here. The scent of freshly cut fir rides the wind nearly everywhere. In Forks (self-proclaimed Logging Capital of the World) I watched 22 logging trucks roll by one morning in just ten minutes—and this was during a recession, when local unemployment was above 23 percent.



"Without logging we just wouldn't be here," said Yvonne Moore, town secretary, daughter of a logger, wife of a forester. "This is God's country, and logging's a man's work," a strapping 23-year-old West End woodsman told me. "There's not much snow, not many hurricanes—and best of all, no snakes. What more could anyone want?"

Fair question. But logging here, as elsewhere, is changing. Men who work in the woods continue to wear the traditional loggers' uniform: red suspenders, striped shirt, denim pants cut off at mid-calf to prevent snagging in the underbrush, and high-top calk boots. By now, much of the big old-growth timber has been cut. Forest managers plant fast-growing "industrial forests" and may even harvest the trees with otherworldly machines that snip tree trunks as if they were flower stems.

On the southern flank of the Olympics, I visited Camp Grisdale, one of the last resident logging camps left in the United States outside Alaska. Grisdale is a company town, buried deep in the woods on the Wynoochee River. In some ways it provides a glimpse of a vanished past. Loggers with families can rent any of its 42 trim wooden houses from the Simpson Timber Company for \$75 a month, and single men could live in the company's long, whitewashed bunkhouses, until they were closed last year. The wooden walks between the buildings carry deep scars gouged out by hobnailed boots.

A sign posted outside the camp cookhouse, where 53-year-old Roger Hanson presided with laconic good humor, says No Caulks. "No trick to running a good cookhouse if you follow one simple rule—be ornery," Roger confided when I showed up at 6 a.m. for breakfast. But he was smiling as the first sleepy-eyed loggers shuffled in and caught a whiff of the cinnamon rolls he had just baked. Logging may change, but loggers' appetites don't. They sat down at lumber tables to a Paul Bunyan-size breakfast of flapjacks, French toast, rolls, eggs, bacon, and coffee. Many returned for seconds.

**L**ATER, with camp superintendent Frank Brehmeyer, I drove up the narrow switchbacks of a logging road that had just been cut through the forest. It dead-ended at the base of a still

steeper slope where a crew of loggers was busy with chain saws.

"There are still big trees in these woods, but to get at them we have to go places like this that are too inaccessible for conventional logging," Frank said. A Sikorsky S-64 Skycrane helicopter, large as a boxcar with the backbone of a dragonfly, was lifting logs off the slope and ferrying them down to the road. When the helicopter paused for refueling, Frank asked if I wanted to take a ride.

In a Plexiglas pod that hung down behind the pilot, I buckled up. With breathtaking speed, we skimmed straight up the mountainside. Pilot Max Evans, cool and competent, explained over the intercom that we would be hoisting lashed bundles of logs off the slope with the 200-foot cable and hook that hung from the helicopter's belly.

A scale attached to the cable registered on a dial on the instrument panel. The Skycrane could lift up to 18,000 pounds of logs, Max said. Anything heavier might start sliding downhill out of control with the helicopter, and the people inside it, in tow.

The cable went taut as we started to raise a bundle of five logs. The big chopper shuddered and strained. Over the intercom, copilot Frank Swisher called off the weight of the logs as we struggled to climb: "17,800 . . . 17,900 . . . 18,000 . . . 18,100!"

"Oops!" Max shouted. The big helicopter bounced like a circus balloon at the end of a string, and the load of logs thumped back on the mountain.

"Sometimes those guys on the ground guess the weight a little wrong," Max said tersely. Down below, the ground crew scrambled to hook up a lighter load.

During the next 42 minutes we made 14 nerve-racking runs up and down the mountain. By the time the helicopter landed to refuel, I was bathed in sweat.

Max poked his head into my Plexiglas pod and grinned. "Staying aboard for another trip?" he asked jovially. I shook my head. Max understood. "*Nobody* ever asks to take a second flight with us," he said.

Steep-slope logging takes its toll in land erosion. Environmentalists and others worry that runoff sediment from the sites and from unpaved logging roads may be choking newly hatched salmon and steelhead in the spawning beds. Runs of wild fish in the

peninsula's rivers have dropped precipitously in recent years. Popular opinion focuses much of the blame on logging.

Fisheries biologist Jeff Cederholm disagrees with this view. In his opinion overfishing combined with logging is to blame for the recent poor runs. Hiking the logged-off areas on the Clearwater River one springtime afternoon, Jeff pointed out pools where tiny salmon fry nipped at dancing mayfly nymphs. "Logging, erosion, clear-cutting—they all affect a stream," Jeff said. "But these are only short-term effects. It's amazing how nature flushes away the sediments that man makes."

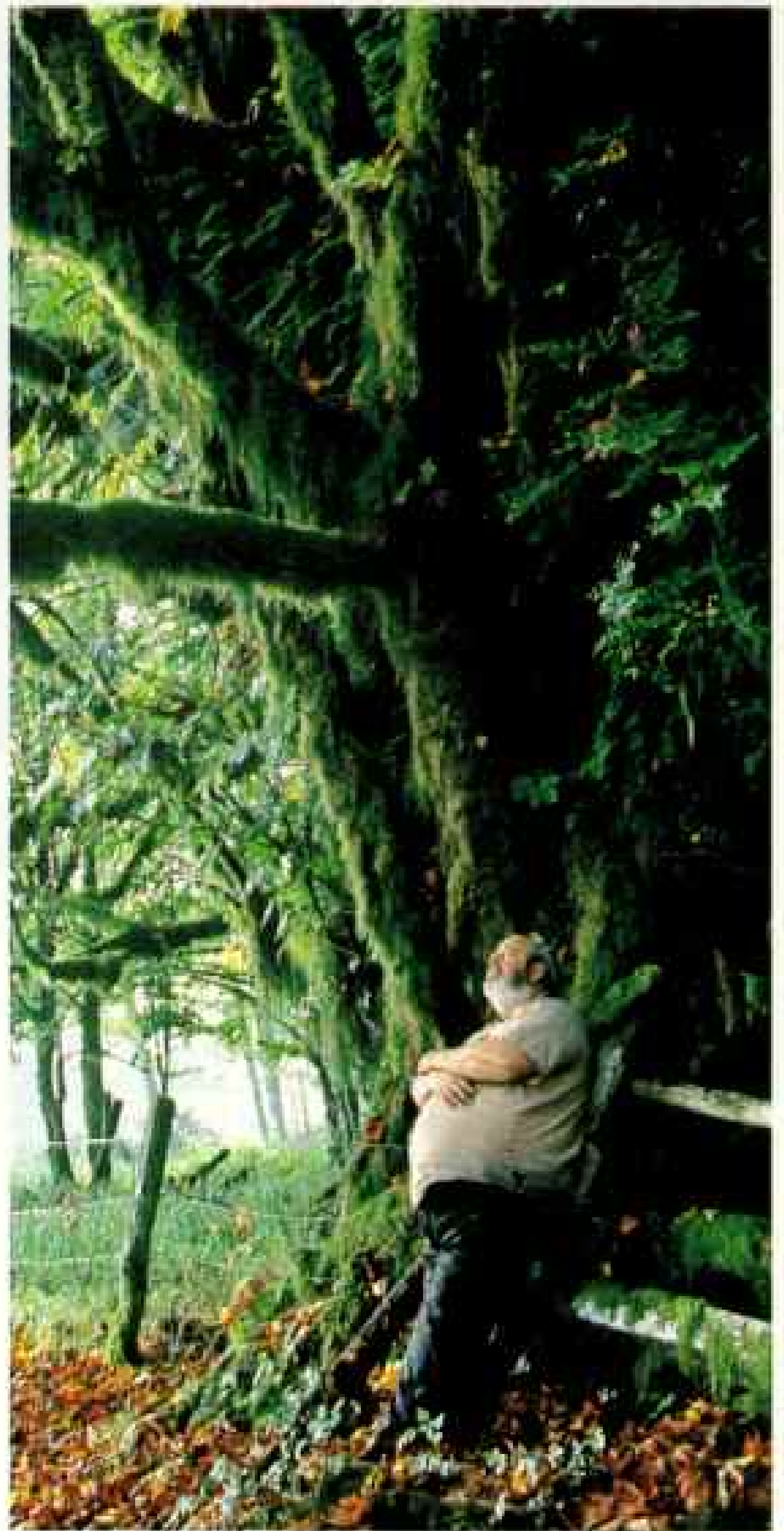
In recent years timber companies have begun working to lessen the sediment problems caused by logging and protect delicate fish-spawning areas, said the biologist. But an even more pressing controversy involving the peninsula's fishery resources has overtaken that concern.

In 1974, in an attempt to clarify Indian fishing rights in western Washington, U. S. District Court Judge George H. Boldt ruled that treaties concluded between the United States and several local tribes in the 1850s gave them the right to harvest fish "in common"—that is, on a fifty-fifty basis—with non-Indians.

The Boldt decision threw the state's 63-million-dollar salmon-fishing industry into turmoil. With non-Indians then outnumbering Indians four to one in the state's commercial fishing fleet, the problems of matching the two groups' catch has strained the limits of authority and diplomacy.

Hundreds of non-Indians have been forced out of the fishing business as regulations have squeezed their season shorter. While legal snarls are still being untangled in court, bitterness has erupted into occasional gunfire on the fishing grounds. "It's the ruination of the industry," a state fisheries patrolman told me sadly.

**A**T NEAH BAY, headquarters for the Makah Indian tribe on the remote northwestern tip of the peninsula, I spoke of the fishing controversy over dinner with Hubert Markishtum and his wife, Jackie. We were eating fresh salmon, caught that very morning by Hubert on his boat, the *Missy Two*.



