DOUBLE MAP SUPPLEMENT: THE ROMAN EMPIRE

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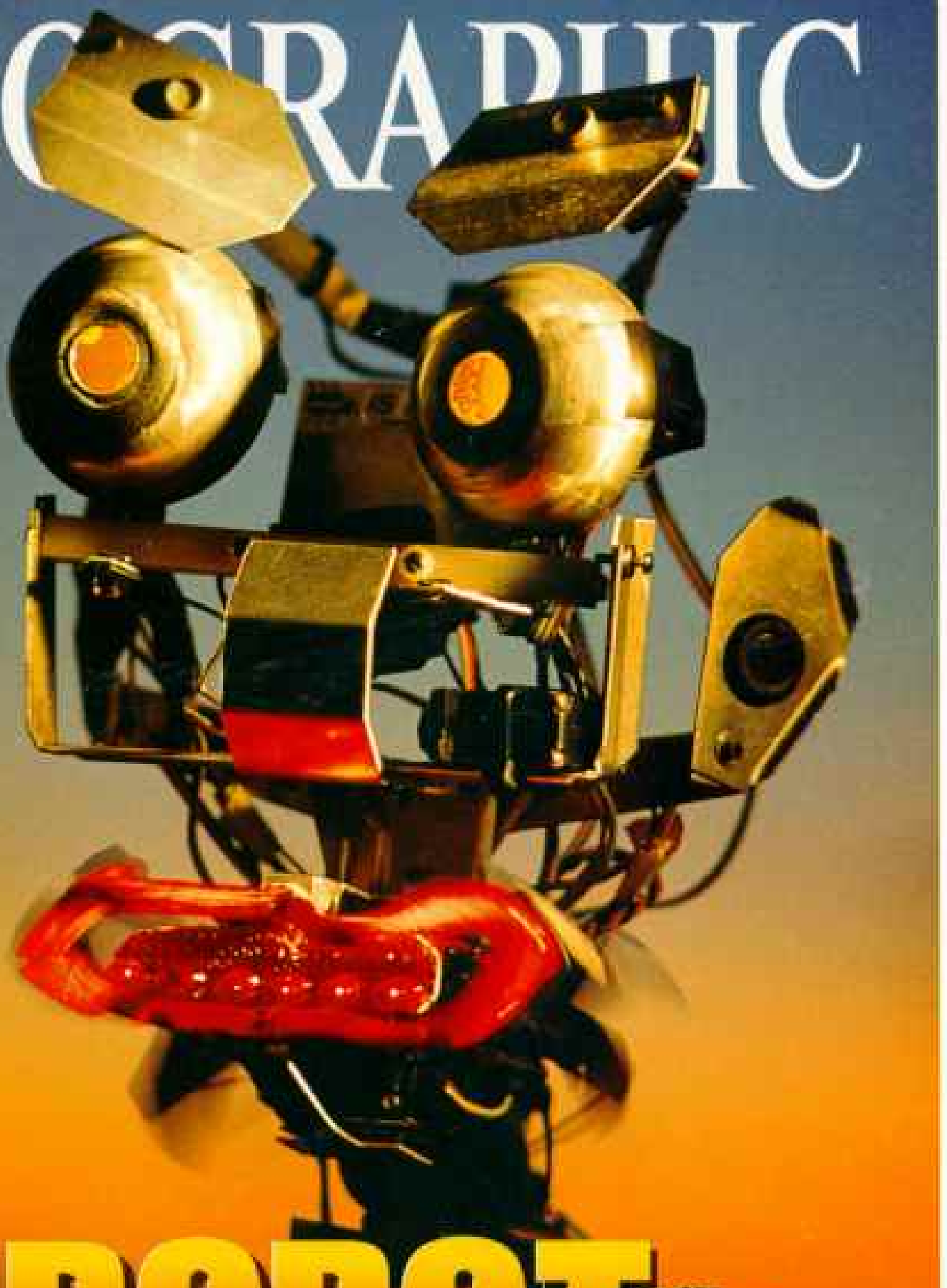

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NATIONAL GEOGRAPHIC

From the Editor

MARK THIESSEN

THE POSTCARD commanded attention.

"Today I walked from Europe to Asia," it said. "Talk about a hard-working writer!" The sender, Tom Reid, was reporting in from Istanbul, describing his 15-minute hike across the Bosporus Bridge linking West and East.

Reid, whose two-part story on the Roman Empire leads this issue and continues next month, was exaggerating about the hard work, but the point was serious.

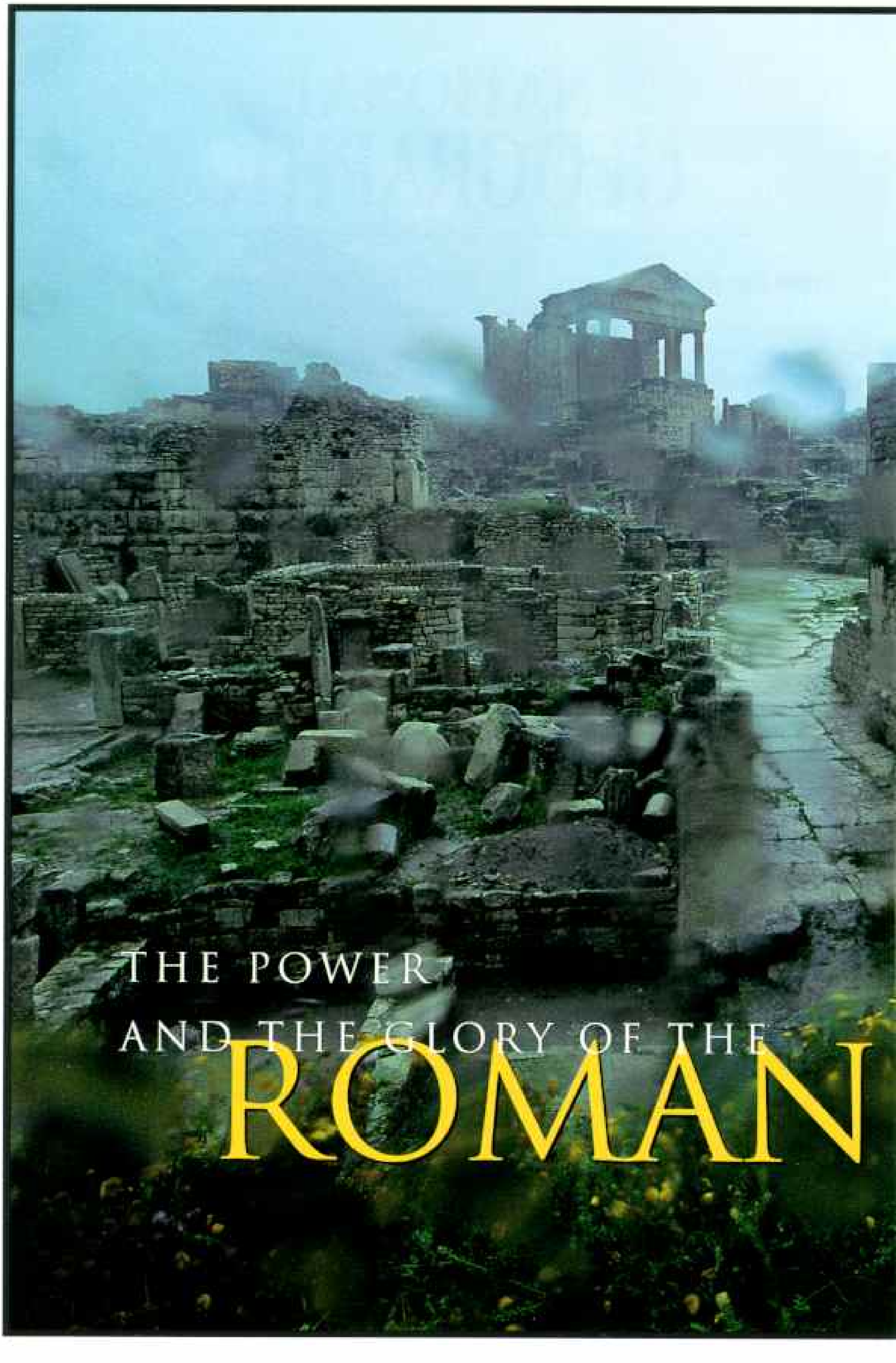
Perhaps more than any other magazine in the world, ours strives for a thoroughness and a dedication to detail that sometimes borders on the obsessive. Our field men and women have braved mobs, totaled rental cars on several continents, climbed mountains and fallen from them, survived robberies and beatings, eluded hippo attacks, and eaten all manner of exotic fare on assignment, from scorpions to sea slugs to sheep eyes—all in the spirit of adventure and bending to local custom.

But most of what goes into a NATIONAL GEOGRAPHIC story relies on painstaking research, extraordinary patience, and a willingness to wait long hours for the right quote or the right light that lifts a story above the routine. Time to do it right is the most precious commodity we can offer.

For the Roman Empire coverage, veteran photographer Jim Stanfield and NATIONAL GEOGRAPHIC editors spent weeks with William L. MacDonald, a leading historian, planning an itinerary that would cover 13 countries representing a thousand years of Roman history. The result took Stanfield some 30,000 miles over most of a year, from Hadrian's Wall in the far north of England to the deserts of Syria.

"You plan it down to the last detail and just hope some of it falls into place," says Stanfield, a legendary perfectionist whose field notes (above) reflect his attention to detail.

Such care, we hope, shows through in our stories each month as we try to achieve the level of excellence our members have come to expect from NATIONAL GEOGRAPHIC.


THE POWER
AND THE GLORY OF THE
ROMAN

EMPIRE

BY T. R. REID

PHOTOGRAPHS BY JAMES L. STANFIELD

Spring rain whispers in the ruins of Dougga, in northern Tunisia, where 1,800 years ago the air rang with the cries of Roman citizens. On such distant market centers Rome stamped its indelible image, erecting temples, forums, and amphitheaters—the imprint of the West's first true superpower.

HAIL CAESAR

Most famous of Romans, Julius Caesar, shown on a silver denarius, spurred Rome's transition from a disintegrating republic to a dominant empire. After his assassination in 44 B.C., his name became an official title for supreme ruler.

ASHMOLEAN MUSEUM, UNIVERSITY OF OXFORD

FOR A COUPLE OF DECADES NOW the leaders of Europe have been struggling to implement a revolutionary and furiously controversial concept: a single European currency. Governments have fallen, fists have flown, and bitter curses have been exchanged in a variety of Romance and Germanic languages over this visionary idea. So explosive are the politics of the proposed Euro that some say the notion of a single coinage for so many different peoples is an impossible dream.

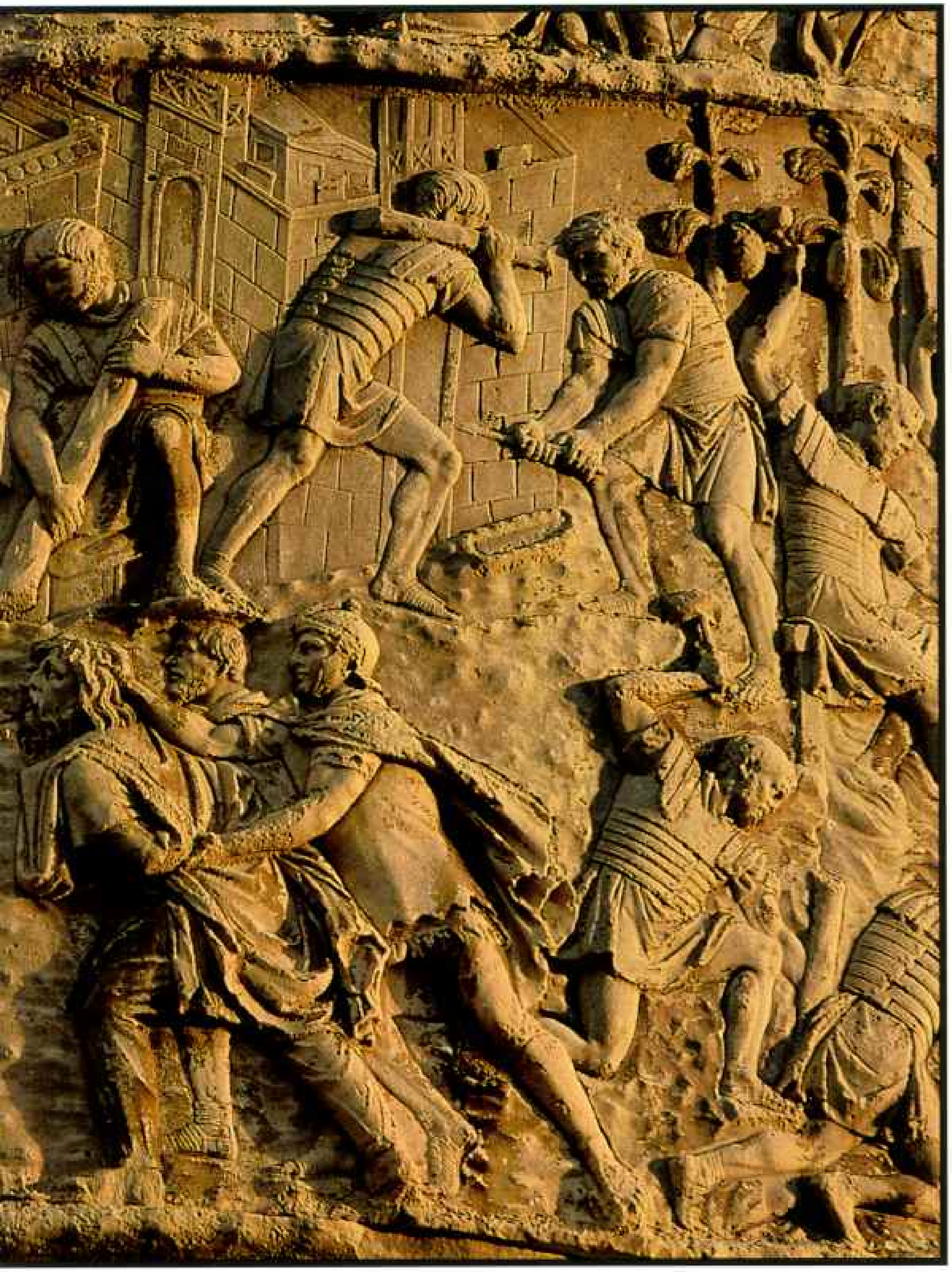
Or is it? For there was a time—measured not in decades but in centuries—when a single currency, a single code of laws, a single army, and a single emperor held sway over a vast swath of the Western world, including the heart of Europe, a large chunk of western Asia, and the northern tier of Africa, from the Atlantic to the Dead Sea. This was the Roman Empire, which pacified and unified the entire Mediterranean rim—a signal achievement in the sheer art of governing. Long before anybody thought of automobiles, airplanes, or e-mail, the emperors efficiently maintained their famous *Pax Romana* over a 3,000-mile-wide territory that today includes parts of more than 40 different nations. They did it with a genius for organization and a tolerance for cultural diversity that was interrupted now and then by bursts of utter ruthlessness.

For a Roman tribune, trader, or tax collector traveling the 53,000 miles of paved road that spanned the empire in the third century A.D., a little problem like common coinage for 15 Western European countries would have seemed trivial. For some 50 million people back then, from the palmy seat of the Pyramids to the frosty moors of southern Scotland, the Roman denarius was accepted as coin of the realm. Still is, in a sense. When I visited the Musée National du Bardo in Tunis to see its Roman coins, I paid the admission fee for this exhibit of the *denarius* in Tunisian *dinars*.

This month and next NATIONAL GEOGRAPHIC will examine this mighty empire in a two-part series. This first article struggles with Rome's rise and fall. How did a minor farming settlement scattered on the hills above the Tiber River create the richest and strongest empire in Western history? How did the Romans keep a vast and varied collection of peoples unified for so many centuries? And once this intricately designed, supremely rational imperial structure was in place, why did it fall asunder? Next month's installment will review the legacy the Romans bequeathed to the modern world in law, language, literature, architecture, government, military affairs, et cetera (one of the countless Latin phrases still in daily use).

MILITARY MUSCLE

In a surge of sculptured motion, soldiers haul a bearded enemy leader before Emperor Trajan. The scene appears on Trajan's column in Rome, its spiraling frieze depicting the conquest of



Dacia (western Romania) in A.D. 101–106. Not limited to fighting, legionaries built many of the towns, roads, and aqueducts that advanced Roman rule.

ANCIENT WATERWORKS

Too massive and too practical to have been toppled by the Goths and Vandals who overran the western empire in the fifth century, a stone aqueduct still carries fresh water above the

streets of Segovia, Spain. Boasted a Roman official, "Will anybody compare the idle Pyramids . . . to these aqueducts, these many indispensable structures?"

PLEASURE SEEKERS

Wine and women intoxicate a pair of revelers on a recently discovered fresco in a banquet room in Pompeii, Italy. Such displays of excess permeated the lives of the upper class, despite the occasional efforts of emperors to lead moral crusades.

CASA DEI CASTI AMANTI, POMPEII

EMPERORS

SOME BRIEF REIGNS OMITTED
OVERLAPPING DATES INDICATE CO-RULE

27 B.C.-A.D. 14	•	AUGUSTUS
A.D. 14-37	•	TIBERIUS
37-41	•	CALIGULA
41-54	•	CLAUDIUS
54-68	•	NERO
68-69	•	GALBA
69	•	OTHO
69	•	VITELLIUS
69-79	•	VESPASIAN
79-81	•	TITUS
81-96	•	DOMITIAN
96-98	•	NERVA
98-117	•	TRAJAN
117-138	•	HADRIAN
138-161	•	ANTONIUS PIUS
161-180	•	MARCUS AURELIUS
177-192	•	COMMODUS
193	•	PERTINAX
193	•	DIDIUS JULIANUS
193-211	•	SEPTIMIUS SEVERUS
198-217	•	CARACALLA
209-212	•	GETA
217-218	•	MACRINUS
218-222	•	ELAGABALUS
222-235	•	SEVERUS ALEXANDER
235-238	•	MAXIMINUS
238	•	GORDIAN I AND II
238-244	•	GORDIAN III
244-249	•	PHILIP
249-251	•	DECIUS
251-253	•	TREBONIANUS GALLUS
253-260	•	VALERIAN
253-268	•	GALLIENUS
268-270	•	CLAUDIUS II
270-275	•	AURELIAN
276-282	•	PROBUS
283-284	•	CARINUS AND NUMERIAN
284-305	•	DIOCLETIAN AND THE TETRARCHY
306-313	•	CONSTANTINE AND THE LATER TETRARCHY
313-324	•	JOINT RULE OF CONSTANTINE AND LICINIUS
324-337	•	CONSTANTINE SOLE RULER

PART ONE

THE MAKING OF

MUSEI CAPITOLINI, ROME

A godly visage suits the lofty reputation of Augustus, Rome's first emperor. After avenging Caesar's death and defeating rival Mark Antony, Augustus assumed monarch-like power. His reign (27 B.C.-A.D. 14) inaugurated Pax Romana—*some 250 years of relative peace and order.*

THE STORY OF ROME is a tale studded with names and phrases we've all heard: *Veni, vidi, vici;* Antony and Cleopatra; Spartacus; habeas corpus; Nero, Caligula, Marcus Aurelius; "It came to pass in those days that there went out a decree . . ."; the Vandals, the Visigoths, Attila the Hun. It is a tale with particular poignancy at the end of the 20th century for citizens of the United States, which happens to be the richest and strongest nation at this moment in history. As the late classical scholar Frank Bourne used to say, "In the age of *Pax Americana*, there's no more important lesson we can teach young Americans than the rise and the decline of *Pax Romana.*" When Bourne taught Roman history at Princeton, he began and ended his course with the words *De nobis fabula narratur*—Their story is our story.

To tell the Roman story, however, we first have to deal with a serious definitional problem—that is, determining what is meant by the term "Roman." The full sweep of Roman history, from the legendary date of the city's founding in the eighth century B.C. to the defeat of the last Roman emperor at Constantinople in 1453, covers more than 2,200 years. Generally, though, the period after A.D. 500 or so—when imperial power had gravitated from Italy to the new capital at Constantinople, the former city of Byzantium—is known as the Byzantine Empire. For most historians the era known as Roman runs roughly from five or six centuries before the birth of Christ to five or six centuries after. (The so-called Holy Roman Empire, an alliance of Germanic and Italian states founded by Charlemagne in A.D. 800, is a completely different entity.)

As with so much else in modern life, it is thanks to the Romans that we can measure

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T.R. REID, a correspondent for the *Washington Post*, was once a teacher of classical languages. JAMES L. STANFIELD's 58 photographic assignments have taken him from Windsor Castle and the Vatican to Bulgaria, Burma, and Bhutan.

AN EMPIRE

these spans of time with accuracy. In the first century B.C. two Caesars—Julius (hence July) and Augustus (August)—formulated our 12-month, 365-day calendar, with a leap day every four years. It was a typically precise piece of Roman engineering, so rationally calibrated that each one-year cycle was barely 11 minutes out of sync with earth's actual transit around the sun.

Even after the invention of this Julian year the Romans counted years as AUC, or *ab urbe condita*—that is, "since the founding of the city." According to tradition the city of Rome was founded in 753 B.C. This is the stuff of legend, but as a matter of history it's as good a date as any to mark the time when the shepherds and farmers on the low, sunny hills surrounding a marshy riverbank forged a community known ever since as Roma. The Roman storytellers said the name of their town came from Romulus and Remus, orphan twins suckled by a she-wolf on the banks of the Tiber. Modern scholars, with considerably less flair for the dramatic, say the name probably comes from Etruscan or Greek—perhaps from *rhome*, a Greek word meaning "strong."

The linguists and other modern scholars have added massively to our understanding of the ancient world. The greatest contribution comes from the corps of scholars who have dedicated their lives to digging (literally) for information—the archaeologists. For these mud-streaked historians, Roman sites—characterized by orderly layouts, strong foundations, and countless inscriptions in handsome, angular Roman letters—have been priceless vaults of insight.

Perhaps the greatest jewel of ancient archaeology is the old port of Pompeii, snuggled in a sun-washed valley between the brilliant blue Bay of Naples and the gentle green slopes of Mount Vesuvius. In the first century A.D. Pompeii was a pretty and prosperous resort town. There were some 12,000 year-round inhabitants and hundreds more who came down from Rome each summer to their villas by the sea.

On a hot summer day, around noon—it was August 24, A.D. 79—the people of Pompeii saw a huge cloud forming over the mountain north of the city. This was the last noontime Pompeii would ever know, because that cloud of volcanic debris was the beginning of a massive eruption that blew the top off Vesuvius, burying the city beneath 12 feet of rock and ash and unleashing a blast of toxic gases. Thousands were killed—in their homes, in the streets, in businesses and brothels. Thousands more fled madly toward the sea.

Those who were running for their lives must have been surprised to see a curious figure who was racing not from but toward the volcano. This was the great Roman naturalist Pliny the Elder. Seeing the initial eruption from a safe distance at his home near Naples, the renowned scientific observer just couldn't stay away. He grabbed his notebook and stylus and hightailed it for Pompeii to gather firsthand information on this prodigious phenomenon. Pliny's curiosity cost him his life—but made him a patron saint to notebook-clutching reporters like me.

For 17 centuries after its final day, the silenced city of Pompeii lay there undisturbed, encased in its tomb of hardened ash. Then a few farmers at the foot of Vesuvius started digging down around the persistent stony outcroppings in their fields—and found not rocks but the roofs of a whole Roman community. It was the dawn of modern archaeology.

They're still digging in Pompeii to this day—in some places with steam shovels and backhoes, in others with delicate archaeological scoops smaller than a thimble. On a balmy day last winter I rode the shuttle railroad known as the Circumvesuviana down from Naples to see what they were finding.

"Garbage! Trash and garbage! That's what we hope to find!" shouted Andrew Wallace-Hadrill, an exuberant historian who heads the British School at Rome. "I tell you, there's nothing like other people's rubbish for getting at history." Professor Wallace-Hadrill and I were standing in the well-preserved courtyard

of an ancient tavern on one of Pompeii's major business streets. He knew it was a tavern because he had found a storeroom filled with tall amphorae, the red-clay containers the ancients used for shipping wine from one corner of the empire to another.

From studying the state of these amphorae and some cryptic markings on them, Wallace-Hadrill had determined that the tavern had just received a shipment of wine from Crete. "It must have been a popping fresh vintage—the newest young wine of the 79 season," he told me in wistful tones. "Too bad they never got to try it."

With the toe of his battle-scarred hiking boot Wallace-Hadrill pointed out a small hole in the floor where he had made "what turned out to be a very interesting find." This was a treasury of garbage—to be precise, a pile of 1,917-year-old chicken bones. Judging from that discovery, the shape of the courtyard, and mosaics found in houses down the street, the professor guessed that he had uncovered one of Pompeii's popular cock-fighting arenas.

"It adds to our picture of what there was in a Roman town," he explained. "There are different archaeologists at work all over Pompeii. We each put together our own analysis of what we're seeing. And when all the pieces are fit together, we know a little more about how the Romans, who were highly skilled at governing, went about organizing a typical city."

THE VITAL FORUM

Orphaned pillars and broken walls barely hint at the events that once swelled within the confines of the Roman Forum, the political and spiritual heart of the empire. Emperors rode chariots past worshipful mobs, orators blazed forth on issues of the day, and priests offered sacrifices to the gods. The monuments eventually fell, and not until the 1800s did archaeologists begin digging up the past.

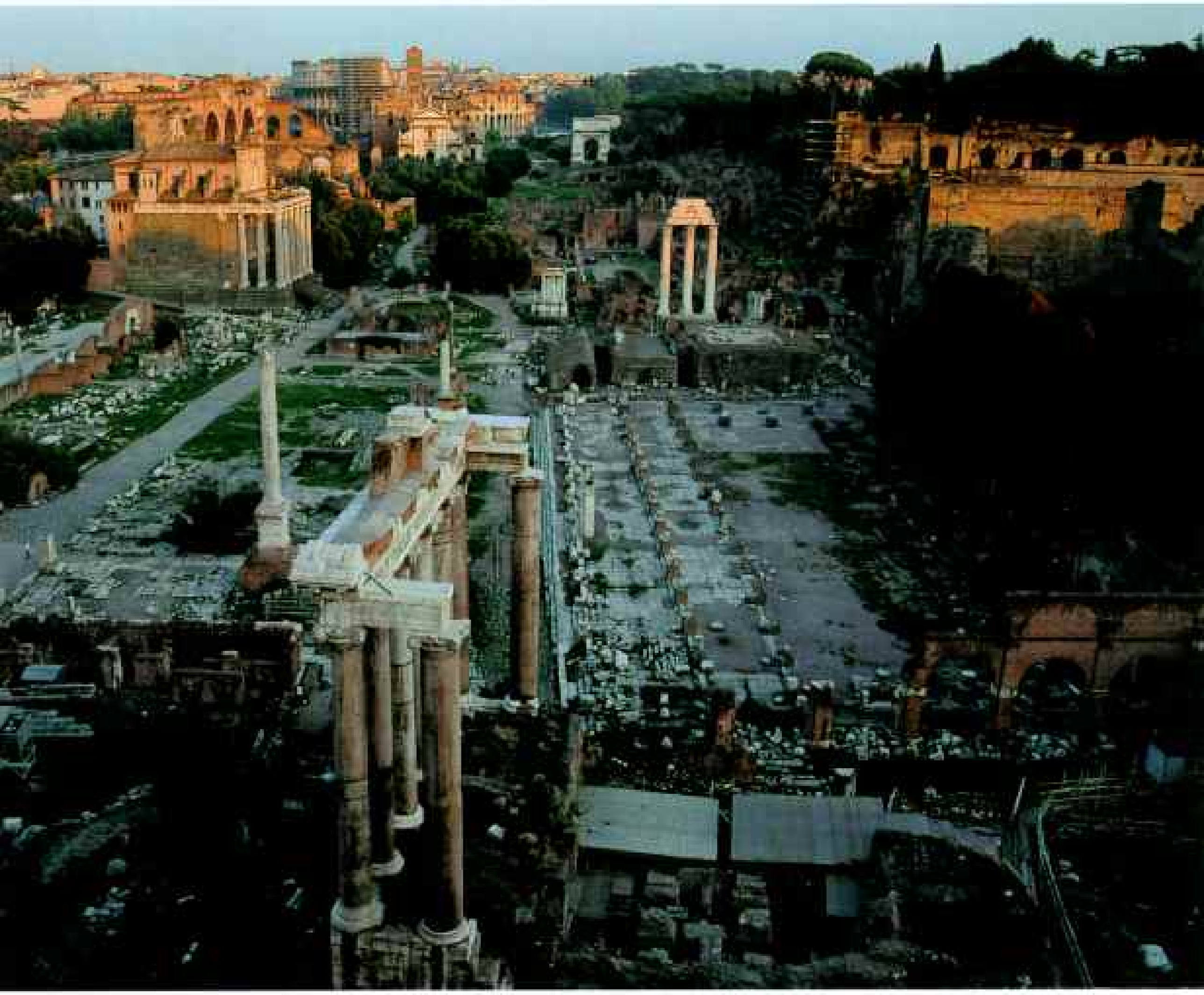
HERE AND THERE around the Roman world archaeologists are using old-fashioned ingenuity and the newest high-tech gadgetry to learn about Rome—so that we, in turn, can learn from Rome's example. The depth and detail of their knowledge is mind-boggling. Archaeologists are particularly great at identifying sherds of broken pottery—right down to the kiln and sometimes the individual potter. Broken pots, after all, are what they always find in their digs, and knowing when and where the pottery was made can help date everything else at a given level in the excavation. But modern archaeology goes far beyond pots.