*Shareholders in Eden, hundreds of private landowners cling to their enclaves in the national park. While many are antagonistic to federal red tape and land purchases, others like Alf Jensen are sympathetic conservationists and willing sellers. Congress appropriated \$338,000 for the purchase of Jensen's 180-acre farm on the Quinault River—prime habitat for elk and big-leaf maple.*



*Paper profits pour from great "industrial forests," like these along the Queets River Valley (above). After a century of exploitation, few giant trees remain on the land available for commercial logging. Thus area timber companies have turned to pulp operations, which make the most economical use of the rapidly grown, thin-trunked new trees that now dominate areas outside the park. For the big timber still being harvested, wood-hungry China and Japan are the*

*best customers, paying top dollar for logs such as this huge spruce being trimmed at a yard near Forks (below).*

*In steeply sloped areas, where logs are moved out with helicopters and balloons, buffers of uncut trees help curb runoff sediment, which can harm fragile fisheries in adjacent streams. To reduce aesthetic pollution, towering borders of hemlock, spruce, and fir create illusions of grandeur along roads like Route 101 (right), concealing scarred landscapes.*





Hubert, president of the Makah Fishermen's Association, pointed out the living-room window at the long, gray swells rolling up the Strait of Juan de Fuca beyond Neah Bay. His tidy ranch house lay close to the sea. "Our ancestors signed a treaty that gave the Makah the right to fish out there, but people seemed to forget," he said, anger edging his voice. "We had guys thrown into jail for fishing where they were entitled to fish."

The Boldt decision placed no restrictions on the length of Indians' fishing season. When the salmon runs thread the Strait of Juan de Fuca with silver, a Makah can bring home \$2,000 in a week. Fishing has filled Neah Bay's dusty streets with brand-new pickups and its harbor with boats carrying the tribal crest—thunderbird and whale. Yet Hubert said not all Indians are happy with the federal regulations.

"Once we could fish where we wanted. Now we have to fish where the government tells us we can fish," he said. "We see Indians battling with each other, as well as with non-Indians, for the best fishing grounds."

Traditionally, the Makah fishermen have held a special place among the peninsula's seven major Indian tribes. They were renowned whale hunters, daring the wild Pacific surf in cedar canoes to chase giant grays and humpbacks that even today swim close to the west coast of the peninsula.

"Can you imagine the excitement when a whale was caught?" asked Helen Peterson, 78. Eyes ashine among the wrinkles of a long lifetime, she described childhood memories of those last great hunts.

"The whale—big as a canoe, even bigger—was dragged up the beach in front of the chief's lodge. People came, most of the village, and they sang their family whale songs." Among the Makah, songs are heirlooms, passed down from parent to child. Helen rose from her reverie and then began a low monotonous chant that had belonged to her father and grandfather, whalers and Makah chiefs.

"We lost something very important to us when the hunting of whales ended," she said softly when the song was over.

**T**RIBAL MEMORIES were fading for most Makah when in 1966 a team of archaeologists began digging at an abandoned whaling camp called Ozette, at the edge of the Pacific near Cape Alava.

But the past soon flooded back. Out of the muck of Ozette came thousands of artifacts—delicately twisted cedar ropes, fragments of canoes, an entire longhouse. All had been preserved by mud slides that swept over this tiny coastal settlement some five centuries ago. Evidence of human habitation nearly 2,000 years old was unearthed, and scientists proclaimed Ozette a major archaeological discovery.

One gray morning, with a mother-of-pearl curtain of cloud and sea hanging just offshore, I hiked the three-mile trail to the site with Makah anthropologist Greig Arnold. The Makah had elected to close the dig for now and concentrate on the nearly 55,000 items already taken from it, he said. Ozette's remaining secrets would remain interred, a great treasury to be probed by future historians.

Greig and I gazed on waist-high beach grass that had swallowed most traces of Ozette and those long-ago hunters of the sea. Beyond the breakers the swirling fog curtain moved in, blurring the shoreline and tiny Tskawahyah Island at the edge of the surf. The sea hunters and their life had vanished. There was an emptiness to the spot.

Still, one knew that centuries ago Makah lookouts had perched on these hump-backed offshore rocks, watching for the first great whales to rise and breach in the Pacific swell.

"When we used to have questions about our past, the only answers we could find were in somebody else's books," said Greig. "Ozette is our book now." □

*Smell of autumn in the air, two Roosevelt elks ford a stream in the sanctuary of Olympic National Park, home to the nation's largest herd. Though many indigenous species thrive here, certain animals native to the Northwest are notably absent, a result of the peninsula's geographical isolation—a factor that has also spared it from being overrun by a wilderness-hungry public.*





**“W**HY ARE *KUBEN* so hungry for gold?” Chief Kanhonk asked me with an air of sadness.

There really was no answer, since his culture and mine were worlds apart.

To Brazil's Kayapo, the term “kuben” includes all non-Indians. And, long before the *garimpeiros*—the gold miners—reached Kayapo lands, other outsiders had violated their domain. Rubber workers, Brazil-nut gatherers, hunters. Then squatters, ranchers, loggers, land speculators.

The Kayapo had fought all of them.

I knew that history well. While doing my research for a doctorate in anthropology from the Federal University of Rio de Janeiro, I had lived for 13 months among the Kayapo Indians on the banks of the Xingu River in the eastern part of Brazil's Amazon Basin (map, page 678). Now I'd come to stay with another group of Kayapo in the village of Gorotire, about 300 miles to the north. They had welcomed me, for I spoke their language and knew their ways.

As forest villages go, Gorotire is large, with close to 90 houses. Its layout is a curious mixture of tradition and modernity. Some villagers, including Kanhonk and his fellow chief, Toto'i, live on the “main street,” a wide avenue between the Fresco River and the traditional men's house, in a plan devised by the Brazilian government agency that preceded the National Indian Foundation (FUNAI). Others live on paths branching off the street. One part of the village maintains the traditional plan: a large circle of houses at the foot of steep but low-lying hills.

The Indian Reserve of Gorotire encompasses much more than just the village of that name. On paper, it is the third largest in Brazil, after Tumucumaque and Xingu National Parks—a total of 2,738,850 hectares (10,575 square miles). But, as is so with most Indian areas in Brazil, it has yet to be demarcated on the ground. Of the 13 Kayapo villages, with a total of about 3,000 Indians, five are located within this reservation.

The Kayapo have long taken pride in their fighting ability. Before whites came, they raided enemy tribes and even skirmished among themselves. Their weapons were clubs and bows and arrows.

One old warrior reminisced about those

## BRAZIL'S KAYAPO INDIANS

# Beset by a Golden Curse

By VANESSA LEA

Photographs by

MIGUEL RIO BRANCO

MAGNUM

*Tradition keeps company with technology among Brazil's Kayapo Indians in their Amazonian village of Gorotire. This man values the radio-recorder for taping tribal songs. His red hat, left by a rubber tapper, is an heirloom. Its feathers signify initiation into manhood. A young relative wears the family's traditional wealth—ceremonial feathers, beads, and cotton bands.*

*Since the first permanent contact with whites in 1937, followed by incursions of squatters, loggers, and miners, the Kayapo have gradually adopted new customs. But now gold strikes nearby bring more cash and increased contact, causing irrevocable changes in their way of life.*





*Ritual makes the world go round. Behind leaders rattling gourd instruments, chanting men in body paint and shell-and-bead necklaces perform a circle dance during a festival in May. Smoke rises from the cooking fires of host families. Kayapo visualize a round universe; they traditionally have constructed circular villages and fields.*

simpler days. "We lived together in the men's house," he said a bit wistfully. "There we were on the alert for attacks on our village, and we planned raids against our enemies. Today the young men would rather stay home with their wives and children."

The traditional symbol of Kayapo manhood—and bellicosity—was a light wooden lip disk about six centimeters in diameter. It, together with a penis sheath, was a part of daily male attire. "But the sheaths are



uncomfortable," a young man commented. "We wear shorts now." He added that lip disks are also falling out of favor. "You can't speak Portuguese when you are wearing one."