One scholar published a 500-page volume on trees and timber in the ancient Mediterranean world. Some experts are uncanny at identifying ancient seeds and pollen, which tell us what people were eating and help the curators of Pompeii replant ancient gardens exactly as they were in 79. Others can identify the minerals in paint and the vegetable dyes in scraps of cloth—and these ingredients, in turn, reveal a great deal about trade patterns.

A team from Japan, appropriately enough, came to Pompeii to carry out an extensive study of traffic flow. By examining the ruts left by chariot wheels in the stone streets, these researchers of the rush hour have concluded that the Romans had one-way streets and no-left-turn intersections.

The problem is, all these thoroughly modern approaches to uncovering ancient information have made the basic work of archaeology go slower; the diggers now have to uncover and preserve all sorts of objects that earlier generations of scholars would never have bothered with.

In a large house on a main street of Pompeii the Italian archaeologist Antonio Varone



showed me his collection of some 5,000 bits and pieces of plaster from a collapsed roof. "We're going to keep looking for these pieces until we can reconstruct the whole roof," he said. "My God," I blurted out in astonishment, "that could take another hundred years!" "We should be so lucky," Varone answered wryly. "We've probably got another thousand years of archaeology left before we finish with Pompeii."

Thanks to the findings of these intrepid diggers and the huge documentary record left behind by the Romans themselves, historians have pieced together a comprehensive picture of Rome dating back to the legendary date for the founding of the city.

We know that early on the Romans were ruled by the Etruscans, a powerful nation of central Italy. Chafing under an often brutal monarchy, the leading families of Rome finally threw over the Etruscan kings—a revolution that would influence, some 2,200 years later, the thinking of Thomas Jefferson and George Washington.

In the year 244 AUC (that is, 509 B.C.) the patrician families of Rome set up a quasi-representative form of government, with a pair of ruling consuls elected for a one-year term. This marked the beginning of the Roman Republic, a form of government that would continue until Julius Caesar crossed the Rubicon 460 years later.

Those five centuries were marked by increasing prosperity and increasing democracy. There were essentially three classes of people in republican Rome: the slaves, who had almost no rights; the ordinary folk, or plebeians, a category *(Continued on page 21)*

1. Theater of Pompey
2. Odeum (concert hall)
3. Pantheon
4. Theater of Marcellus
5. Temple of Jupiter Optimus Maximus
6. Temple of Juno Moneta
7. Trajan's column
8. Basilica Julia
9. Roman Forum
10. Curia (senate house)
11. Basilica Aemilia
12. Forums of the emperors
13. Temple of Vesta
14. Basilica of Maxentius and Constantine
15. Circus Maximus
16. Palatine Hill
17. Temple of Elagabalus
18. Temple of Venus and Rome
19. Septizodium (monument built by Septimius Severus)
20. Aqueduct of Claudius
21. Temple of the Divine Claudius
22. Arch of Constantine
23. Colossus of Nero
24. Colosseum (Flavian amphitheater)
25. School of the gladiators
26. Baths of Titus

MUSEO DELLA CIVILTÀ ROMANA, ROME (LEFT); ART BY WILLIAM H. BOND

ETERNAL CITY

From its rude origins as an eighth-century B.C. village of thatch huts near the Tiber River, Rome ripened into one of the richest, most powerful metropolises the world has ever witnessed. Its monumental grandeur—and its marbled congestion—is seen in a meticulous model (left) showing Rome during the reign of Constantine (A.D. 306-337), when the city reached its greatest size, with perhaps a million residents.

To glorify themselves, emperors built temples and forums, palaces and triumphal arches. To keep the public happy, they erected theaters, baths, and huge arenas like the Colosseum.

After Constantine built a new capital at Byzantium in 324 and renamed it Constantinople, Rome fell into decline. A photograph (right) taken from the same vantage point as the model reveals how a history of sackings, earthquakes, and neglect has erased many of the great structures. Now pollution and vibrations from traffic threaten the redoubtable Colosseum.

STATO MAGGIORE AERONAUTICA

THE REACH OF ROME

To safeguard the ever fragile frontiers and to keep its tax revenues pouring in, Rome pursued a policy of steady territorial expansion. At the death of Trajan in A.D. 117, the empire had grown to its greatest size (map), encompassing 40 provinces (parts of more than 40 modern countries) and almost two million square miles, half the size of modern China.

Area ruled by Rome at Caesar's death, 44 B.C.
Greatest extent of the Roman Empire, A.D. 117
X Major battle or campaign
Roman road
Present-day city names in parentheses
Present-day political boundaries and names in gray

0 400
MILES
NATIONAL GEOGRAPHIC MAPS
PAINTING BY JOHN ROSS

ATLANTIC OCEAN
CALEDONIA
SCOTLAND
Hadrian's Wall
HIBERNIA
BRITANNIA
ENGLAND
Aquae Sulis (Bath)
Londinium (London)
Rhine
Teutoburg Forest A.D. 9
GERMANIA
EUROPE
Seine
Lutetia (Paris)
FRANCE
GALLIA (GAUL)
Danube
Burdigala (Bordeaux)
Lugdunum (Lyon)
ALPS
Aquincum (Budapest)
ROMANIA
A.D. 101-106 DACIA
Verona
Ravenna
ILLYRICUM
Adriatic Sea
ITALY
Tiber
Salonae (Solin)
Black Sea
Caspian Sea
(Arles) Arelate
Segovia
HISPANIA
SPAIN
Tarraco (Tarragona)
(Rome) Roma
Ostia
APPIAN WAY
Naples Neapolis
Vesuvius 4,203 ft
Herculaneum
Pompeii
Byzantium, Constantinople (Istanbul)
Zela 47 B.C.
ARMENIA
ASIA
Mount Athos 6,670 ft
Ilium, Troy
ASIA MINOR
TURKEY
GREECE
Actium 31 B.C.
Athens Athenae
Corduba (Cordoba)
Cades (Cádiz)
MEDITERRANEAN SEA
Carthage (Carthago)
Thugga (Dougga)
Tunes (Tunis)
Tyracusae (Syracuse)
Crete
Side
Carrhae 53 B.C.
Antiochia (Antioch)
SYRIA
PARTHIAN EMPIRE
Euphrates
Ctesiphon A.D. 116
AFRICA
SAHARA
TUNISIA
Leptis Magna
Nazareth
Hierosolyma, Aelia Capitolina (Jerusalem)
Dead Sea
ISRAEL
Alexandria
ARABIA
AEGYPTUS
EGYPT
Nile

MUSEO ARCHEOLOGICO DI OSTIA

WELCOMING PORT

Sailing a marble sea, a cargo ship approaches the flame-topped lighthouse at Ostia, at the mouth of the Tiber, in a scene carved on a tomb. The most eagerly awaited ships came bearing grain from Egypt and Tunisia. A late or missing shipment at times triggered famine and riots in the capital.

that included many freedmen, or ex-slaves; and the patricians, descendants of those first ruling families, who served by right of birth in one of the ancient world's great governing bodies, the Roman senate.

When they marched to war, the Roman legions carried tall guidons bearing the famous initials SPQR: *senatus populusque Romanus*, the senate and the people of Rome. But to a great extent the history of the republic was a history of the struggle between the senators (the patricians) and the plebeians, with the plebs gradually gaining more and more political power.

Much of this "struggle of the orders" was played out amid the open plazas, triumphant arches, and great columned temples of the Roman Forum, the crowded civic center that served as the heart of the city for some thousand years. Here Cicero gave those famous orations that schoolchildren have struggled over for centuries; here Mark Antony came "to bury Caesar, not to praise him" in 44 B.C. The *curia*, the high-roofed rectangular senate chamber, still stands in the Forum today—just across the way from the *comitium*, where the plebeians gathered to express their will through the *plebiscitum*, the decision of the plebs.

By the second century B.C. the right to vote was so firmly established among the plebeians that Rome developed a vigorous political system—one that would not be unfamiliar to citizens of a modern democracy. There were parties and factions, fat-cat contributors, banners and billboards, negative advertising, and a pundit class to castigate the pols.

WHEN I WAS A STUDENT of Roman history, my favorite politician was one Marcus Licinius Crassus, a man so rich and so enamored of ostentatious display that his name evokes an English adjective. The crass Mr. Crassus had business interests ranging from silver mines to the slave trade, but perhaps the most lucrative operation was his private fire department. When a house caught fire, his horse-drawn water tank would clatter through the stone streets. Then Crassus would start negotiating a price for his services—while the hapless customer watched the flames spread. A common result was that Crassus acquired the property, with the former owner obliged to pay him rent for life.

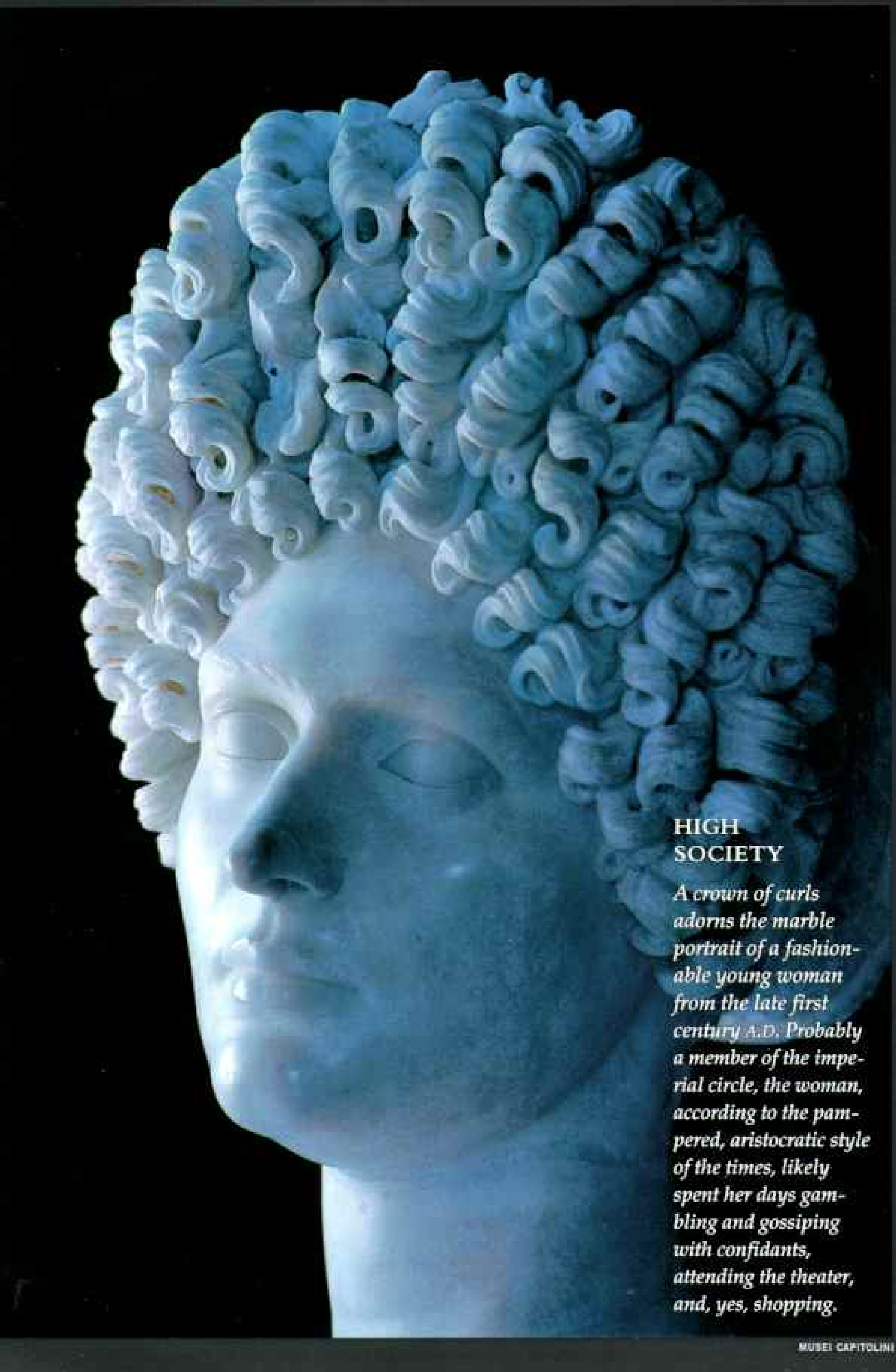
Crassus was perhaps the biggest property owner in Rome, but he yearned for something more: political power. To curry public favor, he threw his money around. When he put down the slave revolt led by Spartacus in 71 B.C. (crosses bearing crucified slaves lined the Appian Way for more than a hundred miles), Crassus celebrated by setting up 10,000 banquet tables in the Forum, feeding all of Rome for days.

He also invested in carefully selected politicians. One of his fiscal beneficiaries was a young up-and-comer named Julius Caesar. As

MAN OF THE PEOPLE

Proclaimed emperor by his troops in A.D. 69, following victories in the Jewish War, Vespasian, a modest, straight-talking commander, stands out as the first nonpatrician ruler of the empire. His ascent coincided with a flowering of realistic portrait sculpture, which, in this damaged bust, shows him in all his common glory.

MUSEO ARCHEOLOGICO NAZIONALE, NAPLES



HIGH SOCIETY

A crown of curls adorns the marble portrait of a fashionable young woman from the late first century A.D. *Probably a member of the imperial circle, the woman, according to the pampered, aristocratic style of the times, likely spent her days gambling and gossiping with confidants, attending the theater, and, yes, shopping.*

MUSEI CAPITOLINI

THE GOOD LIFE IN POMPEII

Entombed in ash after the eruption of Vesuvius in A.D. 79, the houses of Pompeii in southern Italy reveal a standard of living that historian Michael Grant says "was never achieved again until the 19th century." Terentius Neo and his wife advertised their refinement, appearing in a portrait (right) with materials for writing. In another Pompeii home (facing page) even a "beware of dog" sign was a work of art.

MUSEO ARCHEOLOGICO NAZIONALE

Caesar's star rose in the Roman firmament, Crassus trailed along. In 60 B.C. he reached the pinnacle of his career, as one of three triumvirs who controlled the apparatus of the state. After that, the only thing left to acquire was military glory, so Crassus hired his own army. Caesar obligingly sent him off to Syria to fight the treacherous Parthians.

Long after my student days, when I was a political reporter, I met Marcus Licinius Crassus several times in Washington—in the form of successful business people who had started contributing serious sums to one of the political parties and ended up with a top government post. "I read about this guy in Roman history," I used to tell myself. *De nobis fabula narratur.* Still, the comparison can't be taken too far. For the American fat cat the worst that usually happens is defeat in the next election. Poor Crassus met a more drastic end. He was defeated at the battle of Carrhae in 53 B.C. When the Parthians realized they had killed the richest Roman of all, an ancient story runs, they poured molten gold down Crassus' throat on the theory that his lifelong thirst for gold should be quenched in death.

It's doubtful that Caesar shed any tears about the death of his patron. Crassus' disaster not only eliminated a potential rival but also emphasized, by contrast, Caesar's own record of unblemished military success. In an era when the very notion of virtue (in Latin, *virtus*) incorporated prowess on the battlefield, Caesar's enormous political popularity was based on his skills as a field commander.

By the middle of the first century B.C. Rome was a cesspool of political intrigue and civic turmoil. The only good news, it seemed, came from distant battlefields, and people waited eagerly for each new report from afar. Caesar, who could write as skillfully as he fought, turned the composition of military dispatches into an art form. The triumph of this genre was his immortal message back to Rome after trouncing the Parthians at Zela in 47 B.C.: "*Veni, vidi, vici*—I came, I saw, I conquered." It was the second greatest dispatch from the front in all military history. (For the greatest, please read next month's article.)

When Caesar led his army across the Rubicon River in 49 B.C., defying the orders of the senate, it seemed clear that he would seize absolute power. The conspirators who slew him on the ides of March, 44 B.C., probably believed they were acting to save Roman democracy.

In fact, they merely launched another long civil war. In the end Julius Caesar's onetime

sidekick Mark Antony, allied with Caesar's onetime paramour Cleopatra, was defeated at the battle of Actium in 31 B.C. The victor, Octavian, returned to Rome, assumed the august name "Augustus," and eventually established one-man rule—with the once proud senate serving as his rubber stamp. The imperial court Caesar Augustus created would continue for another four centuries at Rome and ten more after the move to Constantinople.

Many ancient nations—and many modern ones—experienced the same sort of turbulent transition from democracy to dictatorship, or vice versa. But Rome's vast foreign empire remained intact—indeed thrived—throughout all the upheaval at home. This is where Rome broke the mold of Western history.

Far to the east the Chinese created a huge land empire in the centuries before Christ. But the Western world, since the dawn of recorded history, had been a world of city-states—of smaller, independent political entities. They regularly sacked and pillaged one another but did not seek a wider hegemony. There were alliances but no empires until Alexander the Great bestrode western Asia in the fourth century B.C. Alexander's empire was a distinguished personal achievement, but it could not survive its founder. The Romans, in contrast, proved to be master empire builders.

HISTORIANS have been debating since ancient times just how Rome came to rule the Western world. In the second century B.C. the Greek author Polybius devoted 40 volumes to the question and concluded that Rome was driven by a concept of manifest destiny, a compulsion to dominate. The Romans themselves, such as the statesman-philosopher Cicero, generally maintained that theirs was an accidental empire, acquired in the process of defending against invaders.

The Roman Empire began, at least, in this haphazard way. Centuries of skirmishes against rival states gradually expanded Roman territory, and by the third century B.C. most of Italy was under Roman dominion—a development that probably surprised the Romans as much as the more established city-states of the Mediterranean world.

"If you're standing in the middle of the fourth century wondering who's going to conquer the world, you're definitely not going to bet on Rome," Professor Wallace-Hadrill, the British historian, told me. "The great powers were the famous city-states—Alexandria, Athens, Syracuse, Carthage. They had the great navies, which Rome didn't have. But the Romans had their army, and they had this doggedness about them. They kept fighting these border wars, and they kept winning. And when they had conquered the world, they turned out to be cleverer than anybody else at organizing and maintaining an empire."

Driven by political pressure and economic need—for grain, for slaves, for metals, for fabric, etc.—Roman expansion shifted into high gear after 260 B.C. One by one the great states of the Mediterranean fell before the steady onslaught of the Roman legions, with their catapults and flame throwers and highly disciplined foot soldiers marching relentlessly forward in centuries (blocks of shielded men).

In just 200 years Rome extended its sway from Syria to Spain, from southern France to the Sahara. Long before Augustus became the first Roman emperor, the empire was largely in place. A few provinces would be added later at the margins—Britannia, Dacia (western Romania), Armenia. But the real task facing Augustus and his successors was not gaining the empire but governing it.

And government, as it happened, turned out to be the supreme Roman talent. Although Romans produced deathless poetry and prose, sublime paintings, and mosaics so perfect they take your breath away, Rome always felt a collective inferiority complex toward Greece in the realms of art, literature, and science. But government—that was different. This was an art form Romans could master.

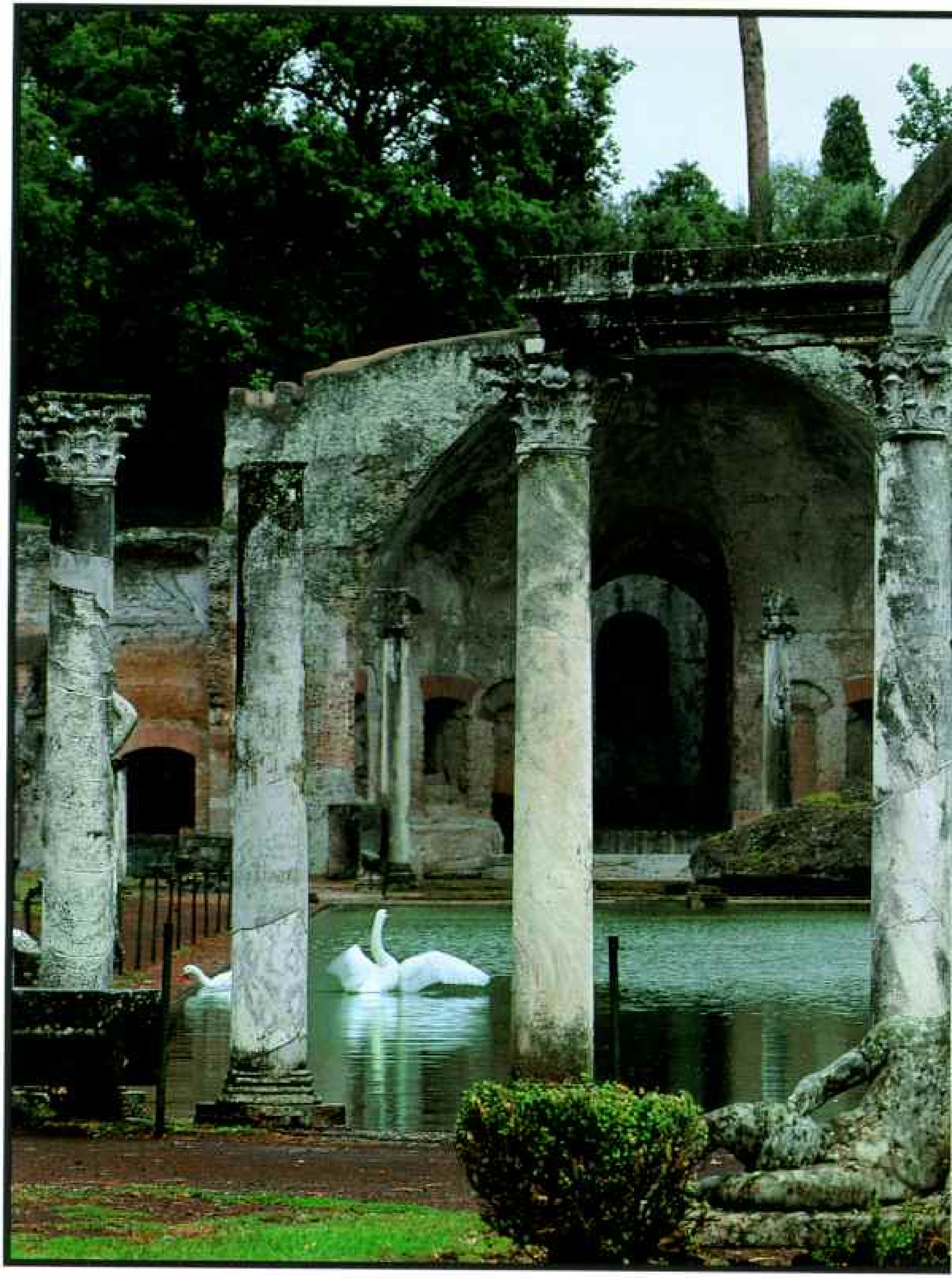
A famous passage from Virgil's *Aeneid* makes the point:

The Greeks shape bronze statues so real
they seem to breathe,
And carve cold marble until it almost
comes to life.
The Greeks compose great orations,
and measure
The heavens so well they can predict
the rising of the stars.
But you, Romans, remember your
great arts:
To govern the peoples with authority,
To establish peace under the rule of law,
To conquer the mighty, and show them
mercy once they are conquered.

—*Aeneid VI, 847-853*

DARK HISTORY

Body casts of adults and children lie in a Pompeii garden, the site where they were struck down by an asphyxiating cloud of gas and ash. Plaster that was poured into cavities left by the decayed bodies created the grim images. Outside a house undergoing excavation, archaeologist Antonio Varone studies the "layer of death," a dark wave of material studded with blown-off roof tiles. The remains of 2,000 people have been found in Pompeii.



HADRIAN'S VILLA

An emperor's love of the Greek world overflowed in a vast estate Emperor Hadrian designed for himself outside Rome. Svelte gods and a row of caryatids overlook

a pool at the ruler's banquet hall. Completed by A.D. 135, the villa with its temples, baths, gardens, and theaters abounds in references to classical Athens.

"TO ESTABLISH PEACE under the rule of law." Virgil could set forth that ideal in a single line of iambic hexameter; to turn it into a practical reality was a more challenging work of art than composing an epic poem. The single code of law was a crucial force in unifying the far-flung Roman world. But it was not a rigid instrument—and this point was key to the Roman success. Within the broad sweep of uniformity, Roman administration at the local level was flexible, tolerant, and open.

The Romans could be downright brutal; they would nail you to a cross in the blink of an eye. But they preferred cooperation to crucifixion, because it worked better. When Rome conquered a new province, the defeated general and his army were carted away in chains; almost everyone else came out ahead. The local elite were given positions in the Roman hierarchy. Local businesses gained the benefit of Roman roads, water systems, the laws of commerce, and the courts. Roman soldiers guarded the town against pirates and marauders. And within a fairly short period, many of the provincial residents would be made *cives Romani*—citizens of Rome—with all the commensurate rights and duties.

The English historian Ronald Syme observed that the British might have found it easier to keep their empire intact if they had learned to co-opt the locals the way the Romans did. If George III had followed Roman practice in 1776, Syme suggested, he would have made George Washington a member of the House of Lords, Ben Franklin a fellow of the Royal Academy, and Patrick Henry the colonial governor of Virginia—and perhaps avoided a revolution.

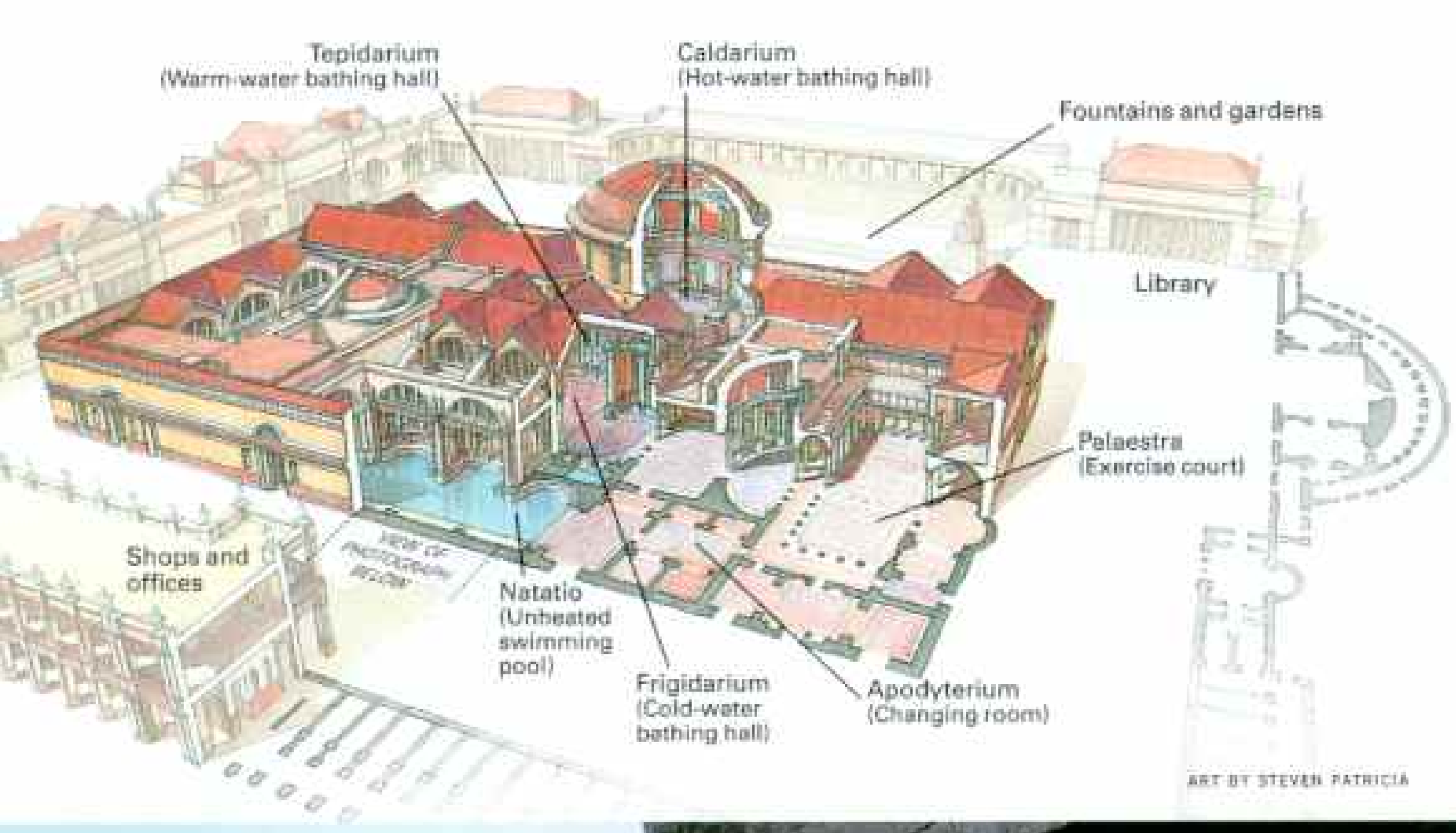
Alexander the Great's empire fell, in part, because he treated his provincial subjects as defeated enemies. The Romans treated their subjects as Romans—not outsiders but contributors. From Britannia, Arabia, Germania, and Aegyptus came authors and lawyers, teachers and physicians, engineers and soldiers to build a better empire. The Roman state was a multicultural melting pot.