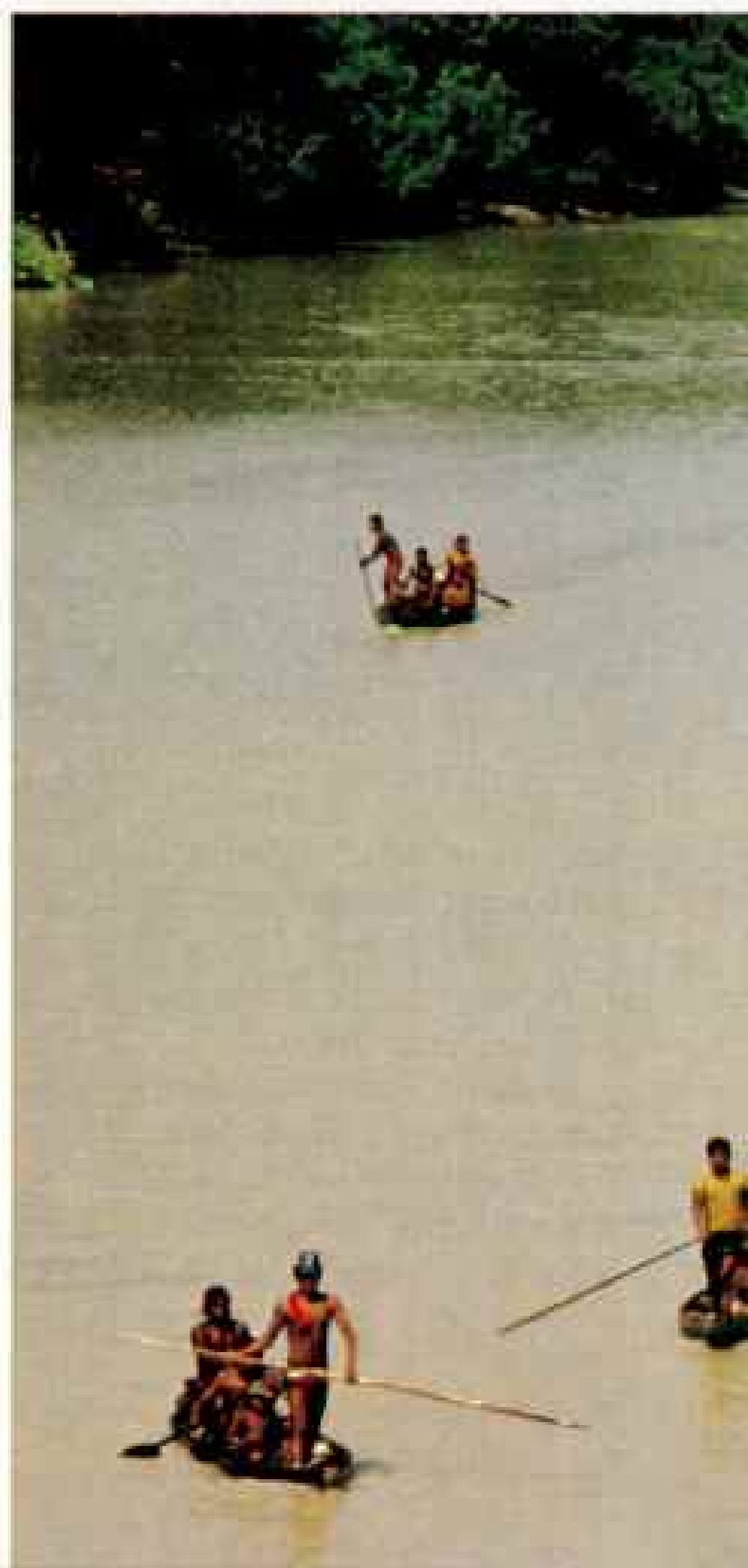
Since few Kayapo know more than a smattering of that language, it probably was self-consciousness, brought on by encounters with outsiders, that caused the lip-disk fashion to wane, though a few older men wear theirs.

Perhaps the ultimate symbol of modern manhood is a firearm. Some have been obtained peaceably, through trade. Many others were booty, acquired in raids. The Kayapo use them for hunting, of course. And some have been used in battle.

Now there are even newer symbols. Tape recorders, for example. During the many Kayapo ceremonies, more and more men, tape recorders in hand, accompany the singers to capture  
(Continued on page 682)

*Design of Gorotire, where the government settled many Kayapo in the 1940s, was inspired by Brazilian towns. But the plaza, supplied with electric lights and piped water, spreads out from the village men's house rather than an urban church. The office of the Indian protection agency, FUNAI, stands at right. Extended families live in the thatch-roofed homes, usually backing on a garden filled with edible and medicinal plants; some also have apiaries. Women plant and harvest the kitchen and distant gardens, while men hunt and fish. Here a hunting party (lower right) brings in fish and turtles for a festival. This stretch of the Fresco River ran clear until fouled by human wastes and tailings from the immense government-controlled gold mines of Cumaru.*

*At the turn of the century several thousand Kayapo were living in one community, but they disbanded because of internal strife. Introduced diseases took a toll. Today 3,000 Kayapo live in 13 villages, of which Gorotire, with 600 residents, is the largest. It lies in a Maryland-size reserve set aside for Kayapo (below), but, as in North America, Indian rights are often reinterpreted. A road will soon link Gorotire to Cumaru. Rumors abound about moving the Kayapo farther away from the mines "for their own good."*





A chief wears many hats, and sometimes a souvenir tie (right). Toto'i (facing page), shown with his wife and daughter, dons a headdress of matched parrot feathers that denotes his family links. Under the Kayapo system of multiple chiefs, Toto'i and his counterpart, Kanhonk, lead through consensus. Each directs a group of men in communal labor, such as harvesting Brazil nuts, clearing an airstrip, or constructing modern houses (below). The chiefs approved the building project suggested by a FUNAI official, bought a kiln, and depleted their supply of cut firewood to bake bricks. This house, sure to be hot, took a year to complete; airfreight quadrupled building costs.







*Gold: the Indians' burden. The Kayapo tried to work as miners, but the high-pressure hose was frightening and panning (below) was backbreaking, leaving them no time for hunting and festivals. So for a mine on their land they experiment by hiring non-Indians (above) and take a share of the revenues.*



the music. Speeches, too, are taped, to be studied over and over.

Like so many other tribes, the Kayapo are trying to fathom the mystery of the bedazzling wealth of the white man's world, source of wondrous products produced in uncountable numbers. And so they have entered the Brazilian gold rush on a modest scale. They ousted intruders from one mining site on the reservation, renamed it Garimpo Kayapo, and hired other whites to mine it for them for a 60 percent share of the profits. Though the Kayapo's 40 percent seems a handsome revenue, the money never seems to go far enough.

**F**UNAI, established in 1968 to protect Indian rights, is spread thin over the huge Brazilian interior. Often native tribes have been left to the care of missionaries, but some have been drawn to government-founded villages like Gorotire.

A scarred old veteran of many battles told me one day about the Kayapo's first encounter with a FUNAI pacification team. "We were going to kill them," he said. "But they had brought so many presents of knives, machetes, axes, beads, and other things that we decided to make peace with them."

Staffed liberally with military officers, FUNAI is intended as a buffer between Indians and whites. Its job on the Gorotire Reservation is to keep Kayapo and outsiders at peace. But that job is not an easy one.

A warrior told me of a battle of just a few years ago, when the Kayapo faced 21 outsiders illegally clearing farmland within the reservation's boundaries. "The government had failed to stop them, so we went there to drive them out. We grabbed one farm worker and began to crop his hair to teach him a lesson. A white girl came to help him, stabbing my brother-in-law. Then another white hit my uncle over the head with an ax handle. We ended up killing all of them."

Such violence must be viewed in the context of years of frustrated efforts by the Indians to obtain their legal rights. "We will fight to the death to hold on to our lands," the chiefs said. Only time will tell whether that threat will come true.

Gold prospectors in large numbers first reached the Fresco River, in the eastern part of the reservation, in the late 1960s.

Though FUNAI initially tried to forestall an invasion, the garimpeiros crossed the borders in 1980, expanding into the Indians' Brazil-nut groves. The police came in to put an end to the invasion, but that effort, too, dwindled away. In March of 1981 the mining complex of Cumaru, headquartered at the site of the same name, became a legal entity, controlled by Brazilian mineral bureaus and by federal and military police.

With a fluctuating population of as many as 20,000 men, the Cumaru complex can marshal a much larger "army" than can the Kayapo. Recently there has been talk of bringing in the miners' families and settling them near the working areas with farm fields to feed them. Exhaustion of the available sites is already predicted, and the search for new ones may well involve further incursions into Gorotire lands.

When I first flew in toward Gorotire, my mind was on my Kayapo friends in the village along the Xingu River. In memory I strolled again along the crystalline blue river. Millions of yellow butterflies carpeted the banks, and I walked along through a golden snowstorm.

Then, suddenly, I looked down from the plane at a river so fouled that not one Indian was bathing or fishing there. It was the Fresco, polluted by the gold camps.

In happier days, before soil runoff, sewage, and chemical pollution tainted the river, it was a center of daily life. Now FUNAI has to pipe water from a stream more than a mile away so the villagers can bathe themselves, wash their clothes, and draw their drinking water.

I found that the central village faucet had been ringed with barbed wire to keep out the local FUNAI staff's 30 head of imported African buffalo, which roam through the village at night. Those animals are an irony of imposed development. "We ourselves don't like the taste of beef," an Indian told me. "We hardly ever eat it."

"We cannot fish near the village now," an old man complained. "To fish with bow and arrow, the water must be clear. Besides, the fish have no taste. Many of them now die and wash up on the shore."

Pollution, sadly, seems to be the price of development. I asked Anazildo Silva, then head of the FUNAI post in the village, if the

water runoff could not be filtered before it leaves the gold camps. He shook his head. "Far too expensive. And it does little good to pressure the officials at Cumaru. But at least they have agreed to mend the plastic piping system that we installed to bring clear water to the village. And they also promise to reinforce the small dam we built up there."

Mining methods at the camps are far from sophisticated. Diesel-powered pumps direct jets of water at the gold-bearing earth, washing it into ponds. Then the muddy result is pumped up into sluices where the gold ore settles out. Not surprisingly, torrents of the mud run off into the river along with sewage and diesel fuel. There is still another harmful effect of the mining: Abandoned craters fill with stagnant water, where malarial mosquitoes breed.

Fish still furnish a large part of the Indians' protein supply, but now the villagers must make a tedious journey upriver to do their fishing. Photographer Miguel Rio Branco and I set off by canoe one day under a scorching sun to see how far afield the source of the pollution lay. Frequently we lost the channel in the murky water and found ourselves aground on mud flats or stranded on barely submerged rocks. Often we had to leave the canoe to find deeper water or tow it up through the many small rapids along the way.

After three hours, we reached the mouth of the Rio da Ponte, which funnels the gold camps' runoff into the Fresco. Above that point the Fresco was clear and fish relatively abundant. It was hard to believe that all our efforts had carried us only a mile and a half upriver from Gorotire.

These days, hooks and lines are replacing bows and arrows, but at times the Indians fish with *timbo*, a vine that is wrapped into bundles and floated on the river. Singing as they work, the men beat the *timbo* with sticks. The beaten vines release a substance that causes the fish to float to the surface, where they are easily gathered.

**T**APE RECORDERS and clubs, aluminum cookware and thatched roofs—the Kayapo of Gorotire find themselves torn between old ways and new. The village has an Evangelical church, where services are conducted by native pastors. I attended





Serious but satisfying, the dry-season celebration called *Bemp*, after a local fish, encompasses initiation, marriage rites, and the presentation of ancestral names to small boys. This recipient (left) sits patiently as a female relative—a rare visitor to the men's house—wraps his knees with cotton strands. Using sticky latex, she glues yellow parrot down to his body and blue eggshells in a halo. In such finery the Kayapo of Gorotire are buried.



An elaborate headdress is shaped from beeswax on Kangati (above), a son of Chief Toto'i, for an all-night song vigil with a ceremonial partner (right). The headpiece with its radiating sun of feathers is believed to represent the universe. Its shaft symbolizes the cotton rope by which the first Kayapo descended from the sky. Later the wax in the ornament will be melted down and saved for the next *Bemp*, a tradition tying the Kayapo to their past and future.



Little Ire-no (left) receives an everyday paint job, without which no Kayapo feels properly attired. Her mother mixes juice from the genipap fruit with charcoal and applies a seasonal design. The paint will last nearly two weeks. Some patterns resemble animal markings, including those of bees and wasps. The Kayapo believe their ancestors learned from social insects to live communally.



a service and heard the preacher warn that only those who listen to God go to the sky—the rest burn in hell. Traditionally, the Indians have a different view of an afterlife: At death one goes to the Village of the Dead, where men sleep during the day and hunt at night. There old men become younger and children become older.

As a non-Indian, I was allowed inside the traditional male assembly building, the men's house. Except on rare occasions Kayapo women are permitted only fleeting visits to deliver food to their male relatives.

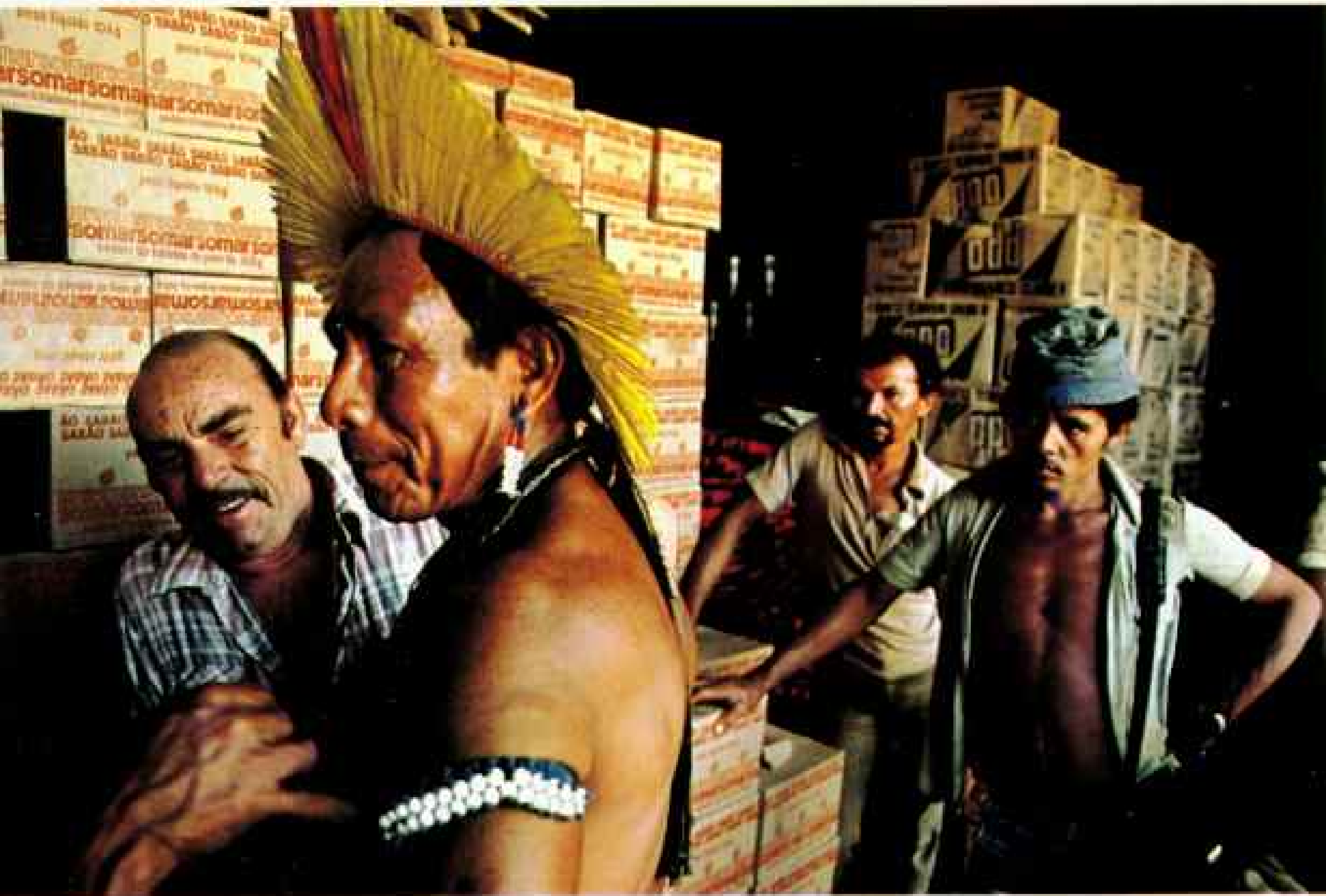
And there I heard a sermon far different from the one in church. "We Kayapo are all brothers now," a village elder preached. "We must no longer fight among ourselves, but direct our battles against the whites who try to take our lands."

The Kayapo are usually in the midst of a

ceremony or making preparations for the next one. In each dry and rainy season they hold one of five major rites to bestow ancestral names on the younger members of the tribe, a dance ritual adopted from another tribe, or a corn ceremony.

They have a rich repertoire of song, and it is stirring indeed to hear a large chorus of voices ringing out under the vast star-spangled sky in the forest night, punctuated by croaking frogs and the occasional cries of animals and birds.

My 18-day stay coincided with Bemp, a great initiation and naming ceremony held every few years. As part of it, the men came toward the village bearing a huge tree trunk that would be the centerpiece of the night dance. It must not enter Gorotire until sunset, so the men guarded it all afternoon, just outside the village. Incongruously, they



*Curious stares greet Toto'i on a shopping expedition to Cumaru (above). The chief radioed for a FUNAI plane to take him to the place he thinks of as "Cobal," the name of the government store, where he shops from a list in his head. When his airlift returns to the Gorotire strip (right), Toto'i's team ferries boxes of soap, rice, and other supplies to his house or warehouse for eventual distribution. The*

whiled away the time by munching imported cookies and drinking canned soft drinks.

So much of the village's gold revenue had been lavished on Bemp that the cost exceeded the previous year's income from the Brazil-nut crop.

"Next year the gold revenue will be invested in agricultural projects," declared Anazildo Silva. A practical idea, but it does not take into account the Kayapo enthusiasm for goods of the outside world.

During Bemp, a small contingent of builders and brickmakers were in Gorotire to construct new village houses. Already much of the cement flown in for the project had been damaged through carelessness, and little progress was visible. At the height of the ceremony, construction ground to a halt while bricklayers joined the dancers.

Gorotire is eager to rival the village of

Kikre Tum, which split away in 1976 after a dispute over use of some ceremonial feathers escalated into a duel between the village co-chiefs. Kikre Tum, in the northern part of the reservation, has achieved affluence envied by Gorotire, after making a more lucrative deal for gold mining in its area. In fact, its chief, Pombo—inspired no doubt by FUNAI's large staff of military men—now answers only to the title of colonel.

**T**HE GOROTIRE villagers conduct some trade with their fellow Kayapo on the upper Xingu River, who are rich in industrial goods but poor in traditional resources. Such goods are freighted in FUNAI aircraft, which fly between the villages.

Since I had lived on the upper Xingu for more than a year, I was asked why the latest shipment had not arrived. "We sent them



village chiefs also put revenues from gold into bank accounts in three cities and have so far purchased for themselves motorboats and gas stoves. They talk of buying an aircraft. Traditionally Kayapo leaders were expected to live poor, share all possessions, and rise early with their men. But now, some villagers complain, they live in the manner of Brazilian colonels.

Brazil nuts, macaw feathers, and babassu oil. But we are still waiting for the beads, ammunition, hooks, and fishing line that were promised."

Well, a mail-order service between two communities where hardly anyone reads or writes—much less knows how to label freight—is bound to become chaotic.

With an eye toward still more white men's goods, the Indians of Gorotire have agreed with FUNAI to have a road built from the village to the goldfields of Cumaru. An outside firm will build it, taking as payment the trees that must be cleared from the roadway.

Many Indian elders are afraid of that road and what it will bring, but the young are more sanguine. "Airplanes can't carry much," a young Kayapo said to me, "and they are expensive to use. But with a road we can have goods by the truckloads—tape recorders, clothes, cookies. . . ."

"Aren't you afraid the road will bring in more garimpeiros and settlers?"

His mind was on material things; he waved that possibility away. "Oh, there will be a FUNAI post along the road, with a gate. Only people bringing goods here will be allowed through."

I had doubts. Roads into Brazil's Indian settlements usually have brought more problems than benefits to the villagers.

**D**URING MY VISIT Gorotire was a beehive of aerial activity; planes and helicopters landed frequently near the village, and we could hear planes serving Cumaru all day long. Frequently the village is visited by the military, by federal police, by Cumaru administrators, and by visiting FUNAI staff.

Both chiefs, Kanhonk and Toto'i, objected to the aggressive nature of those inspections. "I want to put a sign by the runway telling the police not to enter the village with guns," Kanhonk said. "This is our home."

The Kayapo's own gold mining enterprise

*On a cookie break, Bemp celebrators in the men's house enjoy store-bought treats provided by a host family. One soft drink, guarana, owes its origin to Brazilian Indians who domesticated the plant of the same name.*





at Garimpo Kayapo was just beginning during my visit. Accounts had been opened at Cumaru headquarters so the two chiefs could sell the gold, and FUNAI had bought some mining machinery. Four white miners were employed to operate the machines.