The idea is a familiar one to Americans—and how fitting that we express it in the language of the Romans: *E Pluribus Unum*. Any position in the empire was open to a suitable male candidate, no matter what his origin. A North African general named Septimius Severus became emperor of Rome—and served 18

MUSEI CAPITOLINI

LEISURE PALACE

The ultimate gym, Rome's giant-size Baths of Caracalla provided swimming and bathing pools, playing fields, shops, and gardens. Originally sheathed in marble and mosaics, the walls dwarf modern visitors (right). The baths opened in 216, yet another example of Rome's success in building colossal structures of concrete and brick. The baths can hardly rehabilitate the reputation of Caracalla (above), who left behind a trail of massacre and murder.



ART BY STEVEN PATRICIA

SOPRINTENDENZA ARCHEOLOGICA DI ROMA

MUSEO ARCHEOLOGICO NAZIONALE (HELMET); BATHS OF CARACALLA, ROME (CAPITAL); MUSEI VATICANI, VATICAN CITY (MOSAIC); MUSEO NAZIONALE ROMANO (BOXER)

ART LOVERS

Romans craved color, texture, and decoration in their public and private spaces. The dining room of a merchant in Pompeii is enlivened with a mural of cherubs performing grown-up tasks; here they tackle goldsmithing (top). Baths often featured magnificent Greek-inspired sculptures, such as the bronze "Boxer" (left) and an ornate capital fronted by Hercules (middle). A gladiator's helmet (far left), probably reserved for parades, is busy with figures from the fall of Troy. Elaborate mosaics lay underfoot. One of the most charming still lifes—a Greek invention—could be titled "Banquet Scraps with Mouse" (bottom left).

SACRED PLACES

Heavenly light floods through the great dome of the Pantheon in Rome. Commissioned and perhaps even designed by Hadrian, this masterpiece of symmetry housed images of Roman gods and deified emperors. In an underground temple, or mithraeum *(left), in Ostia, acolytes worshiped the Persian god Mithras. A copy of a statue found here evokes the cult's rite of killing a bull. Practitioners washed in its blood.*

peaceful years on the throne. Trajan, one of the greatest emperors, was born in Spain.

Rome executed Jesus and threw early Christians to the lions. But these steps were exceptional. In general the Romans showed enormous tolerance toward religion. The Romans had their traditional rituals, supplemented, after Augustus, by a cult of the divine emperors. But these Roman faiths were heavily flavored by an eclectic spice of foreign religions. In Bath, England, I visited a temple to a deity called Sulis Minerva—an amalgam of a Celtic goddess with Minerva, the Roman goddess of wisdom. Almost every army post had a temple to Mithras, the Persian god of light, who became a favorite of Roman soldiers. When Pompeii was discovered two centuries ago, one of the first structures uncovered in that Roman city was an opulent temple to Isis, the Egyptian goddess of fertility.

In his masterly *Decline and Fall of the Roman Empire,* the 18th-century historian Edward Gibbon offered a famously cynical view of Rome's attitude toward religion. "The various modes of worship, which prevailed in the Roman world, were all considered by the people, as equally true; by the philosopher, as equally false; and by the magistrate, as equally useful. And thus toleration produced not only mutual indulgence, but even religious concord."

Such was the diverse empire Augustus inherited from his republican predecessors when he took power. The first emperor of Rome turned out to be one of the best. Rome had spent most of the past three centuries

on military conquest; Augustus cut back on imperial expansion and focused on civic improvement—roads and bridges, aqueducts, protective walls, and new temples everywhere to remind the Romans that they were a moral people. The Augustan peace ushered in the Golden Age of Latin literature, with Horace, Virgil, Ovid, and Livy producing works that are still being read today.

Augustus used all the tools of governing. Concerned about a decline in the birthrate, he employed both the stick (a crackdown on abortion) and the carrot (tax incentives for big families). To see if his policies were effective he took a census of his empire now and then.

Thus it did in fact come to pass in those days that there went out a decree from Caesar Augustus that all the world should be registered. And just as St. Luke's Gospel tells us, this happened "when Quirinius was governor of Syria," in A.D. 6.

Augustus also busied himself with beautifying his capital. When he died in A.D. 14, he left behind a report to the Roman people, the *Res Gestae*, or What Was Accomplished. "I was born to a city of brick," Augustus noted accurately, "and left a city of marble."

Occasionally, in the centuries that followed, the empire was ruled by other leaders of Augustus' stature. History recalls Marcus Aurelius (161-180), the philosopher-king who maintained perspective in the midst of imperial splendor: "As the Emperor, Rome is my homeland; but as a man, I am a citizen of the world. . . . Asia and Europe are mere dots on the map, the ocean is a drop of water, mighty

Mount Athos is a grain of sand in the universe." And Aurelius had been preceded by four even greater emperors—Nerva, Trajan, Hadrian, and Antoninus Pius—who reigned over the Roman Empire at its height and kept it calmly unified.

Even the cynical Gibbon had to tip his hat: "If a man were called to fix the period in the history of the world, during which the condition of the human race was most happy and prosperous, he would, without hesitation, name that which elapsed from [A.D. 96 to 180]"—that is, the era of those "Five Good Emperors."

But nothing gold can stay. By the end of the third century, the historical forces that would bring Rome to ruin were visible on the near horizon: economics, external enemies, and, as I see it, a sort of moral entropy.

The historian Paul Kennedy coined the term "imperial overstretch" to explain why great powers topple. Rome could be the paradigm. Defending the borders of its giant empire and keeping the peace within required a giant military budget. As modern Americans know—after all, "their story is our story"—it was a difficult budget to cut, because the provinces were loathe to lose the protection and the economic benefits that came from a local army post.

Meanwhile, tax evasion became such an art form among the rich that farmers and peasants, particularly in Italy, were bled white to maintain the revenue flow. And because the whole empire was a free-trade zone, the provinces gradually learned to do their business with one another, leaving Rome and its middlemen out of the picture. In short, an increasingly expensive empire was returning smaller and smaller dividends to the capital.

While these problems spread within, a great historic process was beginning outside the imperial walls: the mass migrations from central Asia into Europe. At first Rome dismissed the Visigoths, the Ostrogoths, the Huns, etc., as barbarian rabble. By the fifth century the barbarians were knocking down the walls. Attila the Hun sacked much of Italy and Gaul; his troops were within a day's march of Rome when he died of exertion on one of his many "wedding" nights. You couldn't say that mighty Rome was brought down by vandals, but an important role was played by the Vandals, a Germanic tribe that overran Spain and northern Africa in the fifth century and thus cut off the grain supply to Italy.

DAILY NEEDS

A straightforward scene of a woman giving birth (below) appears on what is likely the tomb of a midwife from Ostia. The most vivid clues to the everyday life in the empire come from the cities buried by Vesuvius. The ash preserved paintings, graffiti, furniture, utensils, and, from a Herculaneum bakery (right), a carbonized loaf of bread.

MUSEO ARCHEOLOGICO DI OSTIA

THE ROME of the republican era or the early empire could surely have fought back. By the late empire, however, the people had lost their will. The descendants of a people who had conquered the world now gathered at the Forum screaming for *"panem et circenses!"*—bread and circuses!

The emperors obliged. In republican times

the government had staged gladiatorial games three or four weeks a year. By the second century these bloody circuses went on for months at a time. Emperor Trajan's greatest games, continuing for 123 straight days, offered the spectacle of 5,000 humans and 11,000 animals murdered in cold blood. The crowds screamed for more.

Matching this mode of wretched excess, the streets were filled with those huge and menacing marble figures that the Italian museums today designate as *statua colossale*. The great statue of Nero in the Forum was 20 times human size, the height of a 13-story building.

When they indulged these colossal appetites, the people of Rome were merely following their leaders. Over the centuries the imperial throne passed into some of the vilest hands in history—a process that began as soon as the first emperor died. Of the first ten emperors to follow Augustus, eight lost the job through violence.

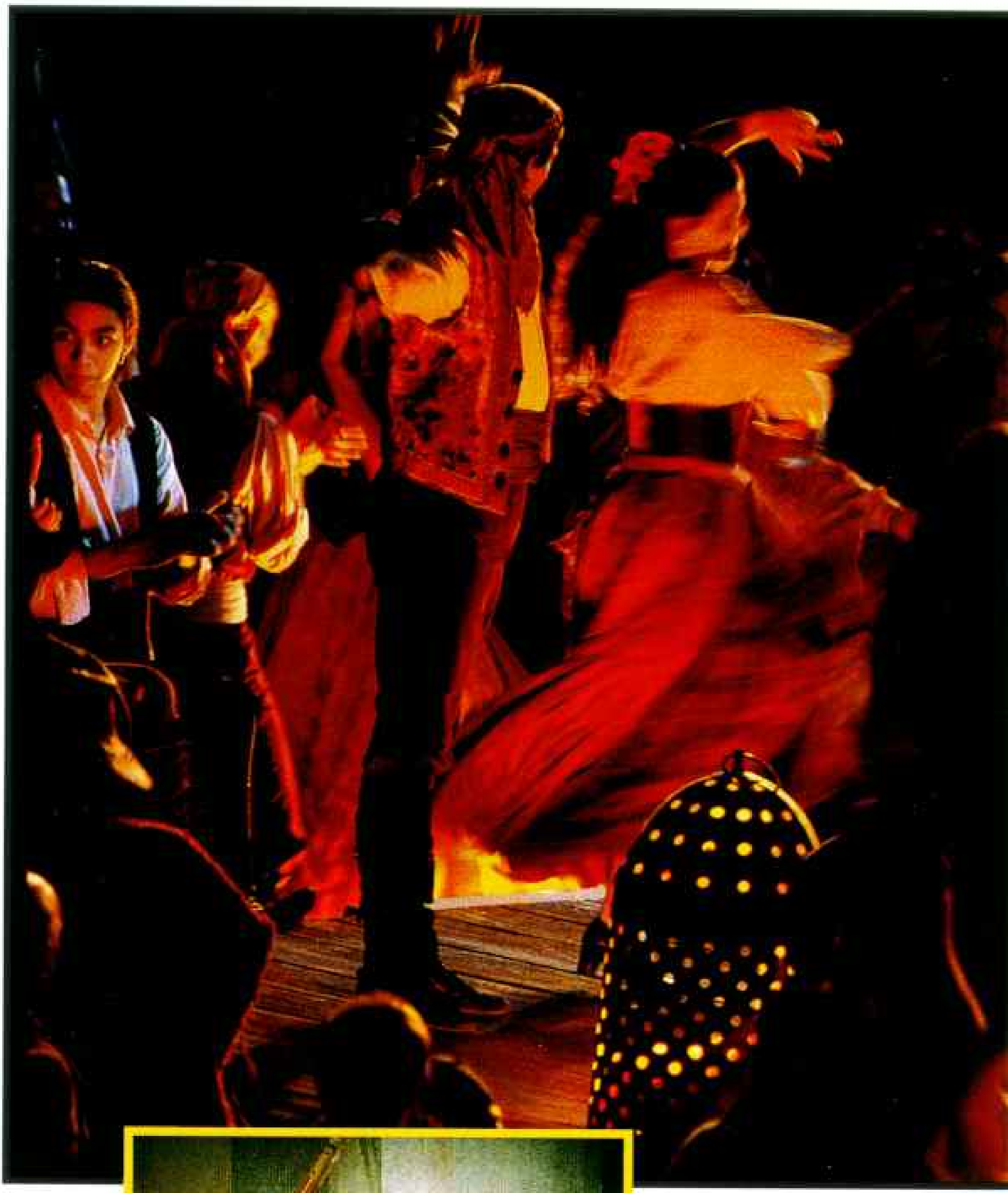
Some emperors were so deranged that they are remembered to this day. There was Caligula (A.D. 37-41), who murdered his brother (among countless others) but loved animals so much he named his horse, Incitatus, to be consul—roughly the equivalent of Bill Clinton's nominating Socks to the Supreme Court.

Then there was Elagabalus (218-222), who started dressing in drag shortly after assuming office and liked it so much he ordered the senate to declare him "Empress of Rome."

Another ruler, Commodus (177-192), son of the great Marcus Aurelius, fancied himself a gladiator. He took the precaution of arming his opponents with swords made of soft lead, so that the tips bent when a blow struck the emperor. Not surprisingly Commodus racked up a long winning record in the arena. His luck turned sour one New Year's Eve, when he was strangled to death by a wrestler sent by conspirators.

Commodus's successor, Pertinax (193), was to reign all of 86 days before he was assassinated. At this point the army auctioned off the post of emperor to the highest bidder, one Didius Julianus (193), who was himself beheaded after two months.

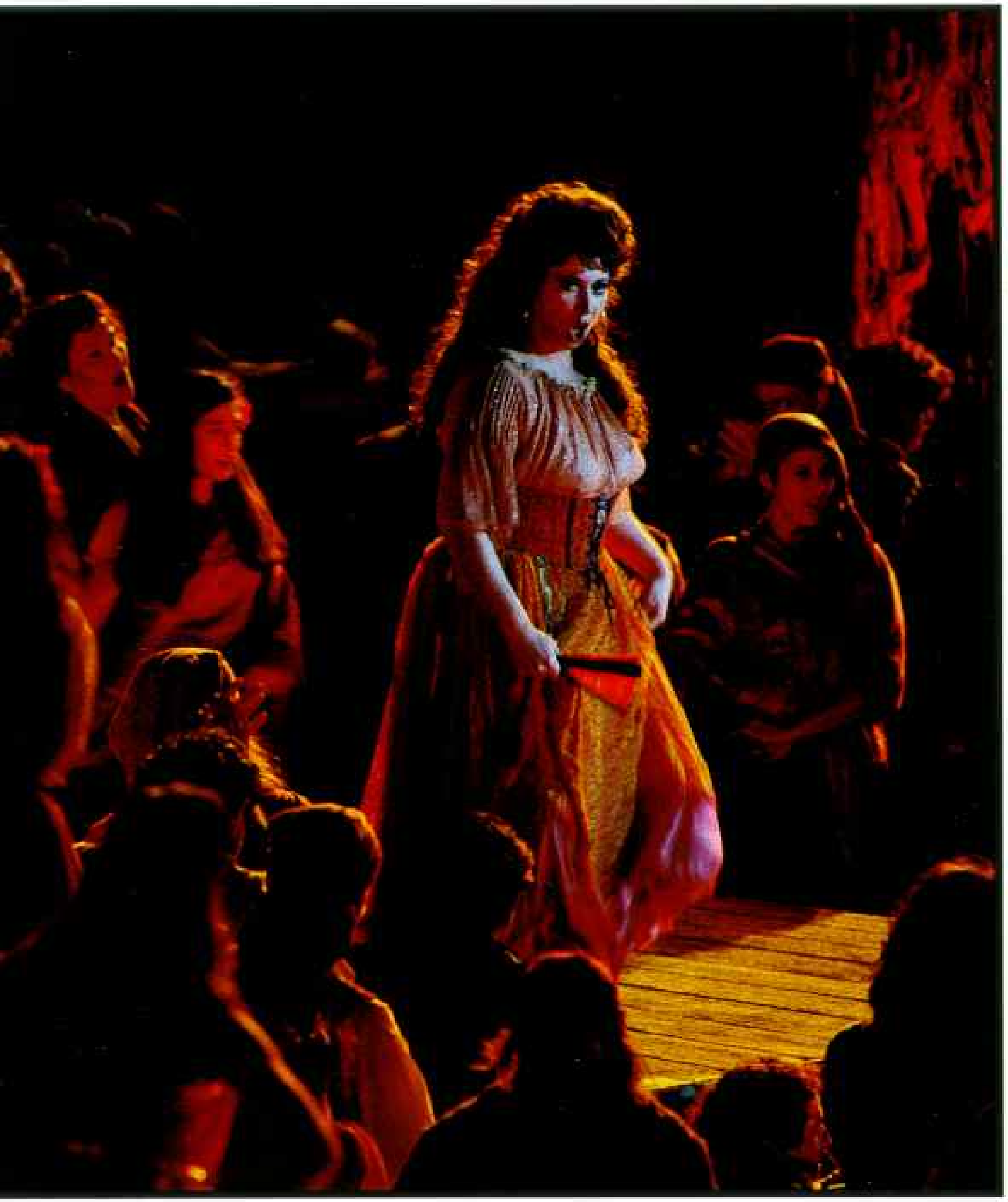
No roster of bad emperors would be complete without the infamous Nero (54-68). He was a thoroughly evil man. Fairness requires the observation, though, that recent revisionist history has acquitted Nero of some of the best known charges against him. I discovered this while touring the Roman Forum with Ida Sciortino, an archaeologist with the Ministry of Cultural Heritage. As we walked past the site where his mammoth statue had stood, I made a crack about Nero.



MUSEI CAPITOLINI

STAGECRAFT

The passionate song and dance that erupt in Bizet's opera Carmen, *performed in a nearly 2,000-year-old amphitheater in Verona, Italy, would have made a spectacle-loving*



Roman audience feel at home. In the early days of the empire, Greek drama enjoyed wide popularity, symbolized by the masks of tragedy and comedy on a second century A.D. mosaic (left). But increasingly Romans turned to the broader styles of farce and pantomime. Theaters grew larger and less intimate, and as a result dialogue gave way to short bursts of song. Soloists became the new stars. Sensationalism also sold, with nudity and live acts of violence steaming up the stage.

Sciortino rounded on me with fire in her eyes. "Now, don't go believing everything you read about Nero," she insisted. "Please remember, a lot of that stuff was written by his political opponents.

"Yes, there was a nine-day fire in Rome in A.D. 64—but Nero was *not* fiddling while Rome burned. He realized that nobody could save the old wooden tenements near the Tiber from such an intense blaze. So he spent that time writing a stronger fire code and designing a new city. He started reconstruction one day after the fires were out."

Even Sciortino had to concede, though, that Nero earned his woeful reputation in other ways. To guarantee an audience at his wretched lyre recitals, it is said that he locked the audience in the theater, with no exit for any reason; some women gave birth in mid-performance while the emperor plucked away, unperturbed.

Moderate when young, he matured into a mass murderer. He killed various relatives, including his brother, his pregnant wife, and his wily mother, whom he attempted to assassinate five times and finally executed. He sent countless Christian martyrs to gruesome deaths in the arena.

In an empire where human life was held so trivial, we should perhaps not be surprised by the rapid growth of a new religious cult centering on a young man executed as a criminal in an unimportant province. When Jesus of Nazareth and a minor procurator named Pontius Pilate came face-to-face in the basilica of Jerusalem—it was around A.D. 30—all the power lay on Pilate's side. But Jesus had the power of an idea. His message, that every life was precious, addressed a human need that the caesars could not fill.

Assisted greatly by the ease of travel and the general tolerance of new religions within the empire, the early Christians gradually converted the entire Roman world.

The historian Eusebius tells of the civil war of A.D. 312, when two Roman leaders, Constantine and Maxentius, battled for control of the empire. Gazing up into the noonday sky, Constantine saw a brilliant flaming cross above the sun. Emblazoned on it were the words *"In hoc signo vinces"*—In this sign you will conquer. (In a later manifestation that famous phrase adorned the label of Pall Mall cigarettes.)

Emerging victorious, Constantine issued his famous edict of toleration. Much later, as he lay on his deathbed, he was baptized, becoming the first Christian emperor of Rome.

Constantine eventually moved his throne eastward to his lavish new capital, Constantinople. A sub-emperor remained in Rome for another century or so, but by now the power was shifting. It was the Christian church and its Roman bishop, the pope, that would come to dominate the Western world.

And as the Roman Empire sank into ashes, Jesus' church would preserve a great deal of the splendid legacy of Rome—the language, law, literature, architecture, and engineering—for the rest of history. But that's another story—a story we will tell next month. □

BLOOD SPORT

"Death is the fighters' only exit," the philosopher Seneca wrote, having watched in dismay the violent entertainments offered for free at the Colosseum in Rome. Crowds of 45,000 packed the amphitheater to watch gladiators in hand-to-hand combat. A mosaic (top) shows the variety of their weapons and costumes. A 24-million-dollar renovation is intended to save the decaying arena, its design and drama having echoed all across this vast, swaggering empire.

SOPRINTENDENZA ARCHEOLOGICA DI ROMA (BELOW); GALLERIA BORGHESE, ROME

Sumo

Iron flowers of Japanese manhood, sumo wrestlers are living icons—heroes of a national sport framed by religious symbolism. Once supported by the patronage of emperors, sumo has roots going back nearly 1,500 years. Before an exhibition tournament in Niigata, competitors trussed in ceremonial aprons enter the arena in the stately and ritualized *dohyo-iri* procession.

BY T. R. REID

PHOTOGRAPHS BY ROBB KENDRICK

BANZAI! The initial clash brings combatants flying toward a thunderous embrace. The object: Topple your opponent or knock him out of the *dohyo,* or ring. Each may grab and pull his opponent's *mawashi* belt, but not the strap girding the groin. Short but intense, most matches last less than a minute. The grandly attired *gyoji* is more than a referee; if wrestlers lock into weary stalemate, he barks encouragement.

ON THE FIRST DAY, The Dawn came up like thunder and sent Koto of Beppu flying wildly from the ring. It was one of those muggy, miserable days you can still encounter in Tokyo even into mid-September. Inside the sweltering sports temple known as the Hall of National Skill, sweat was running in rivers down The Dawn's massive chest and across his enormous belly. But if the discomfort bothered him, you sure couldn't tell it from the way he breezed to victory that day.

It was the first day of the Japan Sumo Association's Autumn Tournament, and Japanese sportswriters noted afterward that it was an unsurprising day of sumo. Nearly all the favorites had won, including the giant who wrestles under the name Akebono, or The Dawn. After all, The Dawn held the sport's highest rank. For him to beat a lower ranking contender like Koto of Beppu was entirely ordinary.

And yet, watching that match from my perch high up in the cheap seats, I couldn't help but feel that something extraordinary had happened. In fact, I get that feeling every time I see Akebono step into the round clay sumo ring. For this fellow is not some ordinary Japanese sumo wrestler, bred to the ancient sport since birth. Rather, Akebono is an American-born former basketball player named Chad George Rowan.

Chad was "discovered" in his hometown of Honolulu in 1987 by a local sumo supporter; intrigued, the lanky American teenager signed on at a sumo training camp, or stable, in Tokyo. Overcoming injury, the language barrier, the culture barrier, and the not so thinly veiled xenophobia of the Sumo Association's governing board, Chad worked his way up to the very summit of the sport. By 1993, when he was 23, Akebono weighed 466 pounds and was so powerful in the ring that no Japanese wrestler could match him. Somewhat reluctantly, the Sumo Association promoted him to its supreme rank: *yokozuna*, or grand champion. He is the only non-Japanese person to achieve that exalted status in the entire history of sumo wrestling.

And that takes in a lot of history, because sumo is one of the oldest organized sports on earth. Bouts were taking place in the seventh century A.D., and an ancient tale reports that the Emperor Seiwa earned his place on the Chrysanthemum Throne by means of a titanic sumo bout in A.D. 858. The imperial court sponsored sumo matches to ensure good harvests, and by the 16th century wrestlers toured the country. The organizational structure of modern sumo began to fall into place in the 1680s, and the basic elements have remained largely unchanged since then.

Exalted by a Shinto shrine replica hung above the dohyo, Tokyo's Kokugikan, or Hall of National Skill, draws zealous fans to a championship. Some sit rapt for ten hours straight. Poised for entry, a *rikishi*, or wrestler, awaits his call (facing page). Falls are cushioned by body fat and topknot, a fashion dating from the 1600s.

Practice. Eat. Sleep. Repeat daily to build a contender. At Tokyo's Izutsu Beya, a sumo stable, apprentices train from 5 to 11 a.m., then have breakfast (above). After a nap, television entertains until they eat dinner and retire. Gorging then sleeping promotes weight gain. Though lighter wrestlers outmaneuver heavier foes, mass plus agility almost always wins.

The heart of each sumo bout is a wrestling match, but these bruising clashes of rotund men wearing long silk loincloths are surrounded by so much color, pageantry, and ritual splendor that the sport of the thing often gets lost amid the spectacle.

This, too, is a function of history, for sumo began in part as a rite of Japan's indigenous Shinto religion. To this day there remains a significant religious overlay to every match. The ring itself is a sacred place, with the graceful sloping roof of a Shinto shrine replica suspended above it; that's why wrestlers must throw a handful of purifying salt before them every time they step onto the hallowed clay.

The heaviest ritualistic obligations are assigned to the few wrestlers who make it to the top rank; a grand champion becomes, ex officio, an acolyte of the Shinto faith. That has always meant added pressure for Akebono, since there are many in Japan who fear an American import cannot fill this unique role in Japanese society.

T. R. Reid is a foreign correspondent for the *Washington Post* and its former Tokyo bureau chief. He wrote and narrated a film on sumo for National Geographic EXPLORER, which airs on TBS. Photographer Robb Kendrick, who was on his junior high school wrestling team, lives in the Texas Hill Country. This is his sixth article for the magazine.

For all the mystery surrounding the sport, the rules are simple. Two wrestlers face off inside a ring 15 feet in diameter. The winner is the first to knock the other guy down or out of the ring. Slapping, pushing, tripping, and judo-style flips are all allowed; punching with a fist is not. There is no weight limit, which is why many sumo wrestlers spend years striving to make themselves seriously fat. The average weight for the top-level wrestlers is 350 pounds.

The Sumo Association runs six major tournaments each year. Each one is a 15-day round-robin, with each wrestler facing a different opponent every day. The man who emerges with the best overall record wins the championship. The tournament champ and other top performers earn prize money and promotions within the carefully structured ranking system. In recent years Akebono has been earning more than one million dollars annually.

It takes enormous mental strength to maintain a winning edge for a whole tournament. "Your toughest opponent in sumo is always yourself," the great young wrestler Takanohana (The Noble Flower) told me. "Making yourself stand up to that daily pressure for 15 straight days is the hardest thing in the sport."

Takanohana should know, for he earned the top rank, grand champion, at the age of 22. For the past two years the competition between the two current grand champions, Takanohana and Akebono, has been the dominant rivalry of the sumo world. Their head-to-head match, always the last bout of the last day of the round-robin, is the most anticipated event of each tournament.

ON THE SECOND DAY of the Autumn Tournament the heat gave way to dismal rainfall. In the ring The Dawn turned cold as well. A tough young wrestler named Musoyama, or Two Battling Mountains, jumped nimbly away from Akebono's initial charge, then sent the grand champion sprawling to the turf with a powerful shove in the back.

ROBB KENDRICK, AURORA

First foreigner to make grand champion, Hawaii-born, 485-pound Akebono (top) is sponged off by a novice, who also runs errands and does laundry. Top-level sumo wrestlers average 350 pounds. The heaviest rikishi ever tops 600.

His ear scarred from wrestling, Shoeito (above) powers up with curls.

To us die-hard Akebono fans in the audience, this loss was an unpleasant, but not devastating, development. Chad's approach to the 15-day tournament regimen is now familiar. He tends to lose a match to a lower ranking fighter early in each tournament, and this seems to gird him to fight harder thereafter. He aims to enter the final day's match with a record of 13-1 and then summon his last reserve of will to beat Takanohana in the clash of the champions.