The Kayapo had already expelled a previous group of workers for trying to steal their gold, and it is fairly predictable that such conflicts will continue. Still, it is doubtful that they will ever want to do all the grueling work themselves, even if non-Indian workers teach them how. One plan is to limit the Gorotire operation to about 40 white workers—though the pressure of gold fever may make it hard to keep the mining on such a small scale.

There are two other large extraction sites within reservation boundaries—Maria Bonita and the adjoining Tarzan site. According to Silva, the Kayapo are receiving a percentage of the federal tax on gold taken from Maria Bonita.

**G**RADUALLY, the Kayapo of Gorotire are moving closer to modern ways. A canteen was set up in the village to supply them with such staples as rice, beans, manioc flour, sugar, coffee, cookies, butter, and milk.

A church, a school, and missionary houses are part of the village now, and a pharmacy. FUNAI radio maintains daily contact with the outside world. Some villagers are being taught to read and write in their own language; others attend classes in Portuguese, though few retain it in later life.

Gorotire's two chiefs even dream now of extending electricity to the entire village; perhaps it will always stay a dream.

Still, despite this heterogeneity of modern contacts, Gorotire maintains much of its highly developed ceremonial life. Body painting—equally cosmetic and symbolic—is part of traditional daily attire. Adults paint each other in group sessions, and women spend long hours decorating their children. With palm strips as brushes, and using various fruit dyes, they paint striking black geometric designs on body and face. They add red “stockings” and paint faces red. Designs vary according to the occasion and subject's age and sex.

And Kayapo women bedeck their children



*Prime candidates for marriage, these teenagers will probably pick partners suggested by their families. Only after the*



*birth of a child is the marriage formalized. For the past few years Kayapo chiefs have discouraged traditional birth control, hoping to increase the tribe's numbers and thus make possible the completion of a full cycle of the festivals essential to their culture.*







*Carrying live game like totem poles, hunters return from a month-long jungle trek with the turtles (left) called for in every festival menu. After a ritual in the men's house the reptiles are delivered to the host families for roasting.*

*Modern symbol of manhood, the rifle once fired at white intruders and enemy Kayapo. Now it and little else accompanies a former warrior (above) on his hunts. He can feed himself because ancestors planted tubers and other edibles at regular campsites on jungle trails. Such sophisticated planning characterizes Kayapo slash-and-burn agriculture. Seemingly abandoned fields are managed in order to attract wildlife, such as the coati hanging from the hunter's shoulder.*

*But as the Kayapo acquire more consumer goods and canned food, some neglect their fields, turning their backs on a rich agricultural tradition that has sustained their people for millennia. The question lingers: Can the Kayapo retain their self-sufficiency, their identity—and their land?*

lavishly with beads. We brought 11 kilos of beads with us, but they soon ran out.

"Is it true," a woman asked me, "that our relatives on the Xingu have so many beads that they use them as blankets at night?"

That, indeed, would be a Kayapo dream come true.

**O**UTSIDE PRESSURES on the reservation continue to grow. To the north lies Brazil's largest gold mine, Serra Pelada. One of the largest gold nuggets ever found, weighing 137 pounds, was discovered there last year.

The Brazilian government has threatened to close Serra Pelada to manual workers, pointing out the danger of mining with hand tools at the site. Press reports suggest that major gold deposits are still to be reached and that the government and multinational companies intend to reap all the benefits by mechanizing operations. There is talk of plans to transfer many of Serra Pelada's 80,000 miners to the Cumaru camps, which would put even more pressure on Gorotire Reservation lands. Meanwhile, garimpeiros have arrived at two Kayapo villages outside the reservation.

Also looming in the future is a vast hydroelectric project that would flood two other Kayapo villages on the Xingu River. Development attracted by that project would have a marked effect on other villages too. But Brazil is in a deep economic crisis, and the costly hydro project exists only on paper for the present.

One of the wonders of the 20th century surely must be juxtaposition of such huge projects with small native communities that live from traditional slash-and-burn agriculture. The Kayapo have always inhabited mixed regions of forest and savanna, farming, hunting game, and gathering wild fruits. "We used to abandon the village," Chief Kanhonk told me, "to go off on long treks through the jungle." Now the Indians, depending on goods from the modern age, have become increasingly sedentary.

The Kayapo are but one piece in a complex mosaic made up of Brazil's many tribes. The Indian population is estimated to be as high as 150,000, comprising about 180 tribal groups speaking nearly as many languages and dialects. When Portuguese colonization

began, the count may have been three million Indians.

Coastal Indian groups were virtually exterminated by diseases to which they had no immunity, and by subjugation and slavery in early colonial times. Many other tribes remained in relative isolation in the interior. Then the rubber boom starting in the mid-19th century began to change their lives.

As the hunt for rubber trees widened, the Indians skirmished with white invaders. The Kayapo attacked and killed the whites, both to avenge raids on their villages and to collect booty, such as arms and ammunition. Part of the tribe moved west to the Xingu and beyond to escape the intruders. But the hunger to exploit the interior grew, particularly after World War II. Brasilia became the nation's capital in 1960, and a vast network of roads laced into the jungle to link the interior with the developed coast.

**I**N 1980 the first Indian organization—UNI (Union of Indigenous Nations)—was established to allow Indians to speak for themselves. Two years later an Indian, Mario Juruna, was elected to the Brazilian Congress. His term of office has been stormy, but he has become a symbol of justice, looking out for the poor and oppressed of his country.

It is frequently said in Brazil that the Indians are doomed to die out. I believe this is overly fatalistic. True, the pressure is increasing, but the movement toward self-determination is making progress too, as exemplified by UNI and Mario Juruna. Some tribes—including the Kayapo—are growing; there were 23 births in Gorotire village during the first half of 1983.

But the future of all Brazil's Indians hinges on the continuing struggle for their rights and their stand against developmental pressures. It is of little use to mark reservation boundaries in the forest if those boundaries continue to be violated or constantly changed, or if groups are forcibly removed from their traditional lands, as is commonly the case.

This is a fact of modern life: Just as Brazil itself is beset by a staggering foreign debt, the nation's Indian tribes—the Kayapo among them—feel the unrelenting pressures of the world scramble for resources. □

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*Introducing Julia...A Victorian Bride*



# Julia

The first doll in a charming new series devoted to the American Bride – from colonial times to the present day

In the tradition of the most highly-prized collector dolls of all time, the Danbury Mint presents *Julia* – the first doll in a series devoted to the American Bride from colonial times to the present day.

This doll combines exquisite beauty with historical authenticity. Like the legendary collector dolls of the past, *Julia* is representative of a particular time and a particular place.

Costume dolls are among the oldest and most beloved forms of collecting. Queen Victoria was a collector. So were millions of Americans in the 19th century. Today, doll collecting is more popular than ever. Some of the finest French dolls of the 1800's are now worth thousands of dollars. But you cannot put a price on many of the most cherished dolls. They are handed down from mother to daughter with love and tenderness. Such dolls not only beautify the home, they serve as a bond between generations.

### A collector doll of incomparable beauty and meaning

You could not ask for a more perfect theme for a doll collection than the American Bride. If ever there is a day in a woman's life when she looks her most beautiful and radiant, that is her wedding day. And there is no more beautiful costume than a young woman's bridal attire. This is why we chose the theme.

And bridal attire has changed throughout history. So a collection of American bridal dolls will be more than beautiful – it will portray the change in dress from colonial times to the present day. The collection will have great *meaning* as well as beauty.

### Each doll's costume will be historically authentic and tailored by hand

*Julia's* gown will be authentic down to the smallest detail – as will the costume of every other doll in the series. Our doll designer has had access to the Victorian bridal gowns in museum costume collections. She has recreated the bridal attire of the period. And it is a *full* attire – not just the gown itself but the veil, petticoat, and pantalets.

Each doll's gown will be tailored by hand with the most meticulous attention to detail. Notice in the photograph all the exquisite features: the fine satin, the elegant lace, the ruffled flounce, the floral appliques on the front of the gown... and the corsage pinned to the bride's wrist.

### Each doll will be made of fine imported porcelain – individually painted by hand!

Head, hands, and feet will all be crafted of fine imported porcelain – for that same delicate look of the famous collector dolls of the 1800's. The facial features will be beautifully sculptured and individually hand-painted to complement the color of the hair. Notice *Julia's* hair – it's hand-styled into a Victorian coiffure. And look at that fresh, youthful, glowing apple blossom complexion – you'll fall in love with her at the very first sight. She is a delight to touch, too – the porcelain is so flawless and smooth, the fabric on the gown is so

fine and so crisp. And like each doll in the series, *Julia* will come with her own stand – so you can not only display your doll on a bed or chair, but also stand her on your mantle or in a cabinet with your other prized collectibles.

### A remarkable value

When you can find collector dolls of comparable quality and size, you can expect to pay up to \$100 at retail. But the Danbury Mint is making *Julia* available to you at the remarkably low original issue price of just \$55, payable in two convenient monthly installments of \$27.50 each. And there is no extra charge for the stand. To reserve *Julia*, send no money now. Simply complete the attached reservation application and return it promptly.

Please note that *Julia* (and other dolls in the series) will be available only directly from the Danbury Mint; none will be sold in stores. As a registered owner of this first Danbury Mint collector doll, you will enjoy the privilege to acquire the subsequent dolls in the American Bride collection at the same low price – *if you choose to continue your collection*. But you are under absolutely no obligation to do so.

### An heirloom to be passed down with love from generation to generation

*Julia* combines everything you could wish for in a collector doll – at a price you can easily afford. She has beauty, individuality, personality, and historical authenticity.

This doll will be a source of lifelong pleasure and pride. She will also be an heirloom to be passed down with love from generation to generation.

This is an opportunity not to be missed – please send us your reservation today.