On the third day, sure enough, The Dawn was dominant. He launched a furious slapping and pushing attack; his hapless opponent never had a chance. It was clear now that Akebono was back in winning form, and he continued to win in smashing fashion for the next six days, drawing rousing cheers from the capacity crowds.

Sumo always draws a sellout crowd. In a nation that loves sports, its popularity is challenged only by baseball's. Tournament tickets are usually snapped up on the first day of sale. But those who fail to line up early enough aren't completely out of luck, because every match is televised live nationwide.

Hard-learned lessons in how to fall jar the bones at Tokyo's Musashigawa Beya. Endless repetitions and ruthless hazing build mental and physical stamina. With an arsenal of 70 maneuvers, a rikishi may shove, slap, even trip his foe, but never kick or strike with a closed fist.

The sheer excitement of tight matches and the colorful hoopla surrounding each day's bouts help account for sumo's popularity, of course, but I think there's a further explanation as well. The sport-cum-ritual of sumo is dear to the Japanese because it reflects, in microcosm, many of the values that Japan holds dear.

Japanese society places enormous importance on rank and hierarchy—and the world of sumo does the same. At any given time there are about 900 active wrestlers in professional sumo, and every one is assigned a specific numerical standing within the complex tiers of rank. Anyone who has done business with the Japanese knows how they tend to use titles instead of names in the office: "I sent the assistant director's proposal to the section chief." In sumo as well, an athlete's rank is as important as his name. "What a fabulous bout!" the national TV announcer shouted at one point during that Autumn Tournament. "The ninth-level new entrant has the second-class sub-champion in a dangerous spot!"

Japan is a nation that cherishes rules and respects authority, and


RALPH LAU

Solid, stolid, and adored, Asanowaka lumbers past admirers in Niigata. In counterpoint to their slightly built fellow countrymen, rikishi are fat, but—with their intense exertions—not necessarily unhealthy, and to many Japanese women they are most definitely not unattractive. At retirement, usually around age 30, some open their own training stables. Others slim down and embark on second careers.

in sumo, too, this tradition is ironclad. No matter how close the match or how dubious the referee's decision, nobody in the stadium—not even the fans!—utters a complaint about the officials. The wrestlers, with their 17th-century samurai-style hairdos, are expected to show samurai-style stoicism as well. No winner ever gloats in sumo, and no loser ever gripes (at least, not in public). When a match ends, the wrestlers bow respectfully to each other and step silently down from the ring. The whole ethos is carefully designed to preserve the transcendent Japanese social values of harmony, civility, and avoidance of confrontation.

Over the past half century, as Japan has become a global economic superpower, the nation has embraced an important new value known as *kokusaika*, or internationalization. It has not always been easy for an insular, homogeneous society to open its arms to the world, and the sport of sumo has been struggling with the problem along with everyone else.

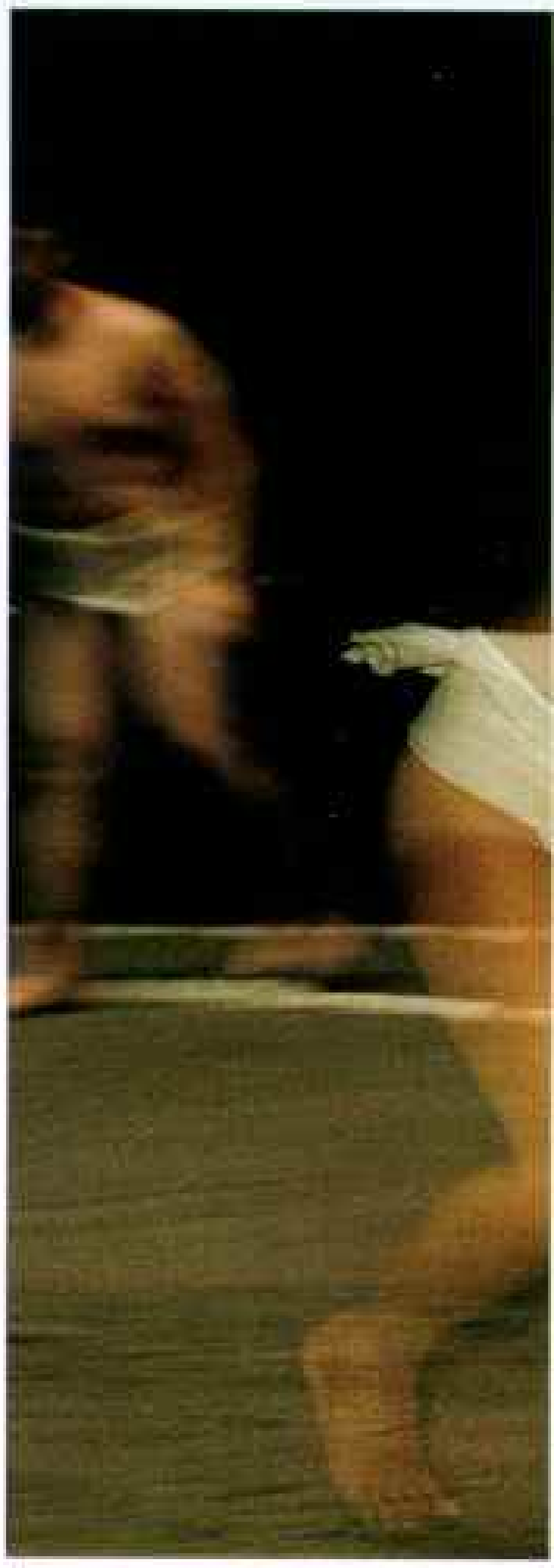
Sumo's era of kokusaika began in the 1960s, when a huge Hawaiian named Jesse Kuhaulua—known in the ring as Takamiyama, The View From a Lofty Mountain—became the first non-Asian to break into the major leagues of sumo. He made it to one of the highest ranks, and his cheery warmth and clear dedication to the sport made him a fan favorite right up to his retirement in 1984. Still, the Sumo Association required that he become a Japanese citizen before he was permitted to open his own training stable.

In Jesse's massive wake a trickle of other Americans entered the sport. By the early 1990s a few had emerged as top-notch wrestlers and clear contenders for the top rank, grand champion.

One was Salevaa Atisanoe, the Hawaiian leviathan who wrestles as Konishiki, or Delicate Embroidery—a stunningly inapt name, since Konishiki is the fattest wrestler in sumo history. A shimmering mountain of muscle and flesh, Delicate Embroidery hovers between 600 and 625 pounds, depending on what he's had for breakfast. On sheer brute force Konishiki won enough bouts in the late eighties to reach the level of *ozeki*, just one step below the supreme rank. But sumo officials showed strong resistance to promoting this outsider to the pinnacle of the sport. When Konishiki took the thoroughly American path of speaking out about his situation in public—"If I were Japanese, I'd be a grand champion now," he told the press—this breach of sumo's collective harmony was so shocking that it marked the end of his advancement. He remains a fan favorite, but is wrestling today in the middle ranks.

Akebono approached sumo's top level about two years after Konishiki and clearly learned from his predecessor's experience. He was diligent, humble, and respectful. "You take things as you find them," he told me a few years back, "and I've found you have to kiss some butt to get ahead in this business."

Benefitting from his pious demeanor, his overpowering success in the ring, and some fortunate timing—three aging champions all retired in a burst, and the elders had to promote somebody—Akebono became the first foreign grand champion. A yokozuna from America! That was front-page news in virtually every Japanese paper, proof that kokusaika—internationalization—had penetrated even the halls of sumo.



Willowy sapling meets hulking oak at a sumo club in Nagano. The master instructs in jabbing the palms under an opponent's armpits. A novice will typically enter the almost feudalistic world of the sumo stable at age 15. Boyish hands may grow to adorn a *tegata* (right), a champion's autographed print that sells for as much as $8,000.

ON THE TENTH DAY, a bright, crisp autumn afternoon, Akebono got wrapped up in a long struggle against a mid-level wrestler named Asahiyutaka—Bounteous Morning Sun. With their fiercely muscled arms wrapped around each other's bounteous bellies, the two carried on an elephantine pas de deux that lasted more than a minute—a long match by sumo standards. Finally Akebono got his opponent backed up against the edge of the ring. Bounteous Morning Sun went crashing backward out of the ring, with Akebono's bulk smashing down on top of him.

The referee waved his lacquered fan toward the west—indicating a victory for Akebono. I was just about to unleash an uproarious cheer when I noticed five big men, each wearing the formal black kimono favored by imperial Japanese courtiers around A.D. 1000, stepping up to the ring.

These were the official judges—former sumo greats who sit at ringside to ratify the referee's decision in every match. On occasion, after a close match, they gather in the ring to review the result, a procedure known as *mono-ii*, or talking it over. A long, evidently heated mono-ii ensued, and then a decision was announced: Some judges thought that Akebono had stepped out of the ring before Bounteous Morning Sun went flying out. Since the result was in dispute, the two wrestlers were to fight an immediate rematch.

The audience (except for me) took this in stride. But I noticed that Akebono seemed to be almost rigid with anger. He fixed a baleful stare at the chief judge; indeed, Chad was so distracted by his inner rage that he barely put up a fight in this second bout. He was flipped onto his back in a matter of seconds. The next morning's edition of *Sankei Sports* showed why Akebono had been so furious. The front page was given over to a massive color photo. It clearly showed that Akebono had been well inside the ring when he pushed Bounteous Morning Sun out in their first matchup. "Akebono Wins!" the headline screamed, in bold red characters. "But They Score It as a Loss!"

For the next four days the weather freshened as the front wave of an approaching typhoon sent cool winds and occasional rain to Tokyo. But in the Hall of National Skill there was nothing fresh about Akebono. In his bouts each day he barely went through the motions; he racked up two more losses.

It was further evidence of something Akebono often said: In sumo, mind is far more powerful than muscle.

"People see these big fat guys tossing each other around the ring, and it's hard to understand that this is a mental sport," Chad told me once. "But the mental side, the spiritual side, is a lot more important than the body. If you can't get yourself in the right frame of mind intellectually, you can't win."

My own mental state was one of confusion. Was it just a coincidence that this bad call had gone against the wrestler from America? If it had been, say, Takanohana or some other Japanese star who had gotten the nod from the referee, would the judges have even bothered to talk it over?

Or was I being paranoid? It had been a close bout. The judges didn't have as clear a view as that photographer. Perhaps a rematch would have been required no matter who had been wrestling.

Toil and sweat done, an apprentice meditates before a Shinto shrine. It sits on a mound he formed from sand spread earlier to allow wrestlers' feet to slide. The ring was then purified with salt. After that ritual it is not to be trod upon until practice

resumes the following morning, though the young wrestler unthinkingly entered to pay his respects. Such regard is emblematic of sumo's stature as *kokugi*, the "national sport" of Japan.

ON THE LAST DAY of the Autumn Tournament, Typhoon No. 17 came barreling up the east coast of Japan and smashed directly into Tokyo with torrential rain and brutal winds. Inside the sumo hall Takanohana came on like a force of nature in his own right. In the battle of the grand champions, Akebono put up token resistance at best. Takanohana downed him easily.

At the elaborate awards ceremony that followed, a navy band played Japan's national anthem and Handel's "Hail, the Conquering Hero" as Takanohana received the wealth of awards given to every tournament winner: two tons of rice, a ton of chestnuts, grapes, and pears, four tons of onions, a year's supply of sake, a new RV from Isuzu. Akebono, playing his stoic samurai role to the hilt, left the arena without a single word for the waiting reporters.

There would be another tournament in six weeks, after all. In the meantime Chad could put on a little more weight, practice his technique, and spend a lot of time just contemplating the wonders of sumo, a sport that packs into the confines of a 15-foot clay ring all the best—and some of the worst—of Japanese society. □

Ash spewing from Soufriere Hills doesn't deter Ian Osborne from a swim at his family's hotel in Old Towne. For two years eruptions have bedeviled this tiny Caribbean island, yet residents are determined to keep their idyllic life afloat.

UNDER THE VOLCANO

Montserrat

By A.R. WILLIAMS NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by VINCENT J. MUSI

GERARD DYER was harvesting his crops, a normal enough pursuit on a cloudless April morning on Montserrat. Half a mile above him, however, at the top of a peak buttressed by forested ridges, steam curled from fissures in a dome of gray rock. Gerard stopped to shake my hand, then turned right back to his work. Moving from patch to patch on ten sloping acres, he hoed sweet potatoes from long mounds of earth, pulled up carrots, picked parsley and tarragon. Satisfied that he'd taken enough, he loaded the produce into a battered pickup truck parked by the dirt track that led to the main road—our only escape from Soufriere Hills volcano.

On Montserrat these days there's no telling when a quick exit might be needed. In July 1995, the year before I met Gerard, Soufriere Hills awoke after almost four centuries, throwing skyward a superheated cloud of ash, steam, and rocks in the first of a series of eruptions that would turn the lives of Montserratians upside down.

"I was right here the first time it blow," Gerard recalled. "The rock come falling down, but we weren't scared. We just stay here and watch the ash drift." He gestured toward half a dozen

Hot clouds of gas, ash, and rock that race down the sides of the volcano at nearly a hundred miles an hour have turned the Tar River Valley into a wasteland. The area was still tropically lush when Joe Devine, a geologist from Brown University, risked a visit to collect rock samples in April 1996 (above). "I didn't waste any time there," he says. "It was get in, get out, and thank your lucky stars."

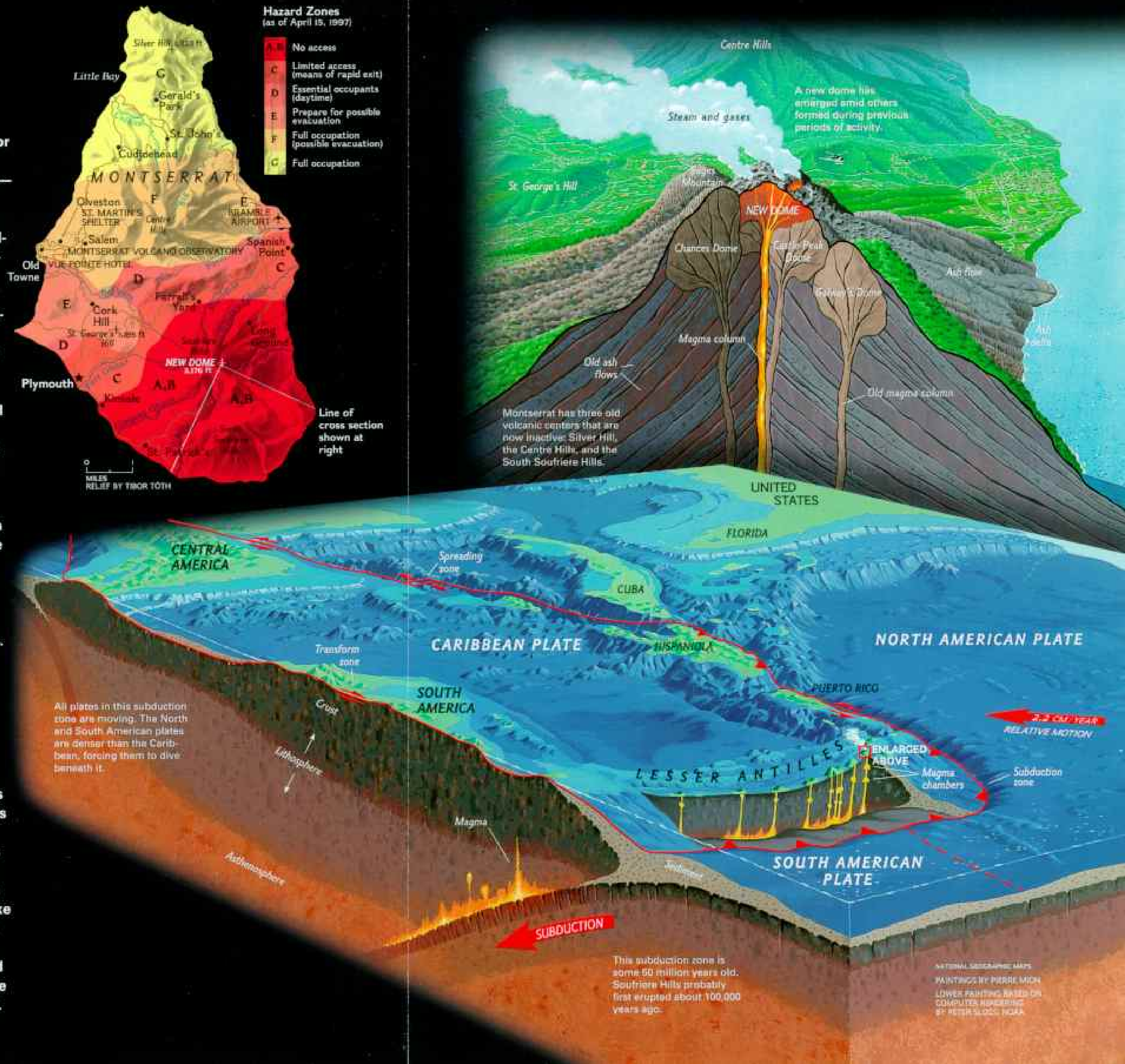
The Making of a Menace

There's not much room to run on an island too small for even one traffic light, but about 5,000 Montserratians—nearly half the population—have been evacuated to the northern hills from villages surrounding the smoldering crater.

In 1632 the first settlers saw emerald slopes reminiscent of Ireland, home to many of them, though Soufriere Hills had recently erupted. The volcano remained relatively silent until reawakening in July 1995.

Under Montserrat lies the tectonic engine that drives the volcano: a subduction zone where the North and South American plates push beneath the Caribbean plate and form the islands of the Lesser Antilles. Rock at the edge of the subducting plates melts into magma, which then rises in columns. "It accumulates at depth and then blips its way up, sort of like a lava lamp," explains Geoff Wadge, a geologist at England's University of Reading.

Between blips a volcano can sit quietly for thousands of years. As the magma rises to the surface, it forms a dome. More magma pushes against the dome, creating rockslides that expose fresh magma in a flash. "That's like pulling the cork from champagne," says Joe Devine. Gases in the magma expand rapidly and can fragment the magma in violent outbursts.



Downwind of the action, Plymouth—the capital—and its suburbs receive much of the airborne ash. "This area has been overridden by such deposits many times in the past," says Geoff Wadge. "It's really an unsafe place to have a city."

other farmers bending over fields that checkered the mountainside. An abandoned stone sugar mill recalled an industry nourished by the rich volcanic soil in the 17th and 18th centuries. Farming, largely a subsistence activity today, has always been concentrated in southern Montserrat, which receives up to 80 inches of rain a year.

Soufriere Hills has taken no lives so far, but its eruptions in the past two years have forced three evacuations of thousands of people from the south to community centers, churches, and schools in the sparsely populated northern hills. Families there have taken in relatives and friends, filling bedrooms to overflowing; foreign property owners have rented their vacation villas to locals who can afford the double burden of rent and mortgage payments on their own houses.

The story of Montserratians and the volcano is a stern example of how humans, whose framework of reality spans mere decades, can be undone by forces of nature that play out over centuries, even millennia. Montserratians have no idea exactly what Soufriere Hills will do next. All they know is that suddenly, without warning, the rhythm of a life that seemed predictable was broken.

The volcano has been reasonably quiet in recent months. But with no guarantee that it will remain so, evacuees are prohibited from occupying their homes and businesses in the south, designated as the unsafe zone. Some 4,000 Montserratians—one-third of the population—have abandoned their erstwhile paradise, most emigrating to other Caribbean islands. Others have gone to Britain, which still holds the 39-square-mile island as a dependent territory.

Who can blame them? No sooner had the island recovered from the devastation caused by Hurricane Hugo in 1989 than the volcano struck. Hotels and restaurants closed down. Cruise ships skirted the island. A medical school that takes in students from the U.S. moved to St. Maarten. Unemployment rose from 7 to 50 percent.

Making a difficult situation worse, Plymouth, the capital and only place of any size, with a pre-eruption population of 4,000,

became a ghost town: it lies well within the unsafe zone, three miles west of the volcano.

"The lifeblood of the country was there," said Midge Kocen, who helps run Montserrat's media center. "All the government offices and utilities, most of the shops and petrol stations, the post office, the cinema, the public market. Explaining all this to you makes me realize how much we've had to adapt."

Montserratians are a people under siege, yet they're going about their disrupted lives with equanimity and determination. "We won't give up so easy. We'll carry on till we can come back to Plymouth," said Nigel Osborne, who manages his family's supermarket in temporary quarters in Old Towne.

No less tenacious are Gerard Dyer and his wife, Judith. They've been staying with friends in St. John's, about as far north of the volcano as you can get. During my visits, when the mountain was judged quiet enough, people could get passes to visit the unsafe zone, which is how Gerard came to be working on the flanks of Soufriere Hills that bright morning.

"If you have animals and crops, you can't just leave them," said Gerard as we walked back to his truck. "You have to come look after them and hope nothing happen." As he spoke, the volcano made a crackling sound like distant thunder—blocks of solid lava rolling down the side of the dome. Gerard didn't even look up.

Montserratians have become so used to the volcano's huffing and puffing that the initial terror has gone. As one woman said, "At first when there was an ashfall, everybody run. Now when the ash falls, everybody look."

Later I visited Judith, who was selling her husband's produce from a wooden shack about a mile inside the safe zone, where the road turns toward the villages that spill down a series of valleys on the northwest coast. On either side of us were tall palms, mango trees, and blossoming oleander bushes.

Drivers stopped to buy a hand of bananas, a few cucumbers, a bag of succulent green squash called christophines, all displayed on wooden shelves and brightly colored plastic crates. Near Judith's stand a woman dished up *pelau*, a stew of chicken, rice, and pigeon peas, from a pot on the tailgate of her station wagon. On the other side of the road appliances were for sale in a makeshift store fashioned from metal-sided shipping containers and plywood. A house behind a hedge had become a branch of Barclays Bank.

Judith said that as long as Gerard can plant and harvest his crops, the Dyers will get by. But there's always worry. "We're afraid they'll stop giving passes for us to get to our fields. I don't know what we'd do then," she said.

I heard similar concerns often during two visits to Montserrat. Every time the volcano erupts, people talk of the fear, but the uncertainty of living under constant threat of an eruption is somehow worse, weighing on them day after day. "No one knows what the end is going to be," a former chief minister told me. "It's a sudden change from what was a very comfortable life."

IT ALL BEGAN with Soufriere Hills spewing out occasional gray clouds of ash and steam. Soon after, the earth shook and mudflows raced down ravines. Then pyroclastic flows rolled down the eastern side of the mountain, turning a tree-shaded valley into a moonscape. Dense ashfall turned day into night. As the eruptions continue, Montserratian optimism has been tempered with hard reality, as people have come to realize that they won't be returning home soon.

"If you'd told us two years ago that the volcano would behave like this, we'd have laughed," said Cedric Osborne, Nigel's uncle, who owns the Vue Pointe Hotel, the only one on Montserrat that's still open.

Minutes before midnight on September 17, 1996, the volcano ratcheted up the action. Part of the dome collapsed, and rocks shot sideways out of the crater. Charged ash particles sparked lightning, thunder boomed, and for the first time pebbles pounded the southern end of the safe zone.

Terrified, people in villages in the line of fire, such as Cork Hill and Salem, ran barefoot from their beds to their cars to escape the volcanic hail. The noise of the eruption carried. "I was up reading and heard what I thought was an airplane," said Colin Riley, who lives on the northern coast near Cudjoehead. "In 15 minutes there was a stream of cars passing by here. They pulled over and lined the roads all night."

"It sounded like a war," recalled a man whose car windshield was smashed by the

VINCENT J. MUSI photographed "Simple Gifts of the Shenandoah" for the December 1996 issue.

Pillows of ash smother Plymouth, long since evacuated, after a big blast in September 1996. That same eruption pelted Nat Davis's empty house in St. Patrick's with pieces of pumice the size of marbles. After staying in a shelter to the north, Davis goes home to pack for a move to London. Many others have also left the island, but most plan to return once the volcano again falls silent.

debris. "It could have been artillery shells falling around the house."

The outburst lasted no more than an hour. A few houses in evacuated areas close to the crater were set ablaze by hot rocks, but no one was injured. Montserratians, however, were shaken.

"I'm never turning my back on that volcano again," said Gertrude Shotte, a teacher, when we met at the Vue Pointe Hotel a week later. "I was one of the ones who spent the night in a car by the side of the road after those stones started to fall. We're getting the idea that this thing really can blow and affect us all."

ON A SCALE OF ONE TO TEN, where ten is equivalent to the Mount St. Helens blowout in 1980, the Soufriere Hills explosion last September didn't even reach one. Steven Sparks, a British geologist from Bristol University—one of an international team of scientists working out of the Montserrat Volcano Observatory (a rented house in Old Towne)—doesn't think the volcano will ever escalate to a ten. "Traffic accidents are a good analogy," he said. "A ten-car pileup somewhere in the United States in a year is inevitable. A hundred cars, possible. A thousand, probably not. It's the same thing here."

Most likely the volcano will go on throwing out ash and stones for years without making the island uninhabitable. Acting on this expectation, the government began the task of shifting human activity out of danger. Public services, roads, and utilities, all centered around Plymouth, are being established in the north, with the help of 37 million pounds (59 million U.S. dollars) from Britain.

"The north of the island has not been affected by a volcano in two million years, so we've based all our contingency plans on that," Frank Savage, Britain's governor of Montserrat, told me one afternoon over tea.

The hospital was an immediate priority, and the staff moved key equipment from Plymouth to a school in St. John's, where classrooms were converted into wards. The phone company moved nearby, building a compound of trailers on a tidy lawn. To provide electricity, two generators housed in trailers by the cricket pitch in Salem started up in mid-1996. Construction crews assembled wooden houses on dirt lots cut into emerald hillsides, giving some people hope of moving out of shelters. Engineers drew up plans for a jetty in Little Bay; cliffs there offer protection for supply ships coming in—or Montserratians leaving in a hurry, if it should ever come to that.

A white lace of breakers in the far distance trims a delta formed by debris that often roils down the Tar River Valley to the sea. About a quarter of a square mile in area, this new land may not withstand the force of hurricanes.

Every day the scientists brief the governor, chief minister, and local officials about the status of the volcano. Decisions are then made about which areas are presumed safe enough to live in and which are too dangerous even to visit. The government aims always to have enough time to move everyone out of danger. "We have to have faith in the scientific advice and hope to God they've got it right," said Savage.

In the evening Montserratians gather around their radios and listen to the volcano report, a ritual I observed at a shelter in the St. Martin de Porres Roman Catholic church in Salem. People are aware of the danger of

another eruption, but frustration at having to live in limbo is building.

"I think what's going to happen is going to happen, and we should all go home," said an elderly man in a golf cap, who gave his name only as Mr. Syers. He was one of 80 or so people evacuated from St. Patrick's to the church shelter. "What are they going to do—keep us out for two years?"

Along with a dozen or so other evacuees, we were sitting on the church steps enjoying the cool breeze that blows in reliably at dusk. Reggae pulsed from a boom box on one woman's lap, and a mother nursed her baby. No one disagreed with what Mr. Syers said, but no one was eager to run afoul of the volcano either. "It isn't my wish, but the government says stay, so I stay," a man said.

Inside the church, rows of cots had replaced wooden pews in the nave; downstairs in the meeting room were more cots as well as stacks of bags and suitcases holding clothes and the few personal belongings the evacuees could squeeze in.

This is an uncomfortable way to live, but the people in St. Martin's, and wherever else I went, were nothing if not stoic. As Charles Daly, a taxi driver with time on his hands, said, "I don't believe in complaining. What's the use of that? You just make do."

At the shelter I got to know a man by the name of Nat Davis, who said he missed his old routine. Sixty-seven years old and retired from his job as a handyman for the government, Nat was the bell ringer for the Anglican church in St. Patrick's. "Six in the morning and six in the evening," he said proudly. "But there's no one left to ring it for now."

Nat said he had no good reason to stay on Montserrat, especially now. He was referring to

Britain's offer of a two-year residence permit, and public assistance if needed, to any islander who could afford the airfare. Nat already had his ticket and would join 900 other volcano refugees in Britain. He planned to live with his brother Patrick, who had moved to London decades earlier.

NAT TOLD ME he needed to make one last trip to his house in St. Patrick's, and I offered to drive him there. Just past Cork Hill we came to a police barricade in the middle of the road. I fished a neon green card from my bag. It said, DANGER. OFFICIAL PASS. HIGH RISK OF VOLCANIC ACTION; PERSONS ENTER AT THEIR OWN RISK. The officer waved us on, and we entered the unsafe zone in a swirl of ash.

Nat's place was a two-story lemon-colored stucco house commanding a clear view of the sea. Chunks of pumice speckled the lawn and orange-tiled roof. A neighbor's goats, let loose to fend for themselves, grazed peacefully nearby. Behind us rose a mountainside whose covering of trees, scorched by volcanic gases, had turned a deathly brown.

"We just finished building this," Nat said, leading me into a hallway tiled in gleaming gray. His three brothers—Patrick in London and two others in the U.S.—had all contributed money for what was intended to be a vacation and retirement property.

In silence Nat busied himself, placing a few clothes in plastic bags, scouring the teapot, sponging the kitchen clean, and scraping the balcony clear of ash caked by rain. Then he began a real project. "My brother wife like her sugar-cake," he said, "so I'll make it and carry it to her." Sugar-cake, Nat demonstrated, is candy made with freshly grated coconut and light brown sugar. He cooked it for several hours the old-fashioned way—on a charcoal brazier, which Montserratians call a coal-pot.

By now the afternoon shadows stretched long and thin. Nat locked the front door and nailed a sheet of plywood across the garage to keep out stray animals. "I'm not really sad to leave this," he said. "I'll be back someday."

Two days later I watched him board an airplane without a backward glance. Two months after that the southwest crater wall of the volcano began to crumble, and the government put St. Patrick's completely off-limits.

Unlike Nat Davis, Matilda Farrell, who came to Montserrat from Dominica 23 years ago, has no intention of leaving her adopted island, despite the urgings of her mother and grown son back in Dominica. "I come as a housemaid when I was 19," she said. "This is my home."

Matilda used to have steady work pumping gas in Plymouth. Now marking time at St. Martin's, she takes what work she can find: a little ironing, selling car parts, making salt-fish sandwiches at a lunch counter.

Like the others at the shelter, she relies on weekly government rations of basics such as eggs, macaroni, meat, and tinned vegetables supplemented by herbs and other garden ingredients. The kitchen arrangements were discouraging—one stove in the church basement, another in an outdoor shed, and a coal-pot—but Matilda created masterpieces nevertheless: kingfish and green bananas, chicken wings marinated in thyme and roasted, a moist cake made from sweet potatoes. I began filling my notebook with her recipes, complete with sketches of island staples such as dasheen, or taro, and tannia—brown, potato-like root vegetables she used to make soup. "You partake of some?" Matilda asked.

The soup was delicious. The meat, falling from the bones of turkey wings, was tender and succulent in a broth thick with lentils and the satisfying starchy roots. We ate sitting on the church steps, side by side like sisters. When I asked Matilda how she coped with life under the volcano, she spoke of faith and gratitude.

"We don't know when the volcano will do something. The geologists do the best they can, but they don't know either. Only God is in control. We can only pray that when the next event come, there is no danger to it. We still have to thank God that we have food and shelter and friends."

Faith is the islanders' bedrock. Most villages, no matter how small, have at least one church, and nearly everyone attends services dressed in Sunday best. Hymns ring across the hills from front porches at sunset, an outpouring of devotion that helps people accept the upheaval. "At first it really gets on your nerves, but then you put God first and everything smooth out," said Rose Anna Ryan, a nursery school teacher.

For many, adapting to the new reality requires a leap of faith. Gertrude Shotte, the teacher whose nerves were jangled by the

Life begins anew in the north: Jeneve Bramble cuddles her son Jal, born after she fled St. Patrick's for a church shelter in Salem. Some of the uprooted are now reoccupying homes trucked one by one from villages near the volcano to the safety of Gerald's Park (below), where children head for temporary classrooms.

Hovering so close that steam swirls into the open cabin, a helicopter carries scientists to the dome to look for signs of an imminent eruption. On the basis of such information, the government constantly reassesses the safety of areas that are still

inhabited. The future? It's an educated guess. "Politicians want clear-cut answers, but volcanology doesn't work that way," explains John Shepherd, a geophysicist from Lancaster University. "You can't predict what a volcano is going to do."

September eruption, taught at the primary school in Kinsale before the evacuation. Now she's teaching English, math, and social studies at the secondary school in Salem, helping fill in for teachers who have gone abroad. I caught up with Gertrude and Ann Marie Dewar, a biology teacher, between classes. "I just finished a class on *Hamlet*," Ann Marie told me, shaking her head.

"No specialist here," said Gertrude, pointing to herself. She turned to me. "Have a good laugh. It's the only way to ease the tension."

Montserratians seem to know instinctively how laughter can heal the soul. Telling me what people in the St. Martin's shelter did for recreation, Matilda said, "We play dominoes and give joke from the olden days. The laughter is there, and no harsh word."

Children learn the knack of treading lightly through life's problems from their mothers and older sisters and aunts—the whole extended world of women that still shapes the family on Montserrat. One evening at the shelter a group of girls and boys cornrowed my short, limp hair while laughing at my blue "dolly" eyes. When I showed them the sketches in my notebook—their school, Matilda's vegetables, the new shops in Salem—they insisted on adding their own. Nearly everyone drew a volcano.

Salem, which lies between the central heights and the sea, used to be a village—not much more than a few bars in brightly painted wooden buildings and a café that served gourmet sandwiches on a patio hung with potted plants. Now it's a small boomtown, with traffic jams and parking problems.

The owners of a number of Plymouth businesses have moved here, in part because Salem is the nearest safe place of any size as you drive north. This is a big consideration if you're

Clouds reflect the glow of magma blazing through fissures in the dome's thin crust, as seen in a time exposure. Mesmerizingly powerful—and potentially lethal—Soufriere Hills could continue to erupt for many years. Come what may, Montserratians' commitment to one another and their island should see them through. "We're very generous and community oriented," said one man. "We're also a very optimistic, hopeful people, so we'll hang in there."

running a business and bringing in supplies via the jetty in Plymouth. Suddenly every square foot of available space in Salem was in demand.

"It's very difficult to get land now," said Alfred Murraine, owner of the Golden Nugget, a restaurant known for its goat-water, the clove-scented stew that is Montserrat's traditional comfort food. Alfred had disassembled the building in Plymouth and was resurrecting it on a leased site next to the new bakery. "You see that slope?" he asked, pointing with his hammer to a deep gully. "That's why I could get this spot. Building here is hard."

While Alfred and I talked, an electric saw whined behind us. Two men were fitting together beams and boards salvaged from the old place. They'd already laid the floor on pilings set into the gully. "Some people move temporary, but I'm permanent," Alfred said. "I can't go with that up and down."

NOT EVERYONE has given up on Plymouth. "We're still hungry to get back," said one woman. "It has a hold on us." Walking around "town," as Montserratians call the capital, it was hard to imagine the place alive with people. I saw block after block of homes and businesses with windows shuttered, doors locked, walls dulled by the gray volcanic powder. Friday nights, I'd been told, were impromptu parties, with people crowding the streets as they ran errands and exchanged news. "Meet you at the Evergreen," they'd call out to friends, who would gather around a giant ficus tree that shaded a small downtown park. Mounds of ash now covered the park benches, and a gloomy silence filled the air.

One day I accompanied Nigel Osborne on a trip from the Vue Pointe Hotel to the family's warehouse in Plymouth. He needed to restock their supermarket, now set up in what used to be a boutique in the hotel. "We haven't moved from town completely yet," he said, loading his pickup from a storage bay full of merchandise. "We still have hope."

The Vue Pointe Hotel has become a virtual village. An insurance company and car dealership operate from desks in the mezzanine. The tennis courts at the foot of a hill dotted with hibiscus are a lumberyard. A dive shop near the perfect arc of a black-sand beach is a hardware store. All are Osborne family enterprises.

The Osbornes believe they have an obligation to help others too. A hotel lounge called the Pelican Club serves variously as a courtroom, an auditorium for volcano lectures and gospel concerts, a hall for "stress buster" dances, and a chapel for Sunday Mass.

Nigel's aunt, Carol, would have it no other way. "We're staying, no matter what. And it's not just because of the property we own here. We have a commitment to this island."

Montserratians under siege are blessed with many things: a sense of community, perseverance, humor, resourcefulness. But of all the impressions I brought home from this charming, beleaguered island, none struck me more than their warmth of spirit.

I was reminded of this when I stopped by the St. Martin's shelter on the way to the airport. Matilda Farrell was waiting for me. She gave me a big hug and a package of sugar-cake to carry home. □

Like a god, roboticist Mark W. Tilden looks down on his creations, simple robots built from discarded electronics and powered by the sun. Wired to seek light, the "photovores" compete for "food," pushing each other out of the sunshine. His latest robots are designed to locate unexploded land mines. Since they entered factories in the 1960s, robots have multiplied in form as scientists create them for new tasks and experiment with artificial intelligence. Fashioned from silicon and steel, more and more behave like living creatures, able to act independently in changing environments.

ROBOT REVOLUTION

By CURT SUPLEE Photographs by GEORGE STEINMETZ

Ping Faces Pong

Obedient to its operator, a master-slave robot in a Salt Lake City warehouse draws back its paddle in tandem with engineer Jon Price, whose motions are measured by sensors and relayed via computer. SARCOS, Greek for "flesh," matches most human moves in speed and smoothness but depends on a human brain for direction. "We do things so easily," says Price. "We don't realize what's involved in getting a robot to do the same thing."


EMPTY

Robo Docs

Off the factory floor and into the operating theater, a modified industrial robot hangs poised over an obliging skeleton in Pittsburgh's Shadyside Hospital. During hip replacement surgery, ROBODOC drills a cavity in the femur (held by steel brace) so that the doctor can precisely fit an implant into the bone.

Flanked by a nurse and engineers, Dr. Anthony DiGioia uses another system, HipNav, to display the exact position of the pelvis and a plastic cup onto a screen so he can accurately place the cup into the socket. Experts predict that within ten years such technology will enter most hospitals.

Since the dawn of human ingenuity, people have devised ever more cunning tools to cope with work that is dangerous, boring, onerous, or just plain nasty. That compulsion has culminated in robotics—the science of conferring various human capabilities on machines. And if scientists have yet to create the mechanical sidekick of science fiction, they have begun to come close.

As a result, the modern world is increasingly populated by quasi-intelligent gizmos whose presence we barely notice but whose creeping ubiquity has removed much human drudgery. Our factories hum to the rhythm of robot assembly arms. Our banking is done at automated teller terminals that thank us with rote politeness for the transaction. Our subway trains are controlled by tireless robo-drivers. Our mine shafts are dug by automated moles, and our nuclear accidents—such as those at Three Mile Island and Chornobyl—are cleaned up by robotic muckers fit to withstand radiation.

Such is the scope of uses envisioned by Karel Čapek, the Czech playwright who coined the term "robot" in 1920 (the word *robota* means "forced labor" in Czech).

As progress accelerates, the experimental becomes the exploitable at record pace. This summer, about the time that NASA's autonomous Mars rover is to crawl across the red planet's surface, engineers will be testing a modified version of the technology on a down-to-earth chore: robots designed to mow 100 acres of alfalfa unattended. Solar-powered, self-steering lawn mowers are already for sale. The eventual demand for similar devices, says Dave Lavery, manager of a robotics program at NASA, could be four times as large as the present market for industrial robots—and there are some 650,000 of them at work worldwide.

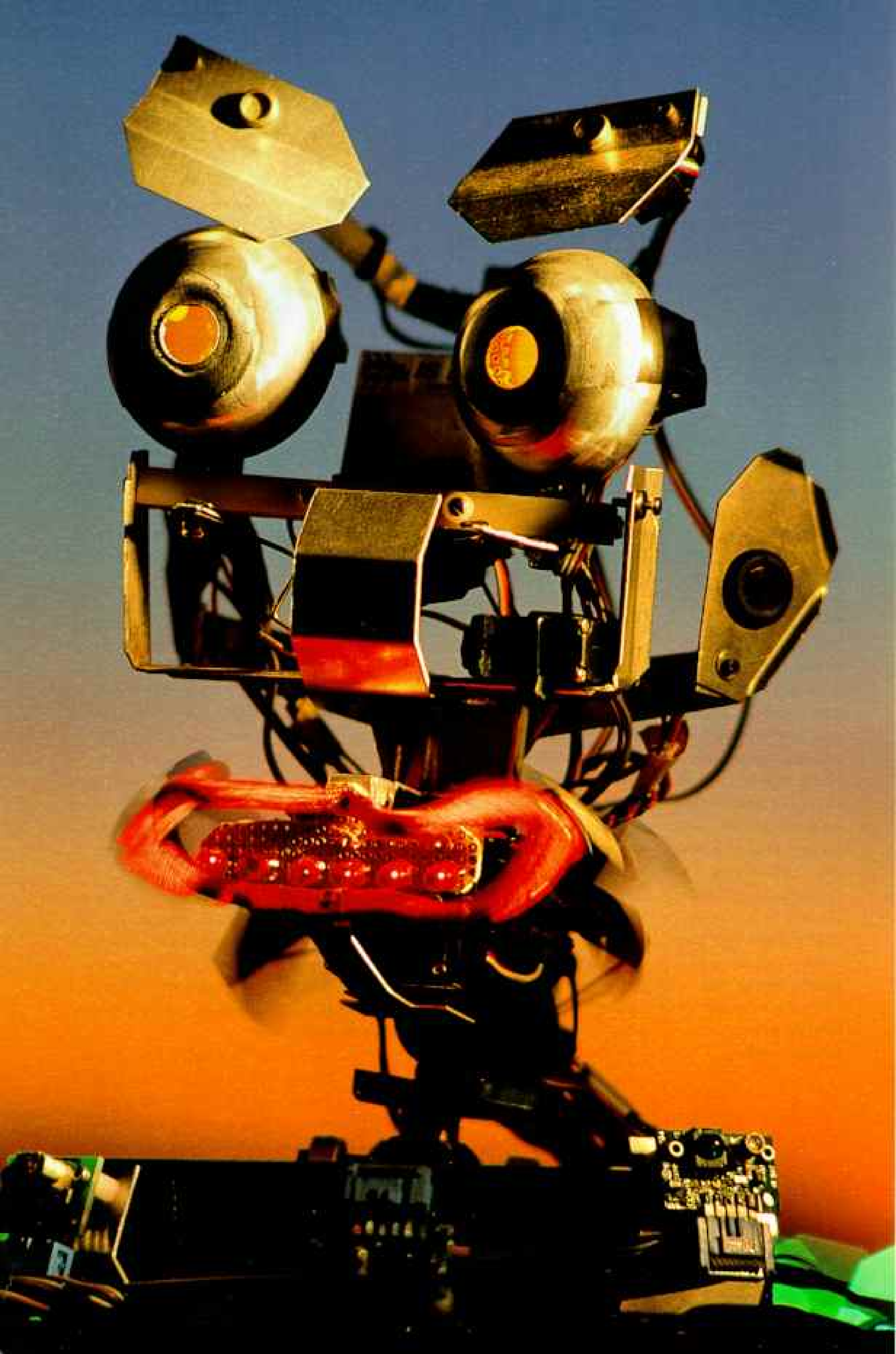
Other innovations promise to extend the abilities of human operators. Thanks to the incessant miniaturization of electronics and micro-mechanics, there are already robot systems that can perform some kinds of brain and bone surgery with submillimeter accuracy—far greater precision than highly skilled physicians can achieve with their hands alone. At the same time, techniques of long-distance control will keep folks even farther from hazard. In 1994 a ten-foot-tall NASA robotic explorer called Dante, with video-camera eyes and eight spiderlike legs, scrambled over the menacing rim of an Alaska volcano while technicians 2,000 miles away in California watched the scene by satellite and controlled Dante's descent.

But if robots are to reach the next stage of laborsaving utility, they will have to operate with less human supervision and be able to make at least a few decisions for themselves—goals that pose a formidable challenge. "While we know how to tell a robot to handle a specific error," says Lavery, "we can't yet give a robot enough 'common sense' to reliably interact with a dynamic world." That's why we don't have robots like the fabulous androids of *Star Wars* and *Star Trek*: humanlike creatures that can play Mozart or marbles and outthink their inventors.

Indeed the quest for true artificial intelligence (AI) has produced very mixed results. Despite a spasm of initial optimism in the 1960s and '70s

Endowed with ESP, Hollywood's 1954 Tobor ("robot" backward) attacked hostile humans and defended friends. Programmed to react to movement, sound, and light, IT (opposite) mimics emotions: Here it smiles because people are nearby. Rodney Brooks, whose firm built IT, calls this "behavior-based intelligence."

CURT SUPLEE, a science writer for the *Washington Post*, is the author of the Society's book *Everyday Science Explained*. GEORGE STEINMETZ, a frequent contributor, won a World Press award for his science photography.



Hovering above a mock town, CYPHER displays its surveillance capabilities at Fort Benning, Georgia. The robotic helicopter, developed by Sikorsky for military use, can take off, fly, and land by itself. An operator need only use a mouse to mark CYPHER's destination on a computer screen. One of a new breed of autonomous fliers, CYPHER, six feet in diameter, is smart enough to track a person and strong enough to carry a 50-pound load to a drop point 30 miles away.

when it appeared that transistor circuits and microprocessors might be able to replicate the action of the human brain by the year 2000, researchers lately have begun to extend that forecast by decades if not centuries.

What they found, in attempting to model thought, is that the human brain's roughly one hundred billion neurons are much more talented—and human perception far more complicated—than previously imagined. They have built robots that can recognize the misalignment of a machine panel by a fraction of a millimeter in a controlled factory environment. But the human mind can glimpse a rapidly changing scene and immediately disregard the 98 percent that is irrelevant, instantaneously focusing on the woodchuck at the side of a winding forest road or the single suspicious face in a tumultuous crowd. The most advanced computer systems on Earth can't approach that kind of ability, and neuroscientists still don't know quite how we do it.

"The hallmark of an intelligent robot," says Chuck Thorpe of Carnegie Mellon University's celebrated Robotics Institute, "is the sense-think-act cycle—and the 'sense' part is the most difficult."

It is in ambiguous circumstances that the human mind excels. And the paramount problem for AI is to model the way the brain holds a representation of the external world and modifies it on the fly to accommodate changing circumstances and shifting context. So far, however, the most avant-garde laboratories can't begin to get a robot to do what a 12-month-old infant does automatically—teach itself to balance, walk erect, and instantly tell the difference between a dark shadow and a hole in the floor.

Nonetheless, as information theorists, neuroscientists, and computer experts pool their talents, they are finding ways to get some lifelike intelligence from robots. One method renounces the linear, logical structure of conventional electronic circuits in favor of the messy, ad hoc arrangement of a real brain's neurons. These "neural networks" do not have to be programmed. They can "teach" themselves by a system of feedback signals that reinforce electrical pathways that produced correct responses and, conversely, wipe out connections that produced errors. Eventually the net wires itself into a system that can pronounce certain words or distinguish certain shapes.

In other areas researchers are struggling to fashion a more natural

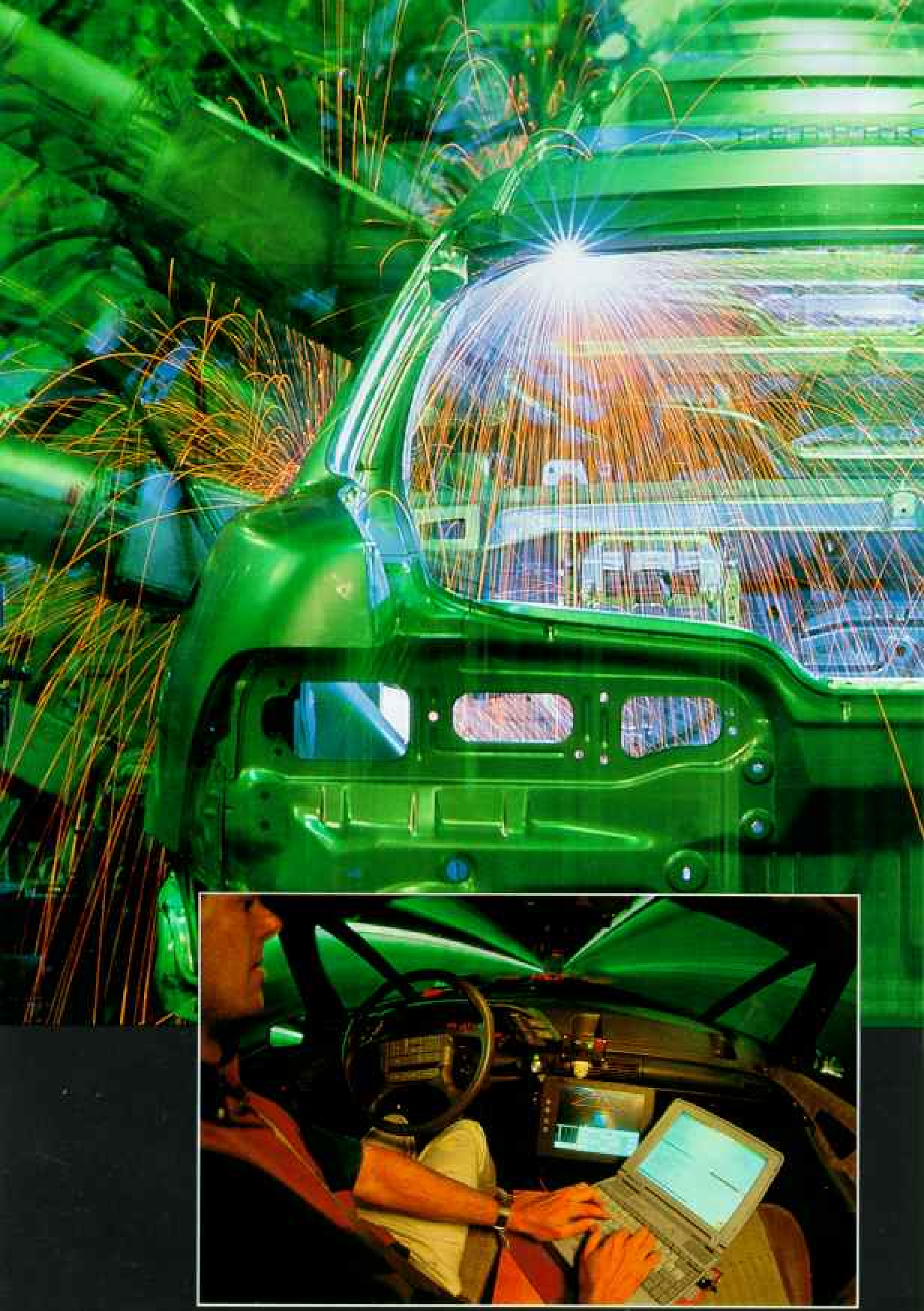
relationship between people and robots in the expectation that someday machines will take on some tasks now done by humans in, say, nursing homes. This is particularly important in Japan, where the percentage of elderly citizens is rapidly increasing. So experimenters at the Science University of Tokyo have created a "face robot"—a life-size, soft plastic model of a female head with a video camera imbedded in the left eye—as a prototype.

The researchers' goal is to create robots that people feel comfortable around. They are concentrating on the face because they believe facial expressions are the most important way to transfer emotional messages. We read those messages by interpreting expressions to decide whether a person is happy, frightened, angry, or nervous. Thus the Japanese robot is designed to detect emotions in the person it's "looking at" by sensing changes in the spatial arrangement of the person's eyes, nose, eyebrows, and mouth. It compares those configurations with a database of standard facial expressions and guesses the emotion. The robot then uses an ensemble of tiny pressure pads to adjust its plastic face into an appropriate emotional response.

Other labs are taking a different approach, one that doesn't try to mimic human intelligence or emotions. Just as computer design has moved away from one central mainframe in favor of myriad individual workstations—and single processors have been replaced by arrays of smaller units that break a big problem into parts that are solved simultaneously—many experts are now investigating whether swarms of semi-smart robots can generate a collective intelligence that is greater than the sum of its parts. That's what beehives and ant colonies do, and several teams are betting that legions of mini-critters working together like an ant colony could be sent to explore the climate of planets or to inspect pipes in dangerous industrial situations.

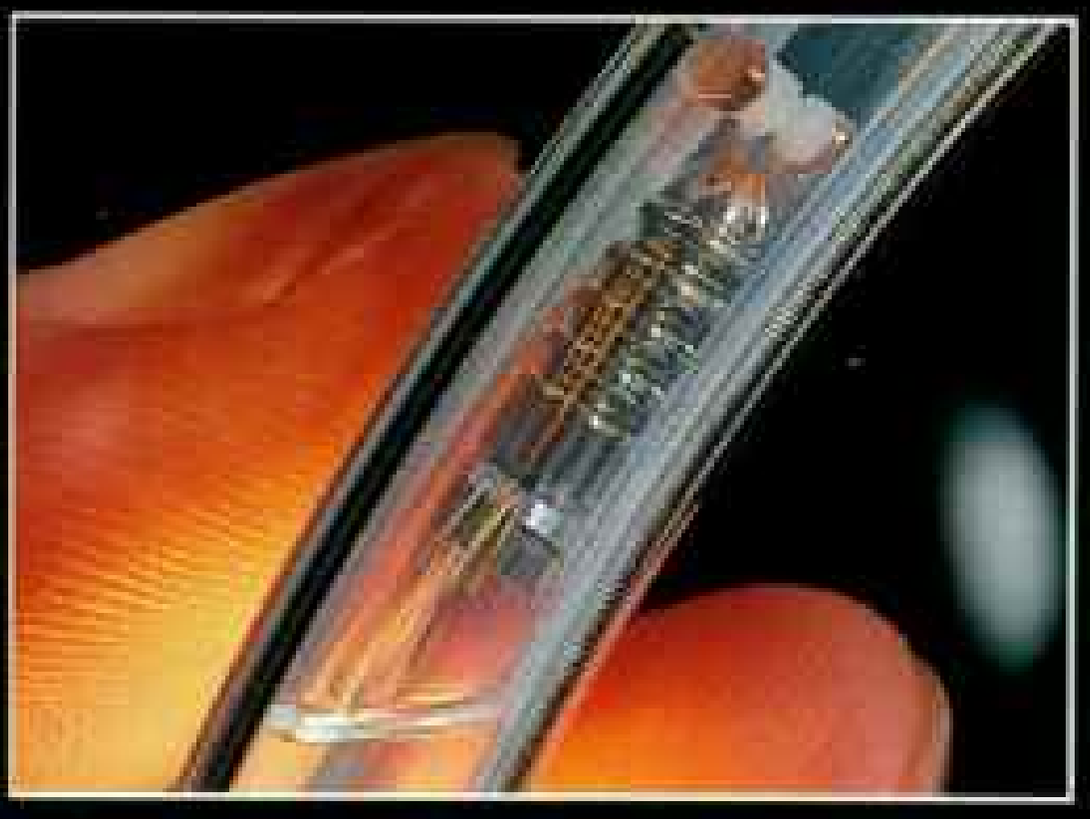
After a decade of setbacks AI enthusiasts are again growing optimistic. Though they are still a long way from replicating the complexity of the human psyche, few theorists now claim that machine intelligence is impossible. Meanwhile, the invention of less exotic devices is exploding in such profusion that scientists are having greater trouble defining the term "robot." Whatever form robotics eventually takes, we'll surely be living with ever smarter tools and toys in the century to come.

Fitted with a backpack microprocessor, a cockroach in Isao Shimoyama's lab at the University of Tokyo is ready to receive remote-control signals that will stimulate its nervous system, setting its legs in motion. Such "biobots" may someday help researchers understand how insects move, says biologist Robert Full of the University of California, Berkeley, where scientists are working to give robots with legs the same speed, stability, and grace.



Driving Forces

Sparks shower a Honda assembly line as robotic arms weld auto bodies in Japan, the self-styled "robot kingdom." Quick to embrace industrial robots, Japanese companies became the world's leading manufacturers and consumers, harnessing automation to raise productivity and quality. To keep up, car companies around the globe installed robots, replacing some workers. Using a video camera for eyes, Navlab 5 (left) steers a van through a Pittsburgh tunnel at 60 mph, leaving Carnegie Mellon researcher Dean Pomerleau with free hands. Soon scientists will demonstrate a highway system featuring robotic cars that within 20 years could do all the driving.