#### RESERVATION APPLICATION

M-32

*Julia*

The Danbury Mint  
47 Richards Avenue  
P.O. Box 5290  
Norwalk, Conn. 06857

Please return by  
June 30, 1984.

Please accept my reservation for *Julia*, a collector doll with a beautifully sculptured, hand-painted porcelain head, porcelain hands and feet, and authentic hand-tailored costume. A display stand will be included at no additional charge.

I need send no money now. I will be billed for the doll in two monthly installments of \$27.50 each.

Name \_\_\_\_\_  
PLEASE PRINT CLEARLY

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State/Zip \_\_\_\_\_

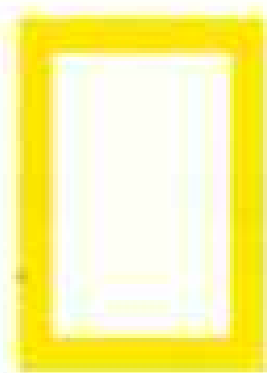
Check here if you want each installment charged to your:

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Allow 8 to 12 weeks after payment for shipment.



## Maps...the heart of our mission and tradition

**A** DISABLED Coast Guard icebreaker needs to know the nearest manned shore station in Antarctica. A battalion of U. S. Army Rangers moves across the Caribbean island of Grenada. A former soldier, Nguyen Van Canh, and a hundred fellow refugees escape from Vietnam. In each case, we later learned, they turned to a National Geographic map—uses of our maps we never could have imagined.

NATIONAL GEOGRAPHIC and maps have been synonymous since the beginning. The very first issue included four foldout charts showing the progress of the great blizzard of 1888.

Mapmaking—the art, science, and practice of cartography—goes to the heart of our mission and tradition. In May 1918 we published a meticulously drawn supplement on the “Western Theatre of War.” In 1933 Chief Cartographer Albert H. Bumstead invented in his home workshop a machine for composing map type by photography. Soon after, Society calligrapher Charles E. Riddiford designed typefaces that still give our maps their distinctive look. In the mid-1940s cartographer Wellman Chamberlin devised a new way to render the spherical earth on flat paper: the Chamberlin Trimetric Projection.

The Society publishes maps of the world’s peoples, historical maps, traveler’s maps, charts of the heavens, atlases, globes, maps for almost every magazine article and book. As might be imagined, production of any of them—especially our big double-sided supplements—is a lengthy, painstaking process involving much research and attention to detail. Now, under Chief Cartographer John Garver and his staff, we have moved into computer-assisted mapmaking. The crux of this new process is a machine originally developed by the Scitex Corporation of Israel to design fabric patterns for the textile industry, a tool well adapted to cartography.

It looks little different from other computer stations, having control consoles, display screens, and operators to make it all work. Yet

what it replaces begins to seem as antiquated as a 19th-century factory. Before, as many as 120 pieces of film were required to show such details as drainage, roads, depths, and various color tones, then made ready for printing the final version.

The new system records that kind of map detail by using a 12-color drum scanner and converts the information into digital form. Then, for example, rivers can be made narrower or wider or roads realigned by the console operator without exacting and time-consuming hand scribing. Cartographers, after several months of training, become adept at drawing with electronics.



ROBERT L. GAZEL, NGS

The digitized contents are fed to a laser plotter that imprints map images on film plates, one for each of the four to six colors used on the press. That is all a boost to speed, accuracy, and flexibility, but there is an even greater bonus. Many maps are heavily illustrated, and the system can be used to change colors, revise details, reposition paintings, and in general help marry art to cartography.

Thus far we know of no unusual use for the historical map of Europe published in December 1983, our first entirely computer-generated supplement. We do know that Nguyen Van Canh paid \$200 on the black market for our 1971 map of Asia as his guide to freedom from Vietnam. He thought it was “worth every penny.”

*Silbert H. Browner*

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY



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# A LASTING



Get it together — buckle up.

It's a fact: Of the nearly 37 million trucks on America's roads, over 12 million are Fords.\*

Why are there so many Ford trucks around? Two reasons: First, they're tough. And second, because they're tough, they're very popular.

Over the last fifteen years, in fact, Ford is first in total truck line sales.\* We make the best-selling line of pickups, the best-selling vans, and the best-selling full-sized 4 x 4's in America.\*\*

And, we make them all extremely well.

**You're going**

\*Based on R.L. Polk & Co. cumulative truck registrations.

\*\*Based on manufacturers' reported total deliveries for CY 1983.

†Based on a survey of owner-reported problems during the first three months of ownership of 1983 vehicles.

# QUALITY.

One out of every three trucks on the road is a Ford.



You see, our commitment to quality is more than just a slogan. It's a program that includes everyone and everything in our company. And it has achieved real results.

An annual survey has shown that Ford is

making the highest quality cars and trucks of any major U.S. manufacturer.†

So visit your Ford dealer soon. We think you'll find the quality you're looking for.

The kind that lasts.

to love the quality.



Quality is Job 1.

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FORD TRUCKS • FORD TRACTORS

# FOUR HEADS ARE BETTER THAN ONE.



It takes no genius to figure out washing machines need water to wash clothes.

But at Frigidaire, it took a meeting of the minds to put that water to work.

One logical idea we came up with is our exclusive Halo Spray Fill System.

With this system, four jets of water fan into a spray, evenly soak clothes and prevent "billowing," where air gets trapped and keeps water out.

After the wash cycle, these same four heads "shower rinse" clothes, knocking down suds and sediment before the deep rinse cycle even begins.

Another way we put water to work has to do with "Tri-Action."

The logical idea behind this is simple: the more water-action, the

cleaner your clothes.

So on a Frigidaire washer, we designed the agitator and the tub, to move in such a way that clothes move up,

down and around (see why we call it *Tri-Action*?).

Then we had another idea about water.

When wet clothes dry in a dryer, they take up more room. So for easy clothes handling, we made the mouth on our dryer extra big.

Finally, we put our washers and dryers to the ultimate "water" test: our Quality Test Track. It's the kind of quality control that gives all Frigidaire appli-

ances, from washers and dryers to our electric ranges, refrigerators and dishwashers, a reputation for being so reliable.

So if you're in the market for a new washer and dryer, consider ours. After you look them over, common sense should lead you to a logical decision.

 **Frigidaire**

Logical ideas that last.



# Members Forum

## Italy

"Surviving, Italian Style" (February 1984) makes a long-overdue point: Italy may not be much of a nation, but it is one of the most successful *civilizations*. An art restorer in the convent of San Marco, repairing the damage of the 1966 Florence flood, was a local hero; it is no accident that portraits on Italian currency are cultural giants like Galileo and Michelangelo. One day the *Nazione* of Florence ran an editorial about the country's bureaucracy, with the title "*Nella Giungla del Potere—In the Jungle of Power.*" I noticed that the editorial's title scans exactly the same as the quartet from *Rigoletto* ("*Bella figlia dell'amore*"), and I was reassured: If you can sing a country's politics, it's probably either safe and sound—or else totally unimportant.

Douglas J. Stewart  
Waltham, Massachusetts

## Southeast Alaska

Your article (January 1984) is a beautiful beginning to discovery of this magnificent sector of Alaska. Two years ago, I worked as an interpretive naturalist on board the Alaskan state ferry M/V *Taku* and traveled the Inside Passage on numerous occasions.

In future years it may or may not become evident that the congressionally mandated cut per decade of 4.5 billion board feet of timber is neither economically nor biologically feasible. However, it is important to note that this timber cut was a trade-off for the 104.2 million acres that were designated as parks, preserves, national monuments, recreation areas, and wildlife refuges throughout Alaska. This includes 13 national monuments and wilderness areas in Southeast Alaska alone.

Anne Huebner  
Fort Collins, Colorado

Your article on Alaska was informative and majestic. There is one point that needs correction in this otherwise excellent article—it says the only access to Juneau is via water or air. This is not so. I had a college chum who came to Juneau another way: He was born there.

The Reverend Robert R. Branch  
Essex, Massachusetts

Your reference to Joe Juneau and *Fred Harris* on page 62 of the January 1984 issue may be incorrect. A well researched book on Alaska from Time-Life Books refers to *Richard Harris*.

Chad J. Bardone  
Dallas, Texas

*You're right. Joe Juneau and Richard Harris were the men who struck gold in Alaska in 1880.*

## Silk

I thoroughly enjoyed "The Queen of Textiles" in your January 1984 issue. When silk is purchased, its weight is referred to in "mummies." China silk, the lightest weight silk, which literally floats on air, is usually four to eight mummies. The heaviest silk I've ever purchased is 32 mummies and is hard to find in New York City. Most silk Charmeuse seems to be between 16 and 22 mummies. It's a nice weight for a drapery blouse and just heavy enough for a dress. I guessed that mummies refer to the number of cocoons used to make up a single thread in the fabric. Does Ms. Hyde know what mummies refer to in the manufacturing of silk?

Alison Todd  
Tenafly, New Jersey

*The term "momme" is a Japanese unit of weight equal to 3.75 grams. In the silk trade, the term indicates the fabric weight per square meter.*

"The Queen of Textiles" fails to mention the sericulture carried on in several parts of the Utah Territory beginning in 1855 and lasting through the early 1900s. Samples of silk from Utah were entered in the 1893 Chicago world's fair and won prizes. Susan B. Anthony wore a dress of Utah silk presented her by the Relief Society of the Church of Jesus Christ of Latter-day Saints, and a silk-lace collar was presented to Mrs. Rutherford B. Hayes.

Leah V. Bryson  
Bountiful, Utah

Your article states that the silk liquid hardens on exposure to air, as if it dried out or reacted with something in air. Several observations, such as a worm's supporting its weight by continuously spinning filament or the passage of the filament through the coating organs before emerging, are persuasive to me that the filament may harden well before emerging.