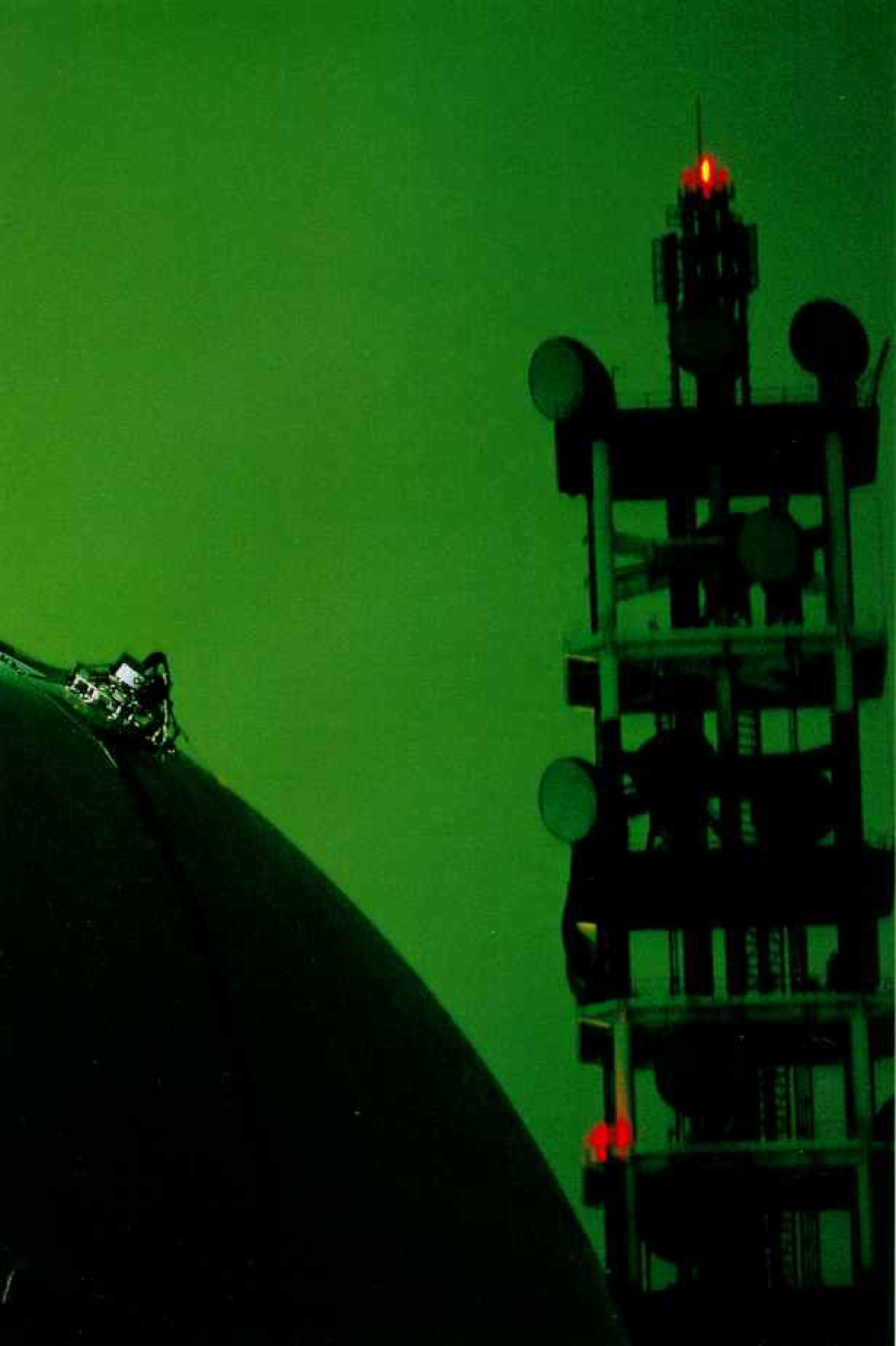


Creepy Crawlers

Clinging to a sphere, a "spider" robot uses 16 legs to clamber over a gas tank in Tokyo, checking for cracks. Like their animal models, robots vary in size and shape as scientists adapt them to specialized niches.

Experimental solar-powered "ladybugs" (top left), developed by Sanyo, use light-sensing eyes to turn toward the sun. A DENSO inspection robot (bottom left) contracts and expands like an inchworm, using minimal power to move through a tube.

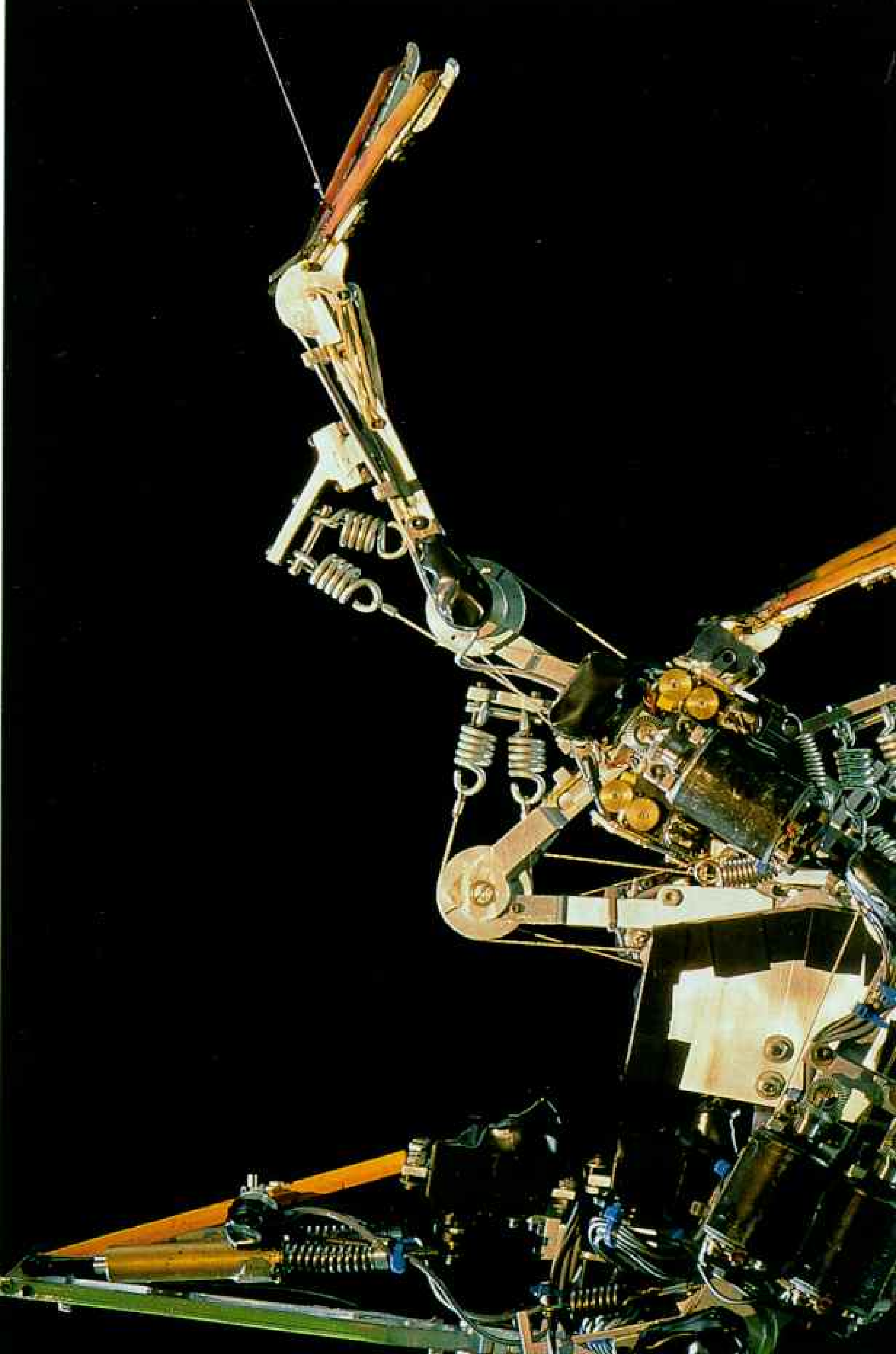
As factories make smaller and smaller electronics, robots will shrink further, says DENSO researcher Nobuaki Kawahara, who says the future lies in micromachines.



Dynamic Dinosaurs

Frozen in flight, "Troody," a replica of a *Troodon,* balances between steps. Sixteen miniaturized motors—the equivalent of muscles—propel her forward. A series of springs adjusts to shifts of weight and speed as she mimics the quickness and agility of a real dinosaur. Wheeled robots are easier to build but limited in mobility, says Troody's creator, Peter Dilworth of the MIT Leg Lab. "The world is a complicated, three-dimensional place," he explains.

Strapped in a telemetry suit, puppeteer Barry Crane (below) prepares to guide the arms of a *Tyrannosaurus rex* about to chase the heroes of Steven Spielberg's *The Lost World* into a waterfall. Crane and five others from Stan Winston Studio controlled the face, head, neck, limbs, and torso of the nine-ton beast, transforming a master-slave robot into a movie character.



Sea and Space

Solo submersible, an Odyssey IIb hangs suspended in a Newport, Rhode Island, acoustic test tank several months after mapping tidal mixing off Vancouver Island. Unlike other unmanned underwater vehicles, the Odyssey IIb is tetherless, making it cheaper, faster, easier, and safer to operate, especially in deep or icy waters. MIT Sea Grant researchers envision networks of such robots, equipped with onboard intelligence, roaming the ocean to gather data for relay to scientists on shore.

A six-foot-long prototype lunar rover (below right) parks on a slag heap where Carnegie Mellon researchers check its ability to guide itself over rough terrain. Plans call for Earthbound "tourists" to steer the rover once it reaches the moon. The vehicle is smart enough to ignore bad drivers. The Sojourner microrover (far right) undergoes final preparations at the Jet Propulsion Laboratory in Pasadena. Sojourner, scheduled to land on Mars on July 4, was built to gather information on soils and rocks. In touch with Earth just once a day, the rover, capable of covering 46 feet a day, will pick its own course, driven by tiny solar-powered motors.

Future Shocked

Arcing from a Tesla coil, 1.8 million volts shoots through a Christmas tree, down a cage holding physicist Austin Richards, and into the floor of artist Christian Ristow's San Francisco warehouse. Later in this performance a claw destroyed the tree. "There's a certain thrill in viewing raw power unleashed," Ristow says. "There's something shocking about a machine that appears alive."

Some futurists speculate that robots may one day replace humans as Earth's dominant creatures. Nikola Tesla, who invented radio-controlled machines as well as the coil, foresaw the impact in 1919. "Teleautomata will be ultimately produced," he wrote. "Their advent will create a revolution."

The First Europeans

Three Europeans share an afternoon in Rome. Geologist Aldo Segre, at left, and physical anthropologist Antonio Ascenzi examine the skullcap of Ceprano man, which may be as old as 900,000 years, at the Italian Institute of Human Paleontology. Recent fossil and archaeological discoveries in Italy, Spain, Britain, and Germany are turning back the clock on the earliest human settlement of Europe.

By RICK GORE SENIOR ASSISTANT EDITOR
Photographs by KENNETH GARRETT

ON A SUNDAY AFTERNOON in March 1994 a glimmer of bone caught Italo Biddittu's eye as he glanced at the shoulder of new roadbed in the Italian countryside, 55 miles southeast of Rome. Two years later, on a warm day in May, the veteran archaeologist and I walk along the fresh blacktop of that still unopened road near the town of Ceprano. The air is filled with birdsong and the smell of mint. We pause as a shepherd leads his bleating flock across the road and then continue on to the spot where Biddittu saw the piece of bone—an eight-foot-high bank of earth created when a bulldozer cut through a small hill.

"In Italy wherever bulldozers work, we inspect in case they dig up something ancient," Biddittu says, explaining why he was there in 1994.

"Something ancient" in Italy usually dates back 1,500 to 2,500 years to Roman or Etruscan times. But the fragment of bone Biddittu picked up in 1994—a specimen from an early member of our genus, *Homo*—was startlingly older, probably dating back 800,000 to 900,000 years. Biddittu didn't realize it then, but he'd just set the clock back at least 300,000 years for Europe's oldest known *Homo* specimen.

"*Qui . . . precisamente,*" he says, kneeling and scraping away the soil that landscapers have since placed over his discovery site. "Right here is where I saw the fragment. It was about four centimeters [one and a half inches] long."

Soon after the discovery Biddittu and a team of his colleagues from the Italian Institute of Human Paleontology swarmed over the site, excavating hundreds more such fragments, many no bigger than splinters. By the spring of 1996 they had pieced together much of the skullcap of what has come to be called Ceprano man.

The news of this surprisingly old European fossil has drawn me to Italy. For much of the past two years I have been reporting on new ideas about the evolution of *Homo* and its spread throughout the world.

Articles in this series focus on early members of our own genus and the hominids that preceded them. Much of this research was supported by your Society.

Biddittu's find is just one of a rash of early human fossil and other archaeological discoveries made in Europe in the past few years. These finds, in sites ranging from Italy and Spain to Britain and Germany, have forced scientists to rethink their ideas about who the first Europeans were and when they arrived on the continent.

Until this decade scientists knew little about humans in Europe before the Neandertals appeared about 230,000 years ago. Only a scattering of older human fossils had been found. Many specialists doubted that any human species had even stepped foot on the continent until about half a million years ago.*

The most logical candidate for settling Europe was *Homo erectus*, a species that probably evolved in Africa about two million years ago. *Erectus* looked a lot like modern humans

*See "Neandertals," in the January 1996 issue, and "Expanding Worlds," May 1997, both by the author.

Determined to leave no bone unturned, archaeologist Italo Biddittu and paleontologist Eugenia Segre-Naldini revisit the highway construction site 55 miles southeast of Rome where Biddittu unearthed Italy's earliest human in 1994. Reassembling the bulldozer-shattered skullcap took a year. Italian researchers identify Ceprano man as a European *Homo erectus*.

2 million years ago — Present

Venta Micena 1.2 to 1 million

Are these the remains of a young human or a very young horse? Debate has focused on a skull fragment and limb bone (above, at bottom) found at the Venta Micena site near Orce in southeastern Spain. At one million to 1.2 million years old, the fossils are controversial contenders for the "first European" title. Prehistoric Spaniards may have used stone hammers and sharp-edged flakes, at center, to scavenge meat and bone marrow from the prey of saber-toothed cats. Bone-crushing hyenas, represented by the lower jaw and teeth at top, likely competed with hominids for the spoils.

from the neck down, but its body was more powerfully built and its head was more primitive, with protruding browridges, a backward-sloping forehead, and a smaller brain.

Although *erectus* may have spread as far as Java by 1.8 million years ago, many scientists believed that it had bypassed Europe. Some thought that the continent's colder climate was too harsh for the tropically suited *erectus*. But the major ice ages that wracked Europe did not begin until around 900,000 years ago. So perhaps it was the intense competition for food that kept early humans out. Fossil evidence indicates that enormous carnivores—saber-toothed cats, hyenas, and hunting dogs—prowled Europe between 1.5 million years ago and about 500,000 years ago, when they became extinct. Opportunities for scavenging hominids would have been slim during that period, and though small groups might have survived for a relatively short time, that fauna might have kept the larger *erectus* population waiting at Europe's gates for millennia.

KENNETH GARRETT has photographed 17 articles for NATIONAL GEOGRAPHIC, including four earlier stories in the "Dawn of Humans" series.

Some scientists believed that by the time Europe did become accessible to early humans, a new species of *Homo*, one better adapted for life there, had evolved. The first European, they thought, could have been a primitive form of *Homo sapiens* or even something entirely different. But there simply weren't enough fossils to determine which species arrived first.

IT WAS INTO THIS MAELSTROM of evolutionary uncertainty that Italo Biddittu stumbled when he picked up the first piece of Ceprano man. The reassembled skull, which lacks a lower jaw and face, now resides in a safe in the office of Antonio Ascenzi, a physical anthropologist in the medical school at "La Sapienza" University of Rome, who worked with the team that excavated and analyzed the skull.

"For now, we're calling him *Homo erectus*," says another team member, geologist Aldo Segre of the Italian Institute of Human Paleontology, as his wife and collaborator, Eugenia, drives me through Rome's morning rush-hour traffic to meet Ceprano man.

The Segres usher me into Ascenzi's high-ceilinged office in the grand old stone building that houses the university's pathology department. "Now you'll see the oldest skull in Europe," says Ascenzi, a courtly man of around 80, as he places the reassembled skull, with its low sloping forehead and large browridges, on his desk. Tracing his finger across the skull, Ascenzi points out features that seem subtle, if not arcane, to me but that indicate to specialists that Ceprano man was a *Homo erectus*, but with some distinctive features.

"Classic *Homo erectus* has a slight crest along the center of its skull," Ascenzi says, running a finger from the forehead back. "This skull has no crest at all." Ascenzi also points out that the Ceprano man's brain was significantly larger than that of the classic *erectus*.

Ascenzi doesn't believe that Ceprano man belongs to the same species as another human fossil, the Mauer mandible, found in 1907 at a site called Mauer near Heidelberg, Germany. Some scientists assign that specimen to its own species of *Homo*, which they call *Homo heidelbergensis*. They believe that *heidelbergensis* migrated to Europe about half a million years ago from unknown parts and later evolved into the sturdy, cold-adapted Neandertals. The

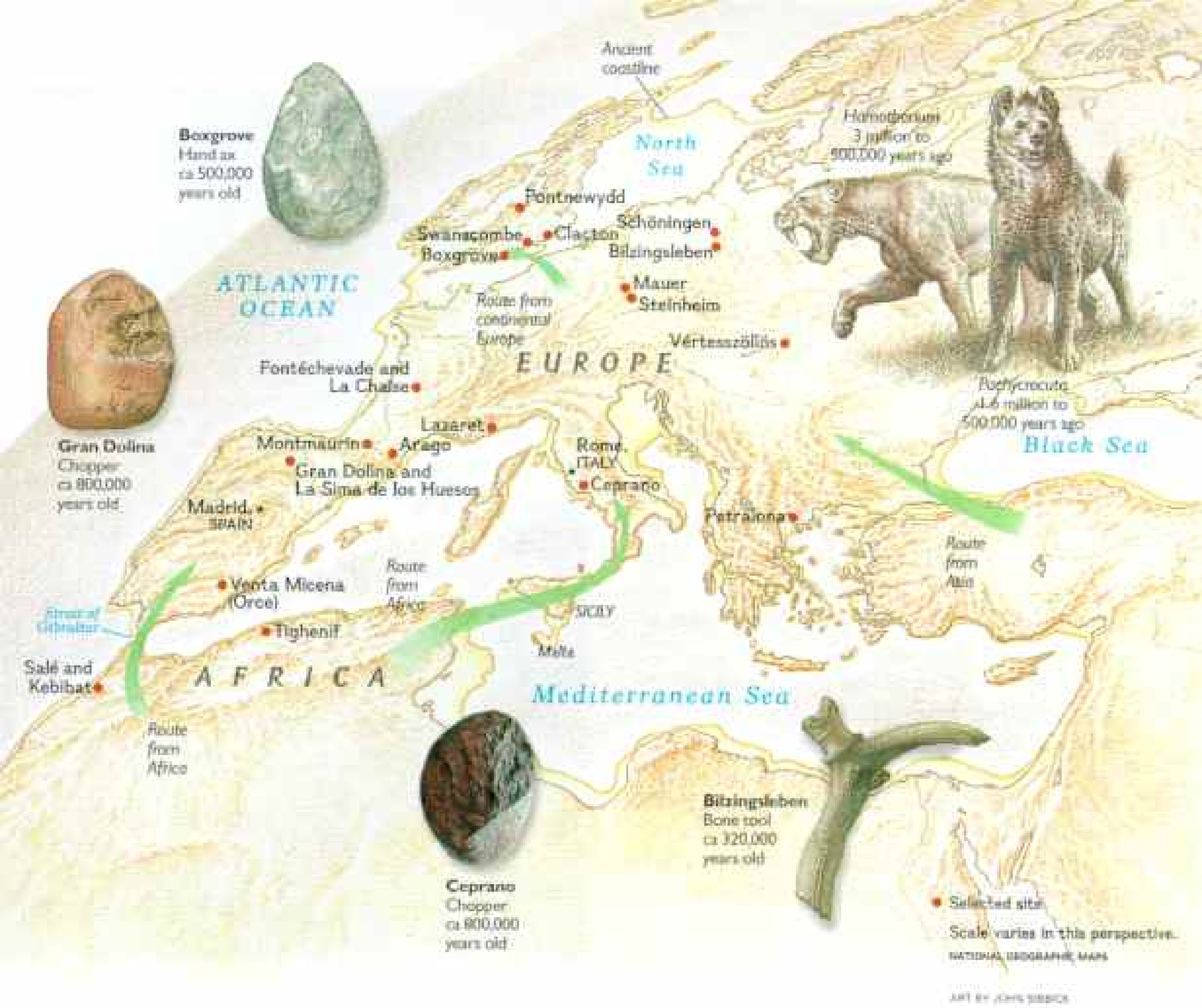
2 million years ago — Present

Gran Dolina 900,000 to 800,000

Bones from level six at the Sierra de Atapuerca's Gran Dolina site demonstrate a human presence in Spain at least 800,000 years ago. Nearly a hundred hominid fossils and twice as many stone tools were collected here in the 1994 and 1995 excavation seasons.

Italian scientists see more resemblance between Ceprano man and *erectus* fossils of about the same age that were found in the 1950s across the Mediterranean Sea in Algeria.

"That suggests that the origin of the people of Ceprano might be North Africa," says Segre. If so, scientists must figure out how those early humans reached Italy without leaving traces in Turkey, Greece, or other points en route. Segre wonders if in the past western Europe and Africa were connected by land. Although other scientists doubt that idea, Segre cites the discovery of early stone tools in Sicily.



ART BY JOHN SIBBICK

Carving a European Niche

"Large question marks" are what British paleontologist Alan Turner sees on potential passages from Africa through Gibraltar and Sicily. Even with a glacial sea-level drop such travel would have required a sea crossing. (Coastlines today and about 700,000 years ago are shown.) Evidence for the first routes into Europe remains scanty. Did early *Homo* find a way to cross deep water? Turner also suggests that large carnivores, like the saber-toothed cat and hyena above, probably created obstacles to sustained hominid settlement north of the Mediterranean until about 500,000 years ago.

FOR THE SCIENTISTS who ponder such migrations, 1994 brought more surprises. Before the Italian team had even begun to assemble the pieces of Ceprano man's skull, discoveries in England and Spain triggered a nationalistic rivalry over which country could claim the first European.

In the spring of that year British scientists working at a site called Boxgrove a few miles inland from the English Channel announced the discovery of the earliest evidence of *Homo* in Britain—a tibia, or lower leg bone, about 500,000 years old (page 108). The excavators also found hundreds of hand axes similar to those being made by humans in Africa at that time. The tibia apparently belonged to a man whose people had crossed into Britain between 478,000 and 524,000 years ago, when the British Isles were connected to the European continent by a land bridge.

According to paleoanthropologist Chris Stringer of the Natural History Museum, London, the people of Boxgrove were *Homo heidelbergensis* and may have migrated to Europe at about that time. The bearded, energetic Stringer brings the tibia from the storage vault

at the museum and places it on a table in his office. Broken into two pieces, the bone is brown and bears faint chew marks, perhaps from a hungry wolf that scavenged the corpse of Boxgrove man. It is massively thick, with at least twice as much bone tissue as a muscular modern human; its length indicates that Boxgrove man stood about five feet eleven inches tall. Large ridges along the back of the bone suggest that the muscles attached to them were immense and powerful. Stringer estimates that he would have weighed about 200 pounds.

But the British had scarcely won the title for the oldest known European when a Spanish team took it away.

In the Sierra de Atapuerca in northern Spain near Burgos, I drove in the summer of 1994 with archaeologist Eudald Carbonell and paleoanthropologist José María Bermúdez de Castro to a site called Gran Dolina. It lies along a narrow canyon that had been cut through a hillside to build a railroad at the turn of the century. We climbed about 30 feet up a scaffold along one of the steep walls of the trench and reached what the team calls level six—an alcove dug into the trench wall. Four archaeologists knelt in the dirt, carefully excavating what had been the floor of a cave once visited by prehistoric people. They were trying to establish the exact age of those people, and fossils of a vole were their only clue. They appeared to be more ancient than voles found at Boxgrove, so the Spaniards argued that their site was older.

"This was a camp used by people who lived before the Neandertals began to evolve," said Carbonell. He could be confident that humans had been here thanks to a discovery just a few weeks earlier by his colleague Aurora Martín Nájera, an archaeologist who had been digging at this site for the past 14 seasons without finding a hint of human fossils.

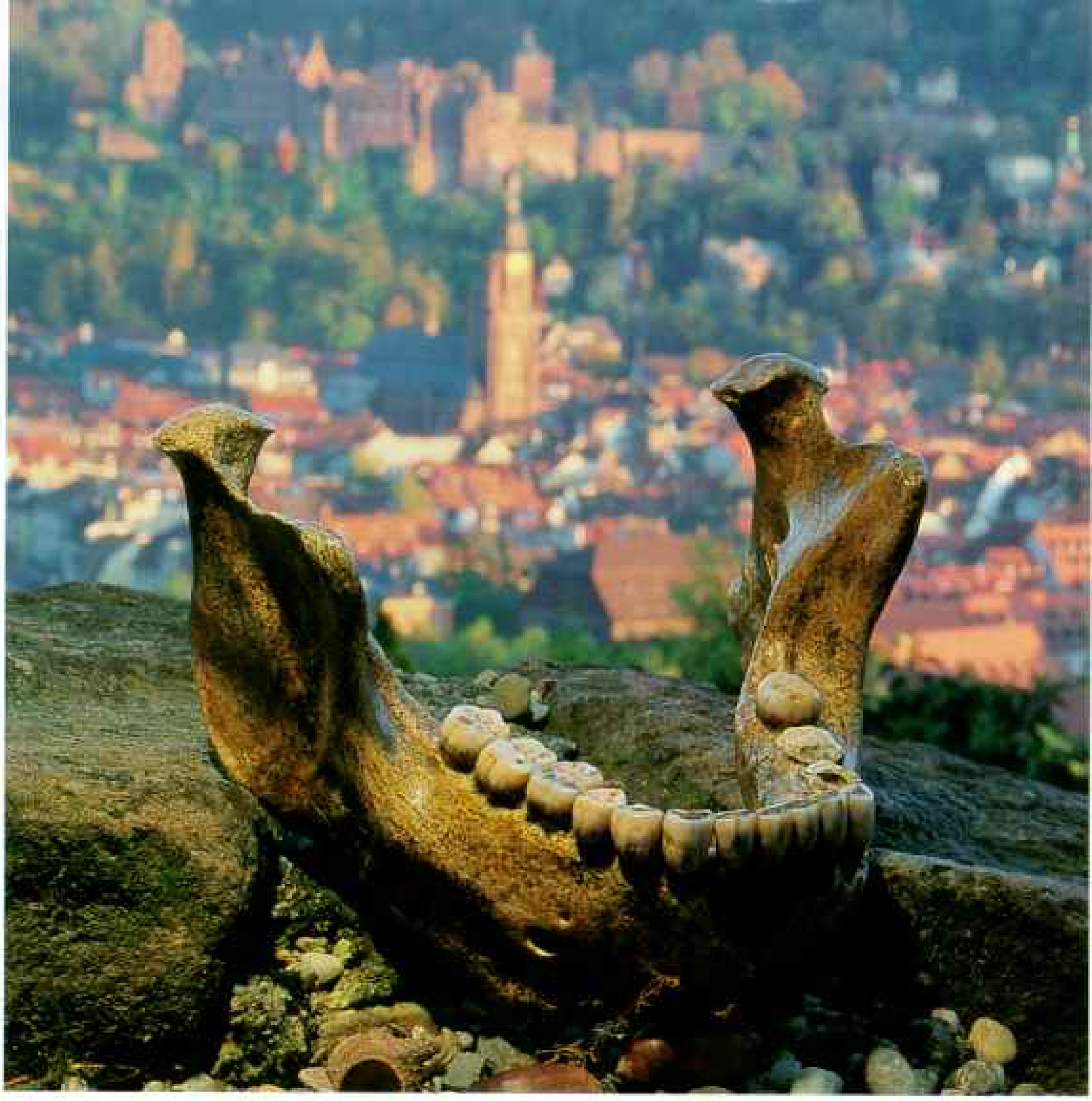
Then, on a seemingly routine day, she noticed what looked like a tooth in the soil. She called out to her colleagues and was soon holding three early human teeth in her hands.

"I couldn't believe my eyes after working here so many years," she said excitedly. "We had to wait for Bermúdez de Castro—our tooth specialist—to confirm they were human. But inside we all knew. We were all trembling as he examined them."

Robust bones of his 1971 Arago cave find led French prehistorian Henry de Lumley, holding a cast of the 400,000-year-old fossil and partial skull reconstruction, to label it *H. erectus*. An estimated brain size exceeding the *erectus* average suggests affinities with archaic *Homo sapiens*.

When Bermúdez de Castro confirmed Martín's discovery, whoops and shouts echoed down the canyon. By the end of the next season the team had unearthed nearly a hundred fragments of human bones, 200 stone tools, and 300 scraps of animal bones from within the excavation site, an area the size of an average bathroom.