What may actually happen, and be the reason for those long tubes, is that the giant protein molecules, which are linear, get straightened out from flow shear. In this conformation, certain functional groups along the molecules could become exposed and are able to react with what water is there to form bridges between them. An analogy is cement, which hardens by incorporating water into crystals, not by drying out.

# Don't wait to inherit this Hamilton Classic.

**The Ardmore: The distinctive timepiece of the '30s, continuing a tradition in a strictly limited edition.**

In the Thirties, the American wristwatch was in its heyday, and finely designed timepieces were always the gift of gifts. Then, as it has been for 90 years, a Hamilton was the standard of design and technical excellence. The Ardmore, which Hamilton introduced in 1935, was widely acclaimed.

Today, discriminating watch buyers will have the opportunity to acquire the distinctive design and timekeeping excellence of The Ardmore, which is being reborn in this limited, registered edition.

**Highly accurate quartz movement.**

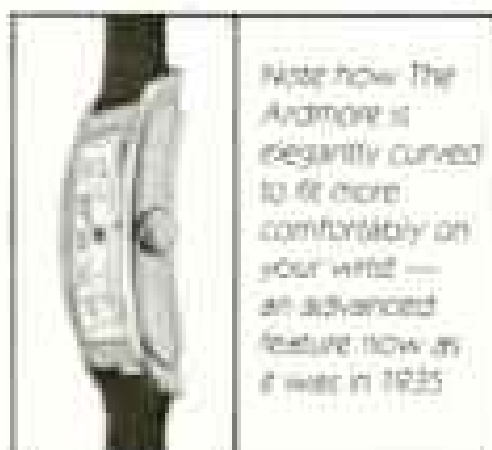
The Ardmore has been updated with an extremely accurate and durable quartz movement and is fully guaranteed for two years. Thus The Ardmore offers all the distinction of an antique but with years longer reliable service and superior accuracy.

In its design and looking The Ardmore stands alone in recapturing the look of its era. Of particular interest is the rose gold tone of the case, and the pigskin strap, a look made famous by Hamilton decades ago. Complementing it is a handsome dial featuring clearly read raised arabic numerals set off against a grained silver background.

**Limited opportunity**

Only 2,500 of these fine timepieces are being made available in a strictly limited edition.

Hamilton's Ardmore wristwatch is \$950, including tax, shipping, handling and three initials engraved on the back. Each Ardmore is carefully packaged in a leatherette presentation box. An accompanying Certificate of Authenticity will bear the registered number of



Note how The Ardmore is elegantly curved to fit more comfortably on your wrist — an advanced feature now as it was in 1935.

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If you're not delighted, you may return The Ardmore within 15 days, in the condition it was received, for a full refund. If the edition is fully subscribed when your

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## The Hamilton Watch Company

Collector's Classic Edition Society Division  
Dept. 340, P.O. Box 7343, Lancaster, PA 17601

Because this lowly worm does its job so well, in an exquisite chemistry, scientists have spent many years trying to imitate this inimitable fiber.

David E. Bosley  
Grifton, North Carolina

Having visited many of the silk centers described so delightfully by Nina Hyde, I offer two comments: China's markets in the United States are likely to remain small because of price and lack of easy-care performance of silk fabrics. Also, the silk-screen "fabric" being checked for defects on page 43 is actually a silk screen used to print the fabric. Most of these "silk" screens are made today with—you guessed it—polyester!

Richard J. Lyons  
Greenville, South Carolina

## Australian Sinkholes

It's amazing, even NATIONAL GEOGRAPHIC doesn't know the difference between a "turtle" and a "tortoise." Look carefully at the chelonian on page 142 of the January 1984 issue. All English-speaking countries refer to the animal as an Australian snake-necked turtle. A turtle is found in water, has webbed feet, and can only eat underwater. Tortoises are found strictly on land, have flat feet, and eat out of water.

Mike Brown  
Carmel, California

*Australian experts commonly refer to this particular species as a "tortoise" to distinguish it from the large marine turtle. Since the story is so regionally oriented, local usage was cited.*

You stated that Mount Gambier was a city built around a volcanic crater lake. I cannot find any reference to recent volcanism in Australia.

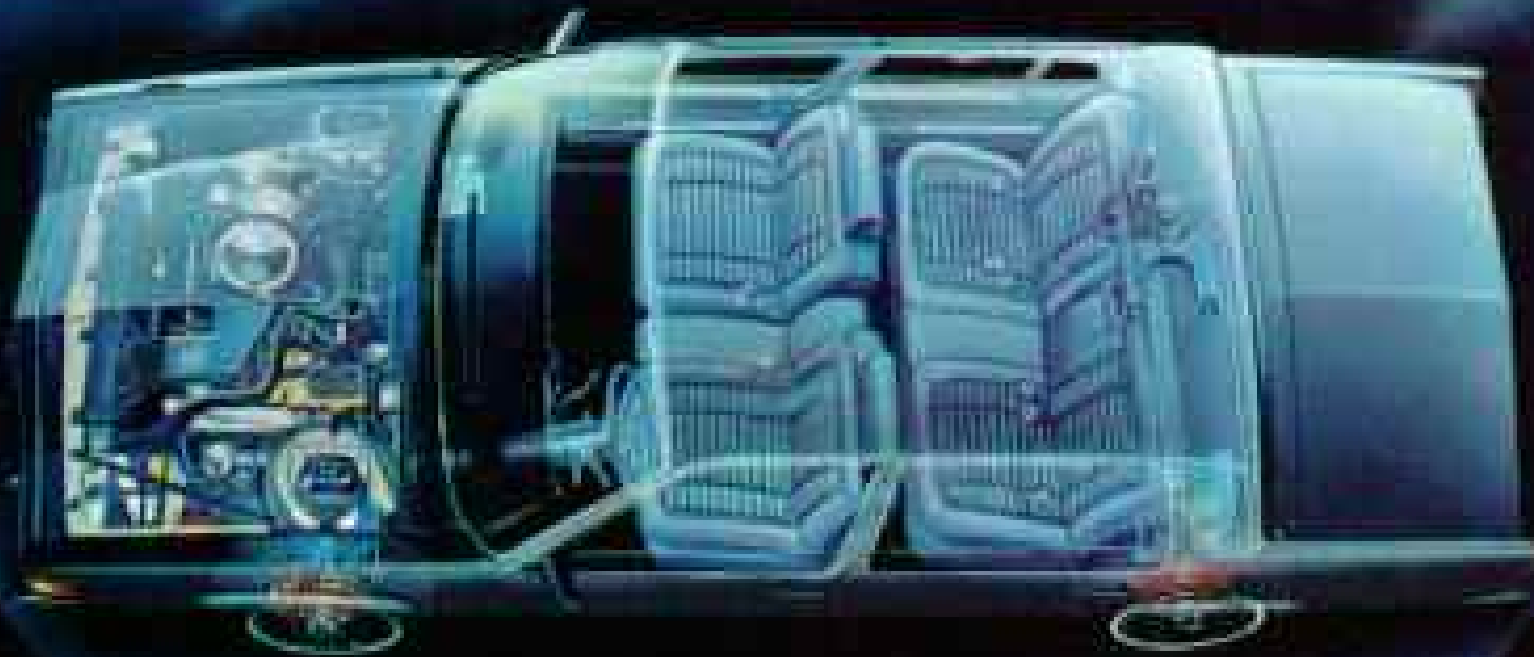
Paul Townsend  
Rochester, Michigan

*Mount Gambier lies atop a hot spot similar to those beneath Hawaii and Yellowstone. It is a mid-plate site of intensive volcanic activity. Specific scientific information about South Australian volcanism is just now becoming available.*

## Catalonia

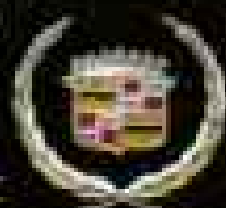
When I was in Catalonia, back in 1977, I noticed that the political climate was very similar to the one I used to know in Quebec: flag waving, patriotic chants, nationalist graffiti, and discussions about separation. Your reporter came to the same conclusion six years later. Maybe we will never know if separation is the best thing for Catalonia or Quebec, but one thing is sure: You will receive angry letters from Canadians who do not appreciate the comparison.

François Roy  
Trois-Rivières, Quebec



# THE CADILLAC OF TOMORROW IS HERE.

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It has been called "The Machine of the Year." For many of us, it's already part of our daily lives. There is no doubt about it, the personal computer is here to stay.

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On page 100 of the January 1984 issue there is a grave error. In his article on Catalonia your writer refers to "their pride in their new autonomy, which, like Quebec's in Canada, has given them the right to use Catalan as their official language." The citizens of Quebec have always had the official right to use either French or English. Any former lack of pride came about because of an outside economic control and complicated factors having to do with religion and education. When the Parti Québécois, now governing Quebec, first came to power in 1976, it proceeded to enact laws that curtailed the English language. It became illegal to put up business or traffic signs in English or for institutions to have solely English names or conduct all their affairs in English. Not until English was denied free use after 1976 did the law take away the right of any Quebec citizen to the language of his choice. Your writer suggested the opposite.

Thelma Pitman  
Rock-Forest, Quebec

### Editor's Page

In your January 1984 issue the Editor passes along a few thoughts regarding the state of the world as we reach 1984. Some of what Mr. Garrett expresses I am in agreement with. But when I read "famine is rare," this, sir, I cannot agree with. Famine, as defined by my dictionary, is "an acute and general shortage of food." Famine is still an ever present blight in the underdeveloped and developed countries of the world. In parts of Africa, India, China, Brazil, and Mexico tens of thousands, if not hundreds of thousands, of children die annually due to lack of sufficient nutrition, and many thousands more adults perish for want of nourishment.

Patrick Carnahan  
Longmeadow, Massachusetts

*We did overgeneralize about the rarity of famine—widespread hunger is still with us. Yet vast, desperate famine is not as common as in the past. China, where in 1876-79 some 13 million people starved to death, now seems to have an upper hand over national hunger. India, after surviving the terrible drought of 1972, is closer to self-sufficiency. Ireland, where one million died of starvation in the potato famine of the 1840s, no longer starves. But large areas of the world are certainly in need of better nourishment.*

.....  
*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.*

National Geographic, May 1984



# In the Northeast, one airline overshadows all the others.



NORTHEAST GEOGRAPHIC AREA AS DEFINED BY THE U.S. BUREAU OF CENSUS.

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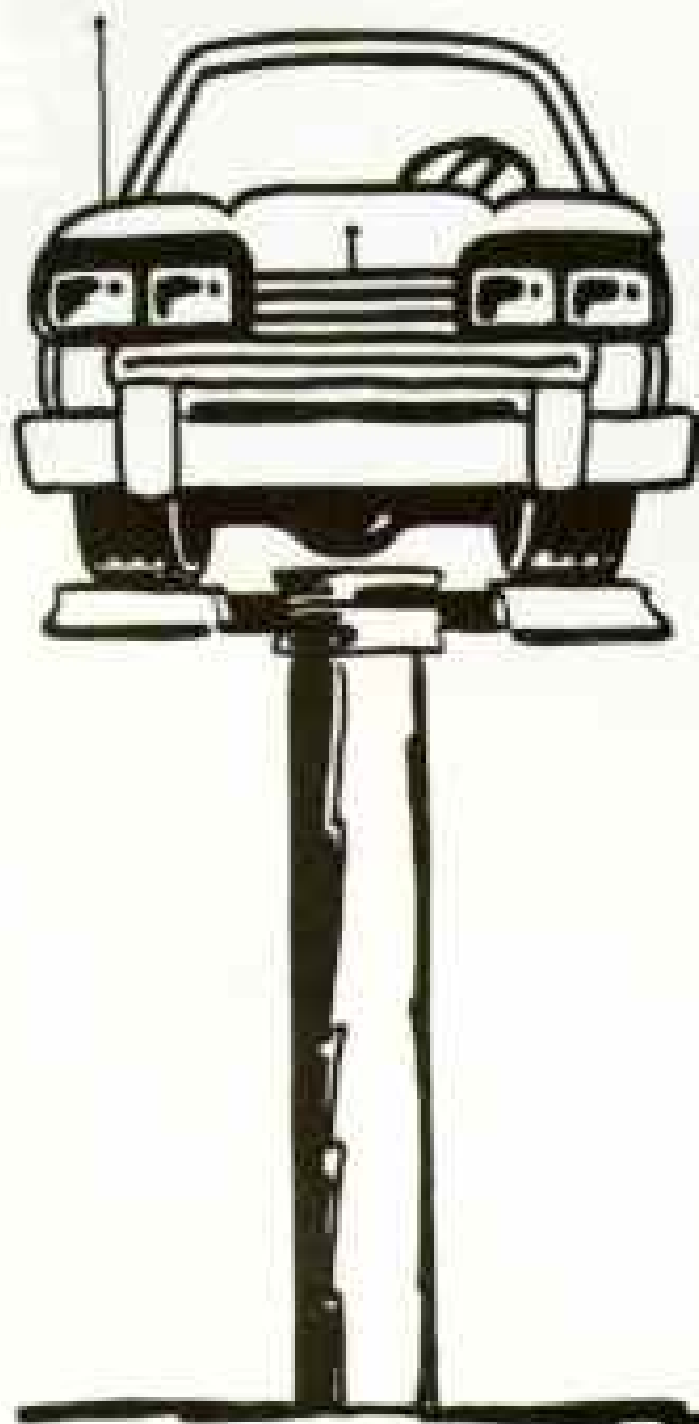
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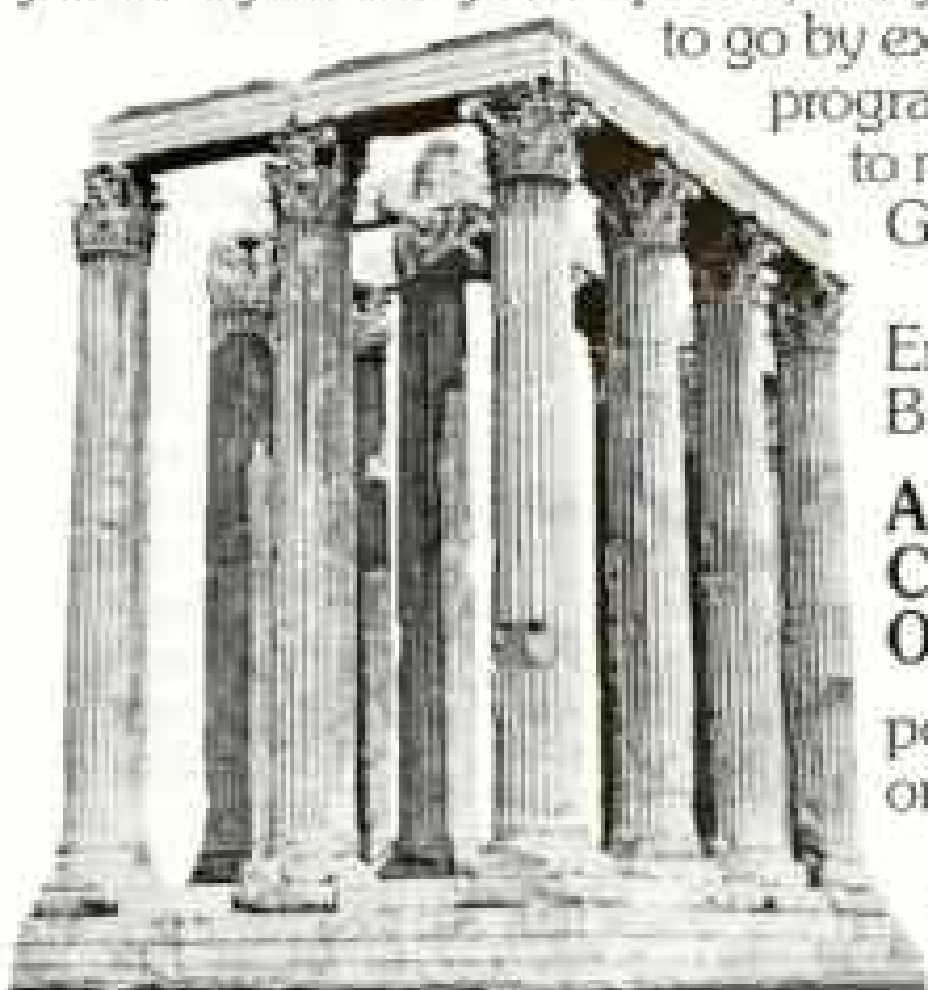
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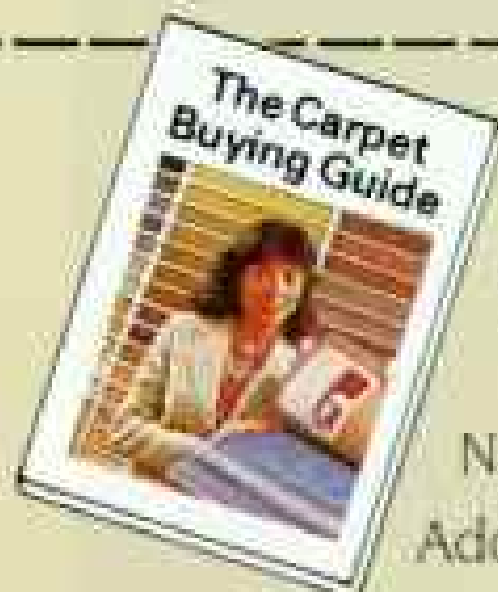
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# On Assignment

**"IT LOOKED SO PEACEFUL,"** recalled senior writer **Rick Gore** of his first sight of Italy's infamous Mount Vesuvius. In fact, one of the most hazardous volcanoes in the world, it has erupted at least 80 times since it entombed the Roman towns of Pompeii and Herculaneum in A.D. 79. Gore and Senior Assistant Editor **O. Louis Mazzatenta**, examining a vent on the volcano's slope (*right, at right and center*), journeyed to Herculaneum as archaeologists dug ever deeper, fueled by new finds of skeletons that provide poignant evidence of how a city lived and died.

For Mazzatenta—who recently covered the Thames River, Italy's Appian Way, and Paraguay—photographing 2,000-year-old skeletons demanded delicate footwork. "You had literally to tiptoe around them, they were so fragile. A slight misstep, and crunch! You could destroy a piece of history," he says.

Nearby Pozzuoli, also a subject of the team's coverage, sits atop a reservoir of magma that may blow at any time. "People there have lived with the possibility of apocalypse for centuries," says Gore, who first became fascinated with the area in 1981 while covering the Mediterranean for the magazine. "It's one of the world's true hot spots."

Looking like one of the natives, photographer **Flip Nicklin** wears a tuxedo-design T-shirt as penguins pass by unconcernedly (*below*). Along the Antarctic Peninsula Nicklin photographed the penguins' prey, the tiny shrimplike krill that are also the food of whales and other Antarctic creatures.



ELLIÉ S. ROBERTS/NATIONAL GEOGRAPHIC STAFF (AROVE); FLIP NICKLIN

The versatile Nicklin pursued krill on land and in icy seas. At the National Science Foundation's Palmer Station he made remarkable close-up photographs of the crustaceans. By day and by night under storm-tossed waves he photographed their giant schools. When the sea was calm, he put his camera gear on an ice floe and used it as a raft while waiting for krill to appear.

On previous assignments for NATIONAL GEOGRAPHIC, the San Diego native photographed humpback whales near Maui and right whales off Patagonia. Completing a future article on killer whales, Nicklin left for Sri Lanka to pursue one of the most elusive of whale subjects, the mighty sperm whale.





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