The fossils turned out to be much older than the team had anticipated, and some scientists believe that they represent a new species. Geologists analyzed the sediments at the site and determined that magnetic minerals in the layer



above the fossils were oriented as if earth's current magnetic north pole were its south, and vice versa. The planet's magnetic field, which occasionally reverses, last flipped poles about 780,000 years ago. The human fossils at Gran Dolina had to be older than that, and thus close to the age of Ceprano man, which had been discovered a few months earlier. And primitive quartz tools found at a lower level of the dig proved older still, dating back about a million years ago.

Carbonell is still ebullient when I meet him in his lab at the University of Rovira and Virgili in Tarragona, on Spain's northeastern coast. He and Bermúdez de Castro show me some of the tools they have recently turned up at Gran Dolina. Those from the older, million-year-old strata resemble the simple cobbles and stone cores from which sharp flakes were napped in Africa before hand axes were invented. Those from the same layer as the human remains are more inventive. One finger-length tool has a sharp cutting edge on one side, while the other has a flat edge that lets my index finger guide the motion of the tool precisely. "It's a knife," says Carbonell. "The earliest one ever associated with humans in Europe."

Humans probably used such knives to butcher animals, from deer and horses to elephants, whose broken bones litter the soils in this ancient campsite. Some scientists now think that our ancestors also used the tools for a more grisly purpose. Examining the bones under magnification, they have discovered cut

How bushy is the *Homo* family tree? British paleoanthropologist Chris Stringer thinks that the 500,000-year-old Mauer mandible (left, with Heidelberg, Germany, in background), represents *H. heidelbergensis*, a species more modern-looking than *H. erectus* and perhaps the first species to populate Europe. According to Stringer, the jutting brow and rounded back of a 300,000-year-old skull from Steinheim, Germany (below), place it on a branch leading from those earliest Europeans to the Neandertals. Many scientists share Stringer's view of a multibranched family tree. Others believe that just two species—*H. erectus* and *H. sapiens*—account for the entire human fossil record outside Africa.

marks on human bones. In sites ranging from South Africa to Croatia to the U.S. Southwest, similar evidence indicates that cannibalism may long have been part of the human heritage. I ask Carbonell how he thinks the unfortunate ones at Gran Dolina met their fate. He shrugs. "They treated their fellow humans the same as the other fauna," he says.

MEANWHILE, to the south in the dry countryside near Granada, other teams of European paleontologists have discovered evidence that humans were butchering animals in Spain even earlier than the Gran Dolina people were.

"This is the Olduvai Gorge of Spain," says paleontologist Bienvenido Martínez-Navarro as we look out over the winding ravine he likens to Africa's most famous hominid fossil site. At a small museum in the town of Orce he and colleague Paul Palmqvist of the University of Málaga show me skull fragments of a saber-tooth. Although other paleontologists disagree, they identify it as *Megantereon whitei*, an African species, and argue that the presence of this cat in Spain about 1.2 million years ago implies that humans had also dispersed out of Africa. "This carnivore took only the fleshiest parts of its prey," says Palmqvist. "In places like Olduvai it left a lot of carrion and bone marrow for hyenas and humans. Humans would almost certainly have arrived with this cat."

Martínez-Navarro also shows me skulls of other immigrants—a rhino, a baby elephant, a

Hunters' Headland

Human voices may have echoed off chalk cliffs like these half a million years ago. A site called Boxgrove in southeastern Britain, now seven miles inland, reveals human activity spanning some 20,000 years. Falling sea level eventually transformed the narrow beach at Boxgrove into a broad, grassy

plain, where cooperative hunters with a diverse tool kit butchered horses and rhinos. Coping with changes in landscape and food sources, early humans survived in Britain at least until glaciers locked much of their world in ice 480,000 years ago.

2 million years ago — Present

Boxgrove 500,000

Under the brush of artist John Sibbick, an ancient Briton appears as he may have been about 500,000 years ago. Inspired by the tibia and pair of lower incisors (below) recently discovered at Boxgrove, this reconstruction also draws on other similarly dated *Homo heidelbergensis* fossils, including a skull from Bodo, Ethiopia. Deftly formed flint hand axes like the one clasped at right were found by the dozen in the same deposits that yielded the tibia. Bone dimensions indicate that Boxgrove man's stature was comparable to that of a husky modern adult. A mid-shaft break reveals the striking thickness of the tibia. Such mass reflects not only the physical demands put on the bone and the exertion of large muscles but also a diet rich in minerals and protein. This northern European population may form part of the ancestral stock of the large-bodied, cold-adapted Neandertals.

horse, and another species of sabertooth. All were found at a nearby site by a team led by Spanish paleontologist Josep Gibert. They were discovered on top of a cache of 15,000 other animal bones of the same age. Almost all show signs of hyena-gnawing, leading scientists to believe that the site was a hyena lair. But the skulls were not crushed as hyenas usually leave the skulls of their prey. Instead, the rear of each skull was missing in all but the sabertooth's.

"We think humans broke into the skulls with stone tools to get the brains," says Martínez-Navarro. Although the sabertooth's skull was not broken, its fangs were missing. Martínez-Navarro speculates that early humans used fangs as knives.

Excavators at this site, known as Venta Micena, also found what Gibert and his colleagues argue is the skullcap of an infant *Homo*. The fossil is a brown patch of bone

three inches in diameter. It was discovered near a seven-inch-long piece of an infant's upper arm bone. Most paleoanthropologists who have seen the bones believe, however, that they belonged to a young horse.

Whether or not the skullcap is human, many archaeologists now think that the presence of African fauna together with human tools and evidence of butchery at Orce support the theory that humans had made it into southern Europe prior to a million years ago.

Not only did members of the genus *Homo* reach Europe earlier than previously believed, they seem to have been capable of advanced behavior. A deep dent across the browridge of Ceprano man may testify to that.

"We studied this with a physicist," explains Antonio Ascenzi, lightly touching the scar while showing me the skull at the medical school in Rome. "We think the man was charged, perhaps while hunting, by an animal the size of a bison. One of its horns struck his forehead at around 35 kilometers [22 miles] an hour. But he wasn't killed. The wound healed." The scar may be the earliest evidence that *Homo* had begun to hunt large, dangerous animals.

British excavations at Boxgrove indicate that the man whose tibia turned up there may have been a hunter too. "We have a piece of horse scapula with a wound probably made by a wooden spear," says Boxgrove's site director, Mark Roberts, as we walk the extensive excavation site, which until 1995 was a hundred-acre gravel quarry. Half a million years ago this landscape of gouged earth, littered with heaps of chalky gravel, was the shore of a peaceful lagoon with white cliffs rising behind it.

"Horses may have moved up and down the coast in herds," says Roberts. "Almost certainly humans would have been hunting them cooperatively, rather than scavenging them. We believe that because we never find butchery marks on top of the tooth marks of scavenging animals. It's always the other way around." Roberts thinks that the scavengers would arrive after the humans had already left with the best cuts from their kills.

"Before, we doubted that humans had speech this early," says Roberts. "But for this kind of group hunting, which would require strategies such as ambush, speech would have been critical."

Even stronger evidence of hunting began to emerge in the fall of 1995 near the town of Schöningen in Germany. There scientists have discovered five artfully shaped throwing spears about 400,000 years old at a site on the edge of an enormous strip mine. I stand near the rim of the mine, which plunges 330 feet down and extends for three and a half miles, with the chief archaeologist, Hartmut Thieme of the Institute for the Preservation of Historic Monuments. We watch a monstrous 140-foot-high excavating machine dig away tons of earth with a conveyor line of dirt-biting buckets.

"We never would have made this wonderful discovery if the mining company hadn't dug here," says Thieme, who for 14 years has preceded the digging buckets to rescue any artifacts that turn up. In 1994 he persuaded the mineowners to spare the promontory where the spears were found along with thousands of butchered horse bones and the hearths of campfires.

"Try to imagine the scene 400,000 years ago," he says. "A lovely lake with herds of horses drinking at the shoreline. Humans hiding in the bushes. At the right moment they leaped out, throwing spears. Since the horses wouldn't run into the water, it was easy to catch them."

In Thieme's lab I see the spears, which had been used and abandoned in a peat bog near the lake. For 400,000 years the spears were preserved by the moist peat. The longest one, now broken into two pieces, once measured more than seven feet. Thieme pulls its tip from the bath that now protects it. Dark brown and glistening, it looks as if it were carved yesterday.

"Look at that tip," he says. "It's so fine and narrow. The heavier weight at the front of the spear tells us it was made to be thrown from a distance rather than thrust at close range. The bases of some of the spears are rounded, perhaps from their use as digging sticks."

Even more provocative evidence of the increasingly elaborate behavior of the early Europeans lies about 60 miles from Schöningen. I drive through the rolling farmlands of the Thuringia Valley to the outskirts of a village called Bilzingsleben. Entering a fenced-off excavation area about a third of an acre in size, I find the site's director,

Dietrich Mania, working with a team of excavators. Mania, an archaeologist at the University of Jena, has worked this site in the former East Germany since 1969; his wife, Ursula, has been digging there with him for the past 16 years. So far, Bilzingsleben has produced five tons of archaeological material, including the world's largest collection of bone artifacts.

"There was a spring-fed lake here," says Mania, "and people camped near the spring. They had workshops, some for working bone, others for stone and wood. Each is different."

The people of Bilzingsleben made structures similar to those of the Bushmen in southern Africa today, says Mania. His team has uncovered three circular foundations of bone and stone 9 to 13 feet across. In the center of one dwelling they found a long elephant tusk, which Mania suspects was the center post. They have also unearthed hearths, both adjacent to the structures and scattered through the site.

But Mania's most intriguing find lies under a protective shed. As he opens the door, sunlight illuminates a cluster of smooth stones and pieces of bone that he believes were arranged by humans to pave a 27-foot-wide circle.

"They intentionally paved this area for cultural activities," says Mania. "We found here a large anvil of quartzite set between the horns of a huge bison. Near it were fractured human skulls."

In a storeroom in the village Mania shows me another controversial discovery—a 15-inch-long piece of an elephant tibia engraved with a series of regular lines.

"Seven lines go in one direction, 21 go in the other," he says. "We have two other pieces of bone with cut lines that are also too regular to

2 million years ago — Present

Bilzingsleben 412,000 to 320,000

Looking beyond the bulging brow of an ancient human, archaeologist Dietrich Mania (left) sees "conspicuous evidence" of complex social activity as early as 412,000 years ago at Bilzingsleben in eastern Germany. Hominids Mania regards as advanced *Homo erectus* used diverse tools crafted from stone, bone, antler, and wood to hunt and butcher rhinos, elephants, and bison. An elephant leg bone fragment (below) carries 28 marks Mania calls "deliberately, regularly engraved cut lines," which he believes "indicate abstract thinking and symbolic behavior." Interpreted as a permanently occupied campsite, Bilzingsleben preserves evidence of structures and a paved space for group rituals (bottom) that may have included crushing and scattering human remains.

be accidental. They are graphic symbols. To us it's evidence of abstract thinking and human language." Most specialists would argue that those engravings, dated at around 400,000 years ago, are much too old to represent symbolic thinking, often regarded as a defining trait of the modern human mind. But if Mania is correct, humans of this antiquity in Europe—and probably elsewhere—were far more advanced in their thinking than scientists have imagined.

BY 350,000 YEARS AGO glaciers blanketed northern Europe, and humans became scarce on the landscape there. However, they continued to live in warmer regions. In 1993 another Spanish team working in the Sierra de Atapuerca announced the discovery of the remains of at least 32 individuals dating back 300,000 years.

The fossils were found in an underground cave called La Sima de los Huesos, or the Pit of the Bones. There workers found the remains, mostly of teenagers and young adults, which may have been thrown down a shaft, perhaps in a ritual that predated the organized burial of the dead. The discovery included three skulls, one of which had contained a brain as large as a modern human's.

"Their facial structure showed the beginnings of Neandertal features, including a midface that projected out like a beak," says one of the team's leaders, Juan Luis Arsuaga of Madrid's Complutense University. "Yet they were about as tall as we are. The Neandertals were shorter." It's still unclear whether these pre-Neandertals were archaic *Homo sapiens*, late *heidelbergensis*, or a new species altogether.

"There could have been a big party of different hominids living in Europe together," suggests Clive Gamble, an archaeologist at the University of Southampton in England.

That diversity could have resulted from successive migrations of early humans into Europe. Once there, those first Europeans would have been shaped by the rigors of living in such a harsh climate.

"In Europe there are long winter months when the food supply shuts down, so humans had to live on meat like carnivores rather than on vegetation like most other primates," says Gamble. This meant getting to the right spot at the right time, and so they had to learn to plan better and organize small groups that often had to separate from the others for extended periods. "To survive in Europe, they had to develop complex social networks," he adds.

Such complexity has left its mark across the European continent. As I witnessed in Spain and Germany, Italy and Britain, and as Clive Gamble had told me in his office, "Europe wasn't the cradle of humanity, but we now know that it was one of its most creative workshops." □

Where horses grazed 400,000 years ago, archaeologist Hartmut Thieme (right, with fossil horse skull and jaws at lower left) has found finely crafted wooden spears honed for hunting. Five spears, their weight balanced for throwing, have been collected at Schöningen, Germany, since 1995. Such discoveries—here and across Europe—promise to reshape our understanding of the human diaspora as dramatically as ground-gnawing mining machinery (above) reshapes the Schöningen landscape.

Torrents of water rocketed from outlet tubes at the base of Glen Canyon Dam for seven days in the spring of 1996. The artificial flood was designed to marshal sediment from the riverbed to rebuild downstream beaches long eroded by the dam's fluctuating outflows. More than 50 new beaches were created, only to be threatened by this year's runoff from a record snowpack in the Rockies.

Glen Canyon Dam has been hailed by supporters for its water storage and power generation but denounced as Pandora's dam by environmentalists. Bruce Babbitt, Secretary of the Interior, recently decided to reduce the range of fluctuation in the dam's outflows to protect the downstream environment from erosion, even though such action limits the dam's ability to generate electricity in periods of peak demand.

The Grand Managed Canyon

Target of five million tourists a year, Grand Canyon National Park is also invaded by frequent air pollution as on a May morning (following pages). Restrictions to reduce noise from sightseeing airplanes and helicopters are being phased in. On the Colorado River, boaters encounter an ecosystem transformed by Glen Canyon Dam upriver. Still unresolved: Can all the canyon's competing interests be satisfied?

By MICHAEL E. LONG
Photographs by PETER ESSICK

THE BIG WAVE in the Colorado River's Crystal Rapids churns in place like an ocean breaker that doesn't know where to go. The first four dories of our fleet have avoided it by hewing to Crystal's relatively calm right flank. As we enter the rapids' tongue in *Sequoia*, boatman Martin Litton loses his left oar because of a cantankerous oarlock, and the oar floats beyond the desperate grasp of guide Stephanie White. We find ourselves pointing toward the monster wave, 25 feet high—the centerpiece of one of the most intimidating half miles of white water in North America.

With a display of brawn that would do credit to a twentysomething, 79-year-old Litton, the grand master of dory boatmen, keeps *Sequoia* straight on. We ascend the big wave as a climber ascends a vertical face of rock—and lose momentum. I see wavelets frothing on the curling crest, and instantly we are flipped like frying eggs, sunny-side down, into the green, wet womb of the Colorado.

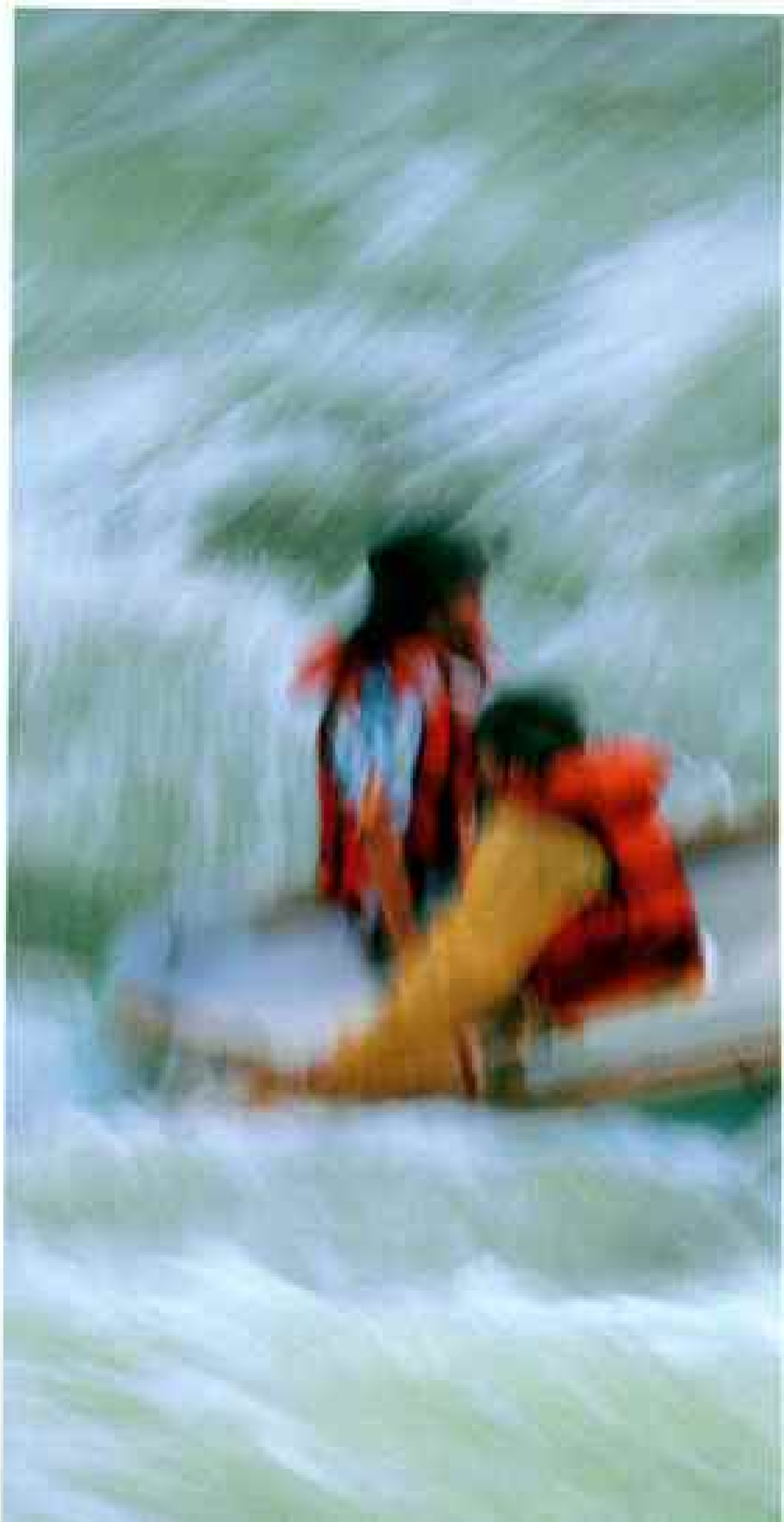
When I surface, I see Litton near the capsized *Sequoia*. I hear White screaming, "Swim right!" We are being carried toward the Rock Garden, a phalanx of boulders marked by blisters of surf. The aluminum dory crashes into one rock, then another, generating great *barooms* that resonate through the canyon. The current delivers me into a rooster tail of foam. Like a twig in a torrent I carom off a boulder, banging a leg and lacerating a thumb. In this tempest a rescue dory appears. We are hauled over the side like rag dolls.

Later, on a beach across from Thank-God Eddy, we contemplate the stove-in stern of our 18-foot dory. "You're not going to write about this, are you?" Litton asks. It is a wry question. He knows perfectly well I'm going to write about our flip in Crystal Rapids. The rapids are part of my reason for being here.

I have embarked on this voyage to experience a river altered by man's hand: Since 1963 Glen Canyon Dam has been like a tourniquet on the Colorado River, restricting the river's flow and changing its environment. Crystal Rapids is a pretty good example of that.

Crystal was built by a debris flow—a powerful slurry of boulders, mud, and detritus fed by heavy rains—that cascaded down Crystal Creek Canyon December 6, 1966. Like churning concrete, the mixture stormed into an unremarkable stretch of river, creating deadly rapids that have killed five people, more than any other Grand Canyon rapids.

"Crystal remains a dangerous rapid," says



Planting his oars in the teeth of Horn Creek, one of 95 major rapids in the canyon, a boatman braces his dory to keep it from flipping. Tempestuous Crystal Rapids capsized the author's boat, dumping its crew into frigid water for a four-minute sluicing through rock-studded white water before they were rescued by another dory.

Bob Webb, a hydrologist with the United States Geological Survey, "mainly because Glen Canyon Dam, 113 miles upstream, constrains the Colorado's flow to somewhere between 5,000 and 20,000 cubic feet of water per second." Before the dam, flows of more than 120,000 cfs piled through rapids, rearranging rocks like a cue ball disperses billiards.

"Everybody talks about the Grand Canyon cutting downward," Webb says. "Now it's filling up. Debris flows from the tributaries are controlling the hydraulics of the river, creating new rapids and enlarging others."

Such debris flows are only one of the environmental problems that have dogged the river since the dam closed its gates in 1963, inaugurating an epochal transformation. "The dam provides us with recreation and electricity, but its alteration of the river's flow has been decisive," says Rob Arnberger, superintendent of Grand Canyon National Park. "One ecosystem was destroyed and replaced by another."

GLEN CANYON DAM is a hangover from early 20th-century water wars among states served by the Colorado River and its tributaries. With thirsty California at the end of the pipeline, Colorado and other upper basin states feared they would lose their share. The states resolved the matter in the Colorado River Compact of 1922, agreeing that Colorado, New Mexico, Utah, and Wyoming would deliver 7.5 million acre-feet a year of river water to the lower basin—Arizona, California, and Nevada.

Congress authorized Glen Canyon Dam in 1956 as a water-storage facility to help fulfill the compact and to generate cash through the sale of hydroelectric power. The dam was 300 feet thick at its base and 710 feet high, a convex

Running canyon rapids in air-conditioned comfort, armchair boaters sit transfixed before a screen six stories high at the Grand Canyon Theater at Tusayan. The production is sponsored by an affiliate of National Geographic Television. Playing to packed houses 13 times a

day in the summer, the movie "Hidden Secrets" chronicles the history of the Grand Canyon—from Native Americans to the first Spanish explorers to the exploits of Maj. John Wesley Powell and his boatmen, who faced the perils of the Colorado River in 1869 and 1871.

Cleaving canyon walls at the rate of less than an inch a century, Deer Creek gnaws through Tapeats sandstone, deposited in the Cambrian period more than 500 million years ago. Vishnu schist, the oldest rock in the Grand Canyon geologic staircase, is nearly two billion years old.

chunk of nearly ten million tons of cream-colored concrete that looked out of place in the red-rock sandstone of the middle of nowhere that is Page, Arizona. Few people were asking whether the dam might affect the Colorado River downstream.

The predam Colorado, muddy and fierce, rose and fell with the seasons. Carrying millions of tons of sediment, its floods scoured streamside vegetation while depositing enormous sandbars at the river's edge. A mud-caked cadre of river runners mucked it up in the world-class rapids during the few months of the strong flow, which ebbed to a chilled trickle in winter.

After the dam the river's annual torrent was replaced by daily tides that fluctuated as much as 13 feet according to power demands, gnawing at those sand beaches and leaving river runners high, dry, and mad. Or low, wet, and mad, as was Bruce Babbitt, now the secretary of the interior but in 1987 a private citizen on a river trip. "The river went up and down like a toilet tank," he told me. "You'd throw your bedroll down on a nice wonderful stretch of sand and wake up in six inches of water."

Yet the postdam river seemed to offer compensations. It was clear and 49 degrees cold year-round, its water drawn from the reservoir's depths. Sunlight penetrated the clear water to forge a new food chain. Green blooms of *Cladophora* algae attracted diatoms that attracted *Gammarus*, an introduced shrimp-like amphipod fed upon by trout that in turn fed bald eagles.

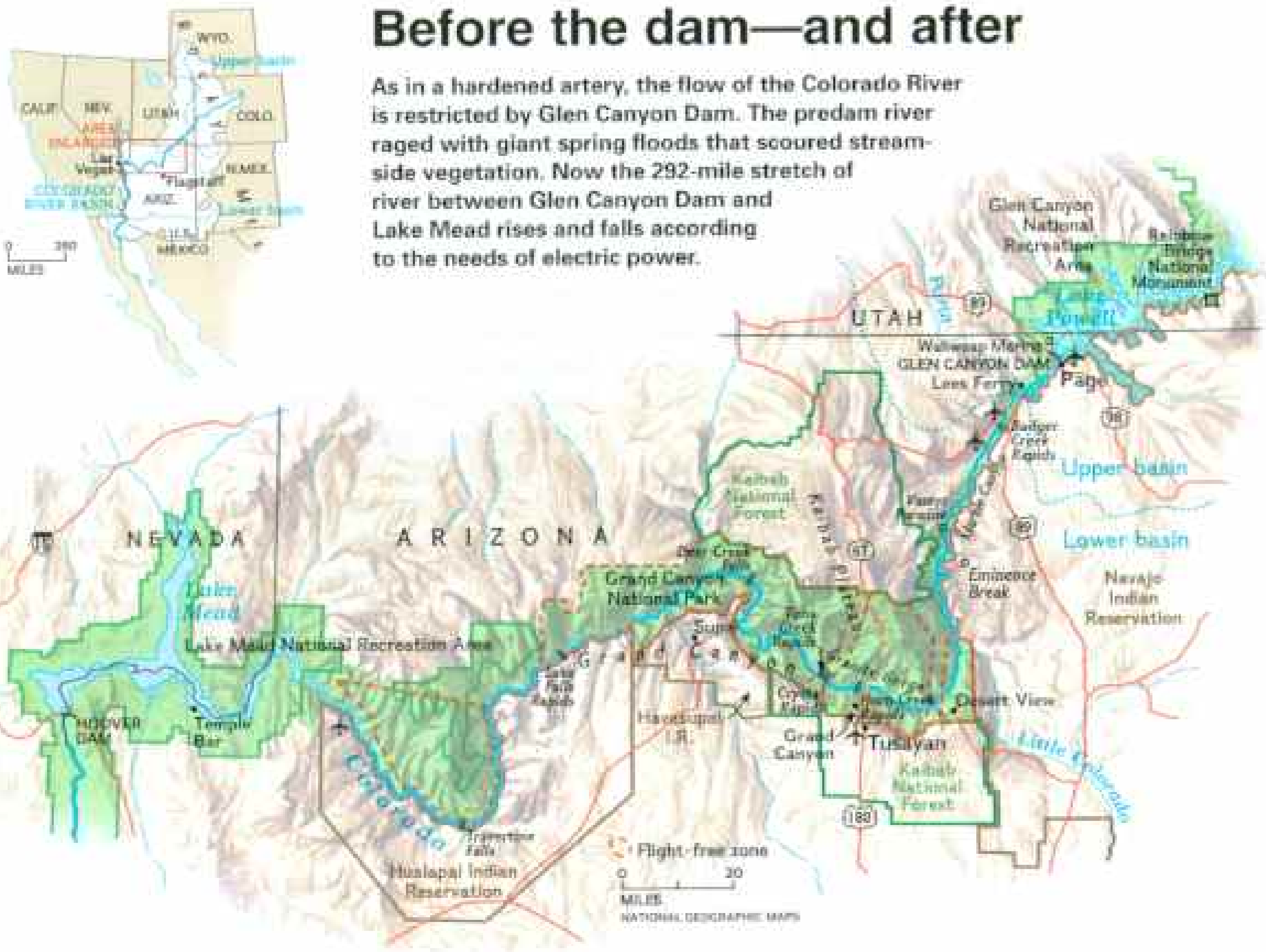
On banks and sandbars no longer scoured by floods, exotic tamarisks and native willows proliferated. Migrant birds passed the word about foliage stocked with millions of tiny leafhoppers. Peregrine falcons passed the word about all the birds and came to prey on them, creating the largest population of nesting peregrines in the lower forty-eight.

Glen Canyon Dam had wrought a mighty

Former staff writer MIKE LONG is a recent transplant to the West. He last reported on Colorado's Front Range for the November 1996 issue. PETER ESSICK's photographs have illustrated numerous GEOGRAPHIC stories, including "Our Polluted Runoff" in February 1996 and "A Passion for Trout" in April 1996.

Before the dam—and after

As in a hardened artery, the flow of the Colorado River is restricted by Glen Canyon Dam. The predam river raged with giant spring floods that scoured streamside vegetation. Now the 292-mile stretch of river between Glen Canyon Dam and Lake Mead rises and falls according to the needs of electric power.



Plants and shrubs have gained a foothold on formerly bare banks. In the predam riparian zone, only short-lived herbs and grasses survived the annual flooding of the Colorado River, a torrent that reached 300,000 cubic feet a second in 1884. Above this zone perennial acacia, mesquite, and ocotillo took root. In the postdam ecosystem exotic tamarisks and native willows crowd beaches. Teeming insect life draws birds preyed on by peregrine falcons. Bald eagles feed on rainbow trout, which now outnumber native humpback chub.

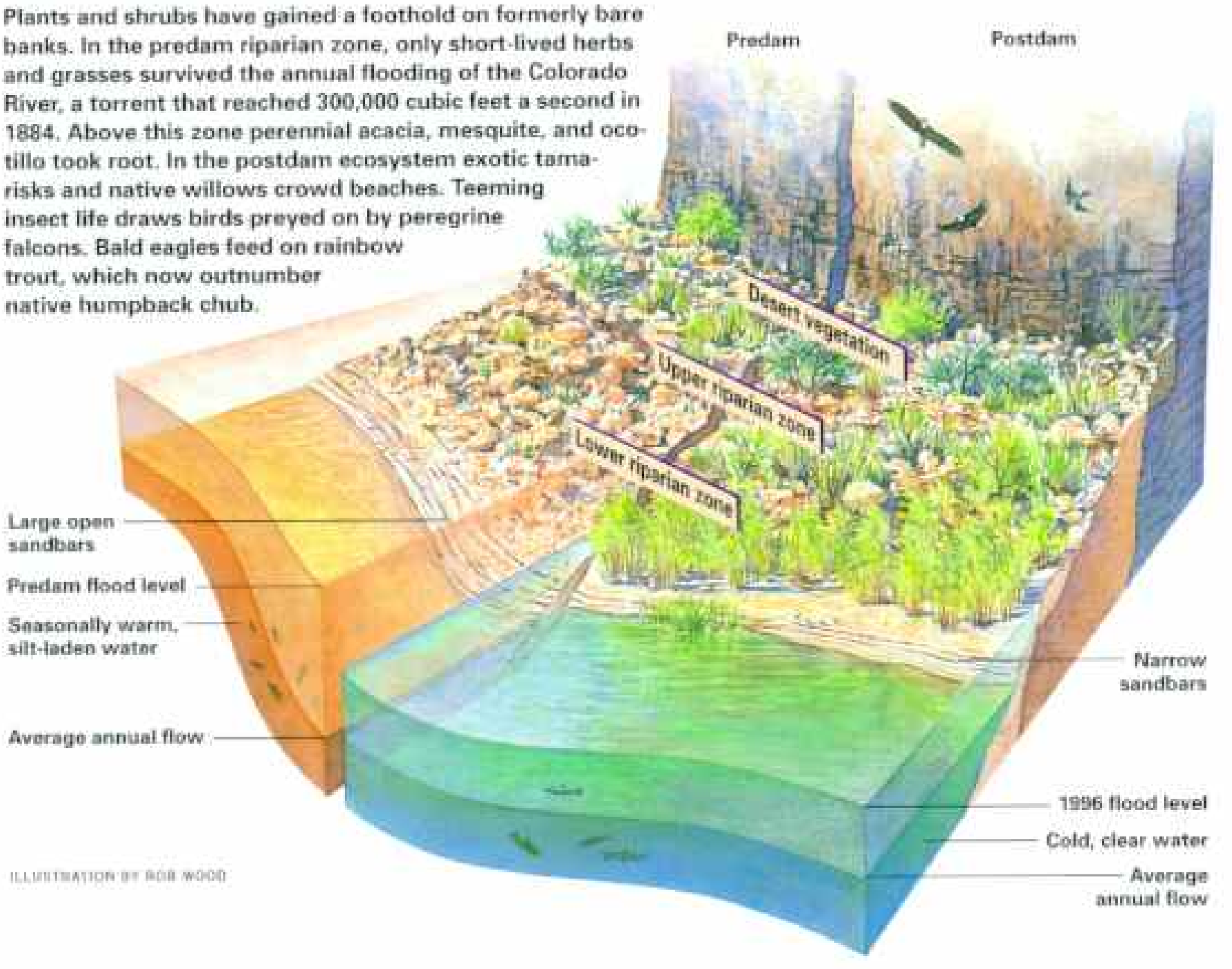


ILLUSTRATION BY ROB WOOD

change in the riverine ecosystem. But what to make of it? Depending on your point of view, the new environment was to hate or to love. Edward Abbey, the environmental writer, had a solution—blow up the dam. David Foreman and others of Earth First!, a radical green group, unfurled a 300-foot-long sheet of black plastic down the face of the dam to simulate a crack. And one river-running folksinger, Katie Lee, excoriated the U.S. Bureau of Reclamation as "wreck-the-nation" dambuilders who had "wiped out the good Lord's work."

Yet below the dam river-running tourists were showing up in ever-increasing numbers; in 1996, 26,000 people ran the river. Still, the river runners and their guides did not care one bit for those fluctuating tides, which could strand their boats.

In 1982 the Department of the Interior inaugurated a Glen Canyon Environmental Studies Program headquartered in Flagstaff, Arizona. Its corps of scientists branded those fluctuating flows as too extreme, too frequent, too erosive, and altogether too detrimental to the riverine environment.

Responding to these concerns, Babbitt's predecessor as secretary of interior, Manuel Lujan, decreed a reduction in maximum flow from 31,500 cfs to 20,000 cfs. These so-called interim flows rankled the power community because the reduction took some of the edge from the dam's capacity for peaking power—the ability to boost power output quickly by running more water through the turbines.

Under the environmental-impact process, the dam's effect on the river was up for scrutiny and comment by all sorts of interested parties. Dam and power folks looked around the table and saw Indians, hydrologists, river guides, fisheries biologists, sedimentologists, archaeologists, and environmentalists of several stripes. The discussion proceeded under ground rules set by the Grand Canyon Protection Act of 1992, which mandated that the dam would henceforth be operated to "protect . . . and improve" the natural, recreational, and cultural resources of the Colorado River downstream of Glen Canyon Dam.

After several years of sometimes heated discussion, hundreds of river voyages by scientists, and thousands of letters, nine operating regimens were identified, from no action at all to fluctuating flows to steady flows year-round.

Participants selected moderately fluctuating flows, arguing that it met two key needs—environmental protection of downstream resources and the generation of electric power, albeit at a slightly reduced output. The stage was set for Secretary Babbitt to choose the dam's operating regimen.

Meanwhile, scientists were discovering the dam's capacity to surprise. "We were dead sure that fluctuating flows were the problem," said Jack Schmidt, a geomorphologist at Utah State University, "but the sandbars kept eroding despite flow reductions." Schmidt and others began to realize that the river was telling them something. While most of its normal sediment load was being shortstopped by the dam, downstream tributaries were contributing sufficient sediment for beach rebuilding, argued Ned Andrews, a hydrologist with the U.S. Geological Survey. He declared that a "flood flow" from the dam could mobilize this material from the bottom of the river channel to create new beaches.

Despite early opposition from the Upper Colorado River Commission, an organization of upper basin states very protective of the water stored in Lake Powell, the flood was an idea whose time had come.

In the early morning of March 26 last year, Babbitt himself turned the wheel to begin a flood that maintained a flow of 45,000 cfs for seven days. Compared with predam floods it was wimpish, but the river swelled, swirled, and eddied, colored itself chocolate brown and made whirlpools, preening for scientists deployed downstream to monitor the effects on beaches, vegetation, and endangered species.

Soon after the flood was over, Babbitt declared victory—new beaches, new backwaters. It was true. Smooth as churned butter, beaches had been built up on both sides of the river. Would they remain?

No, said Martin Litton. All the flood had done was "move sediment downstream, closer to Lake Mead. Sure there are some bigger beaches, but they'll be gone in a year or so."

To assess the changes firsthand, in late April I join Litton for a 16-day, 280-mile dory trip from Lees Ferry into Lake Mead, through the entire Grand Canyon. There are 20 of us. We rendezvous with the boatmen and their dories—*Sequoia, Ticaboo, Dark Canyon, Ootsa*

A congregation of tamarisks stands on the shoreline at Eminence Break. Brought to the United States from the Middle East as an ornamental shrub nearly 200 years ago, tamarisks now crowd many western waterways. Here they offer food—hordes of tiny leafhoppers—and shelter to increasing numbers of birds, which in turn have drawn a healthy population of peregrine falcons. A Bewick's wren (below left), whose nest is hidden in a tamarisk north of Lees Ferry, has brought its brood a meal of insect larva. At Vaseys Paradise, an oasis marked by cliffside springs, the endangered Kanab amber snail (below right) lives on watercress, another introduced plant. This snail, like hundreds of others, was marked and removed to higher ground for safety and study during the flood of 1996.

Lake, and *Okeechobee*. We choose life preservers at random. On the back of mine, I read "Upset Rapid." A frisson courses my spine.

We shove off on a brilliant afternoon, three or four passengers and a boatman to each dory, whose belowdecks stowage capacity is roughly equal to that of five refrigerators. Foodstuffs are cooled by the frigid water. Two oar-powered rubber rafts accompany us, piled high with tents and sleeping bags.

Litton made his first trip through the canyon in 1955. He remembers the "great dunes" of the predam river that were "covered with wildflowers and stretched as far as you could see, and the hordes of cliff swallows. There's not so many now. They required mud for their nests, and there's little of that left."

I note that there's been a reported increase in migrant songbirds such as Bell's vireos.

"How many Bell's vireos did God want?" Litton asks.

The first water is serene. I listen to the river speaking in gurgles, suckings, and lisps. Vortices swirl and die. After chattering in their locks, oars slap at the river. Little mountains of eddies ripple into calm, smooth water. I hear a basso, unsettling roar and see the sneering lip of the first rapids—Badger Creek.

Here I learn that dories dance to the river's lead in a basic two-step—sudden pitch-ups of 45 to 60 degrees fore and aft, combined with half rolls when a wave pummels from the side. All this revolves around a still point, the dory's center of gravity, which tends to be in the vicinity of a boatman's gluteus maximus. *Sequoia* sloshes with water, which we scoop out with buckets.

In the late afternoon we beach the dories,

Links in a new food chain, rainbow trout flourish in the cold, clear water issuing from the depths of Lake Powell. The trout feed on amphipods living in *Cladophora* algae; bald eagles in turn feast on the trout. The chilly habitat has eliminated three native fish. The humpback chub survives but remains an endangered species.

choose campsites, and take our seats for this evening's performance of the Grand Canyon dinner theater. A towering canyon wall serves as scenic backdrop for a rising moon. On the river stage, a procession of waves passes in sinuous, undulating, unceasing rhythm, auditioning for a place in our memories.

On a luminous morning we float the upper Granite Gorge, framed by the tangled geometries of two-billion-year-old schist that is veined with seams of granite. There is no wind; the Colorado is like a mirror. The strains of "Shenandoah" pipe from a boatman's recorder. For once the river seems unconcerned about missing its appointments downstream.

Entering Crystal Rapids, I note that my seat cushion is not in its usual position. I become superstitious. Should I orient it correctly? I decide not to. We flip.

Later, Litton explains that flipping in Crystal is nothing new for him. One look at the fierce rapids in 1967 persuaded him to take his dories through solo; he didn't want his boatmen to feel guilty if they smashed one. Litton flipped on three successive tries, bashing three boats that took a day and a half to repair.

After lunch Litton takes *Sequoia*'s oars as if nothing has happened, and we approach Tuna Creek Rapids. I see the other dories pitching in front of us, and now that I know what a rapid can do, I am fearful. Litton launches into *Macbeth*—"If it were done when 'tis done, then 'twere well It were done quickly"—and we crease through Tuna in a perfect run.

THE DAYS PASS, the sun burns. At the oars of *Dark Canyon*, Regan Dale wears a white hat with a neck flap and is beginning to look like Lawrence of Arabia. In *Okeechobee*, Andre Potochnik, a doctoral candidate in geology, promulgates the kernel of his dissertation: Long ago in geologic time the ancestral Colorado River flowed northeast. Rock swelled upward on the Colorado Plateau and tilted slightly, just enough to cause the river to reverse direction. Potochnik is still wearing the denim shirt he started with. Litton confesses that he once wore the same shirt for 21 days.

Now we are in the still water approaching Lava Falls Rapids, like Crystal a threatening presence. I am in *Ticaboo* with Regan Dale's wife, Ote—short for Coyote. Against the wind, it is a long, hard pull. We beach, and from a ridge I marvel at the tumult of Lava. The guides congregate to scout the rapids. Back in the boat, crouching, Ote turns our dory sideways for maneuvering purposes. She decides, sits, and points *Ticaboo* at the monster's maw—we are committed.

It's an anticlimax. After ten seconds, a couple of good uppercuts, and hooks right and left, Lava punches us into an eddy. Ote shouts, "I

nailed it!" The other dories transit safely. Litton claims *Sequoia* didn't take a drop of water. One of his passengers confirms it. "It was Moses Litton," she says, "parting the Red Sea."

Lava is the exclamation point at the end of the sentence of Grand Canyon rapids. A few remain, but they are far between. That is OK with me. I am confirmed in a decision—never again will I risk my neck in Crystal Rapids or any of her menacing sisters.

By choosing the preferred alternative from the list of dam-operating regimens, Bruce Babbitt essentially sanctioned a maximum flow of 25,000 cfs, abetted by occasional floods to build beaches and enhance habitat. The decision also set in motion a program of adaptive management and long-term monitoring. Thus began the era of the Grand Managed Canyon.

Dave Garrett, director of the new Grand Canyon Science and Monitoring Center, parses "adaptive management" into two elements—close, scientific observation of the riverine ecosystem and, as scientific findings dictate, recommendations to the secretary to make changes in the dam's operating schedule. Long-term monitoring means that this could continue, roughly speaking, for centuries.

Garrett, an economics professor turned environmental troubleshooter, welcomes stakeholders or interest groups of all persuasions. "Anyone who wants to come to the table gets to the table," says Garrett.

A nutcracker issue is the future of the endangered humpback chub. River runners may never see one of these prehistoric-looking fish with the trademark hump and skinny tail, but with the Endangered Species Act in their corner, the chubs are calling the first shots in adaptive management. To promote spawning, Garrett's team and Bureau of Reclamation specialists are looking at ways to warm the water issuing from the dam. A multilevel intake structure costing up to a hundred million dollars is under study.

The U.S. Fish and Wildlife Service argues that a steady flow scenario can also benefit the chub. Reclamation officials counter that scientific data are lacking, and that such flows would eliminate peak-power output. The Fish and Wildlife Service can invoke a so-called hammer clause to force steady flows. While the discussion continues, the hammer is poised. And the river has its own hammer. Some biologists fear that Lake Mead's voracious striped bass, at present corralled by the cold water, may storm upriver in warmer flows to prey at will on the chub and other native fish.

Hydrologist Bob Webb comments, "Managers are more concerned with issues of law, such as endangered species protection, than they are with the Grand Canyon operating as a natural system. If all you do is pay attention to endangered species, you're missing the big picture. I think we should ask, 'What's best for the canyon as a whole?' not, 'What's best for the humpback chub?' "

So a grand debate is under way in the Grand Managed Canyon. But at the moment there are no grand answers. Babbitt welcomes the discussion: "The more we look into our relation to the land, the more likely we will reaffirm natural values. But final decisions will be made by the American people."

A grand question: What kind of river environment do the American people want in the Grand Canyon? "Just by manipulating the release of water from the dam," says Bryan Brown, an ornithologist, "you can manage for native fish, or vegetation, or birds. It's like a giant test tube." Or an anomaly. Brown notes that the southwestern willow flycatcher, an endangered species, prefers to nest in tamarisks, an introduced shrub. "How should managers respond when human-caused habitat changes threaten this bird?" he asks.

How one answers, of course, depends on what one thinks the Grand Canyon should be. Here are value statements from persuasions I list as predam, postdam, and dambuster.

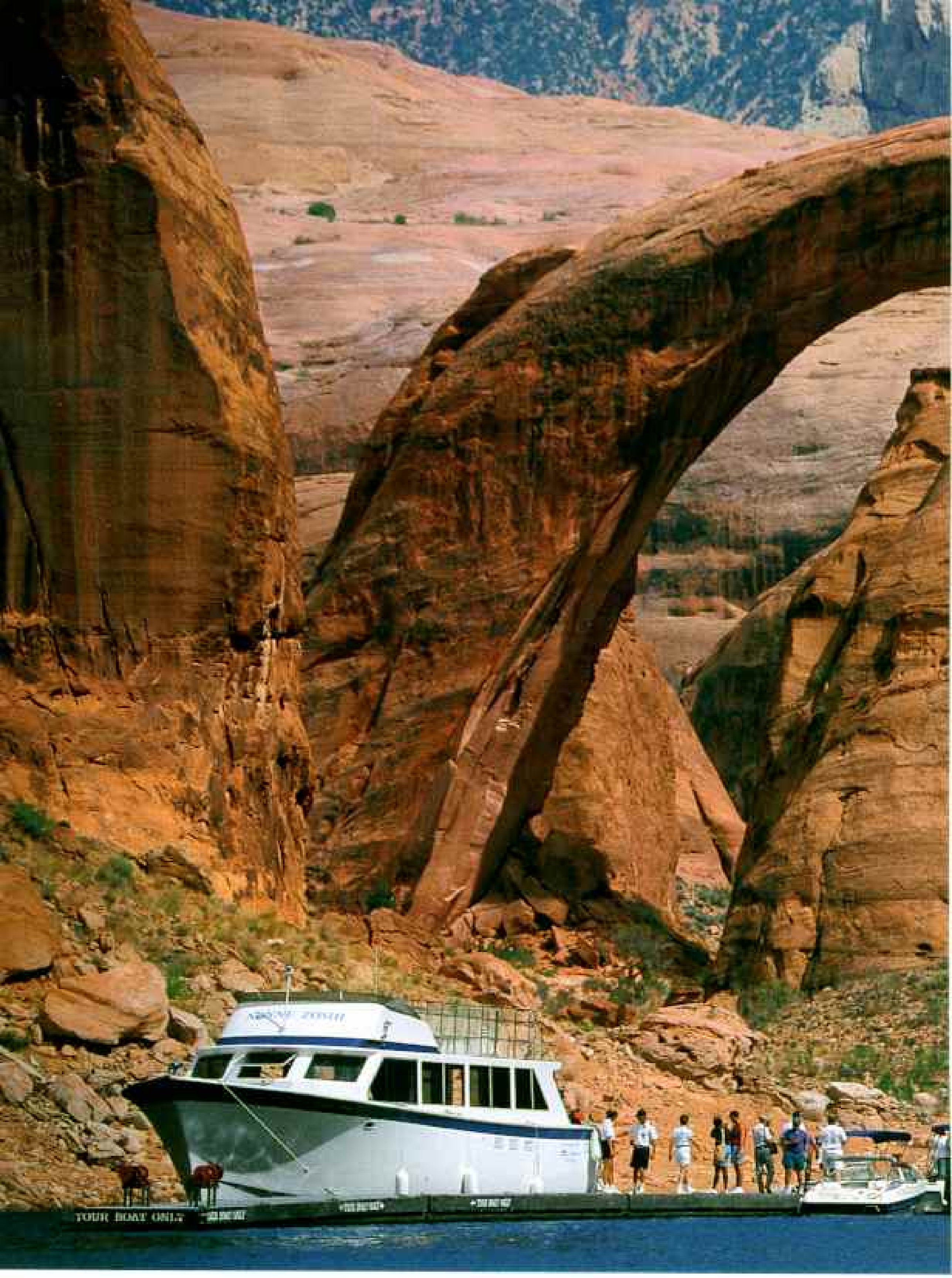
Let Jack Schmidt, the Utah State geomorphologist, speak for the predammers: "We have an obligation to maintain the condition that first attracted people." Schmidt wonders why we "keep sending all those boatloads of scientists downriver, forever measuring and tweaking, trying to keep everything in the system happy." Schmidt proposes a pipeline from Powell that would carry more sediment into the river, permit more floods, and make more beaches. "I think we should manage the river to be as close as possible to the predam conditions and then get the hell out of the way."

Larry Stevens, a river ecologist, responds that we can't go back to the predam ecosystem

A muddy cloud of sediment-laden water from the Paria River mixes with the clear Colorado at Lees Ferry. The Paria, the Little Colorado River, and smaller tributaries annually contribute about 20 million tons of sediment, raw material for rebuilding eroded beaches. Narrow banks mean less space to set up camp for a visitor near the mouth of the Little Colorado (below), one of the roughly 22,000 people who run the Colorado River each year.

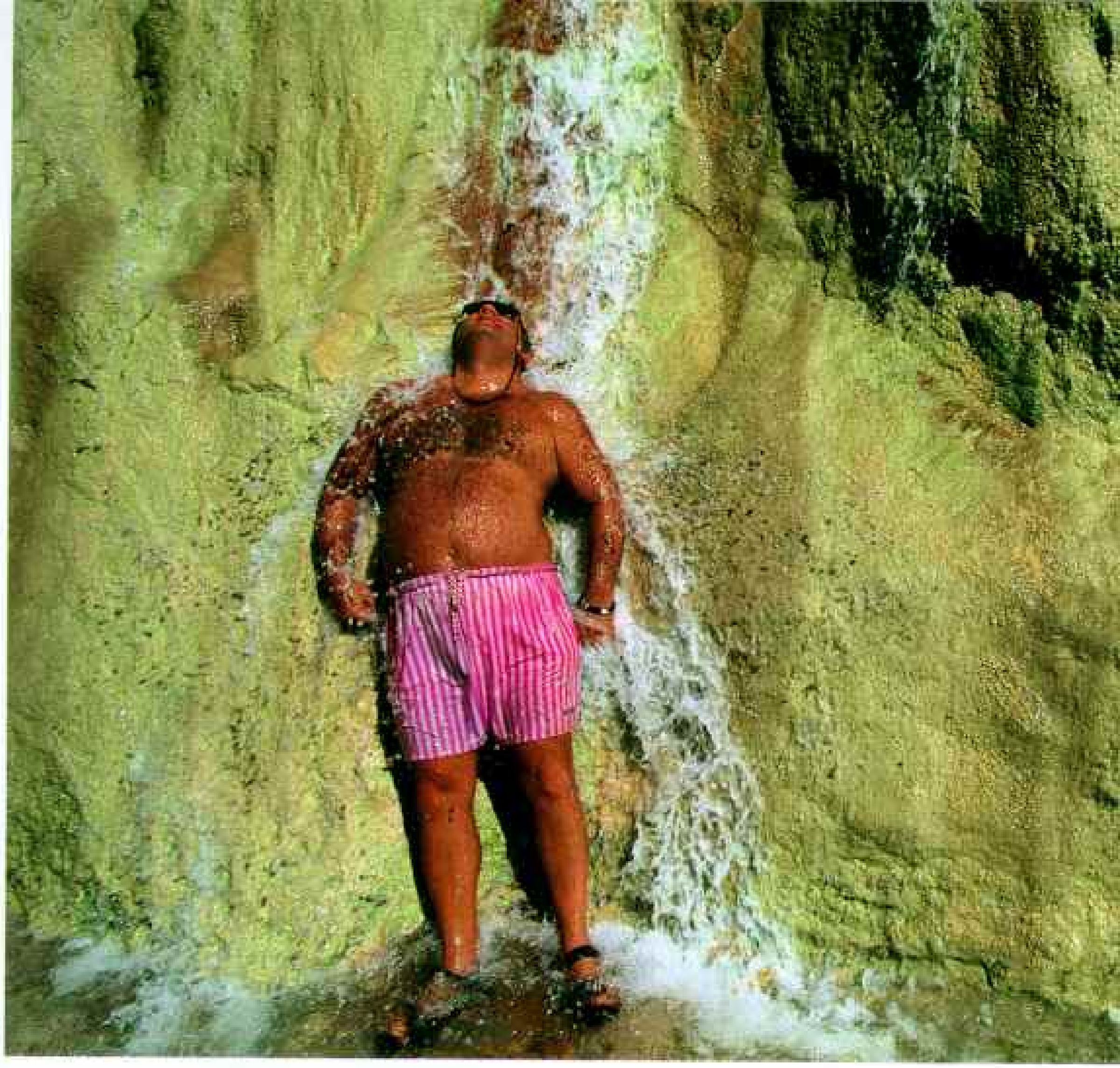
Meanwhile, scientists argue about how to manage the river. Some say large annual floods would serve to restore the river's predam environment. Others favor the postdam ecosystem, noting that new sources of habitat and food support increasing wildlife. A third camp, the dambuster view espoused by the Sierra Club and the Glen Canyon Institute, advocates pulling the plug on the dam and draining Lake Powell to restore Glen Canyon, which was inundated by Powell.

"It's a healthy debate," says Interior Secretary Babbitt. "The American people will have to decide what they want this river to be."



Now available to the masses, Rainbow Bridge is only a half-mile stroll after a comfortable two-hour boat ride from Wahweap Marina on Lake Powell. More than 300,000 people make the trip each year. In predam days a mere handful of visitors faced a mini-expedition.

After a boat trip on the Colorado River to the mouth of Forbidding Canyon they endured a daunting six-mile trek up the aptly named defile. "Lord, it was miserable," remembers Joan Nevills-Staveley, a second-generation river runner.



because nobody really knows what it was. "There isn't much data," he says. "If you really want to restore the river, spend ten billion dollars tearing down the hundred dams in the Colorado River Basin. But that's not too likely."

Stevens argues that there's a new ecosystem, "functioning, diverse, and relatively stable. We've gained more streamside vegetation than was lost in Glen Canyon. We have waterfowl that now spend the winter because there is habitat and food. The tamarisk produces the highest biomass of insects of any woody shrub down there. So we have new vegetation, a new food source, and new wildlife."

Would 22,000 river runners prefer the pre-dam environment? "No way," says Stevens. "With all that mud, slime, and warm beer? Your average, oversanitized American won't put up with that."

They may have to if David Brower, the ardent conservationist and dambuster, has his way. Executive director of the Sierra Club during the dam wars of the fifties and sixties, Brower lost one when Lake Powell drowned the beautiful glens, alcoves, amphitheaters, seeps, and arroyos of Glen Canyon. Brower—now 84—has ever since felt personal responsibility and even guilt.

But not permanent defeat. Arguing that Powell loses an enormous amount of water each year through evaporation and seepage, Brower reopened the Glen Canyon issue with the board of the Sierra Club. By unanimous vote last November, the board recommended that the government drain the reservoir by opening the diversion tunnels. "We'll get Glen Canyon back," Brower promised.

Brower's old antagonist, Floyd Dominy, who

Cooling cascade of Travertine Falls refreshes Nick Zotos, a lawyer from St. Louis, Missouri. Zotos flew in from Las Vegas to join a dory trip for three days—"The gentleman's way," he explained. He liked it so much he's ready for the full 16-day jaunt. And so the Colorado has made another conquest, polishing its reputation as the river of return.

once headed the Bureau of Reclamation but is now an Angus breeder in Boyce, Virginia, was aghast at the idea of draining Lake Powell. "Ridiculous!" he told me. "Glen Canyon Dam is in place. It's doing a good job and will never be removed."

And Wayne Cook of the Upper Colorado River Commission says: "If Powell goes, growth in the upper basin states, from a water standpoint, is over. Sometimes we'd have to deliver the entire year's flow of the Colorado River to the lower basin. There would be no storage for our obligations under the compact." Secretary Babbitt agrees, arguing that Powell is "essential to the economies" of those states and that draining the reservoir is "unrealistic."

Draining Powell could also be dangerous. Geoff Barnard, president of the Grand Canyon Trust, says, "I think it's important to stake out a vision of a free-flowing Colorado River, but there are many problems right now. For 30 years Lake Powell has been concentrating sediment contaminated with heavy metals, pesticide residue, even radioactive material. So you just can't open the gates. You could have a disaster downstream. However, there may come a time when society decides to decommission Glen Canyon Dam."

WHILE SOCIETY IS DECIDING, nature herself could intervene. "We may not recognize this river in a hundred years," says Ted Melis, a USGS hydrologist. "As erosional cycles change, the river could be overwhelmed by sediment from tributaries."

The time seems sure to come when the Colorado itself will silt up the reservoir and overwhelm the dam. Estimates range up to 700 years for the establishment of Glen Canyon Falls, followed later by Glen Canyon Rapids, when the dam crumbles. "The river laughs at that dam," says Rod Nash, a writer and river runner. "With time and erosion on its side, the river will win."

Something else had been eroding with the passage of time—my fear of rapids. The bad dreams of Crystal had ceased. In a process that was by no means rational, I began to realize that a part of me was being drawn back to this wonderful river and to the dories, those little boats that dance with it and to which the river entrusts its secrets.

One day Martin Litton called. He was putting together a trip, a sort of 80th-birthday voyage down the Colorado with old friends and boatmen. He asked if I would like to come along. This was an invitation I was almost ready to accept, but for a moment an image of Crystal flashed through my mind.

"What about Crystal?" I asked.

"Awwww," he said. "It's only water." □

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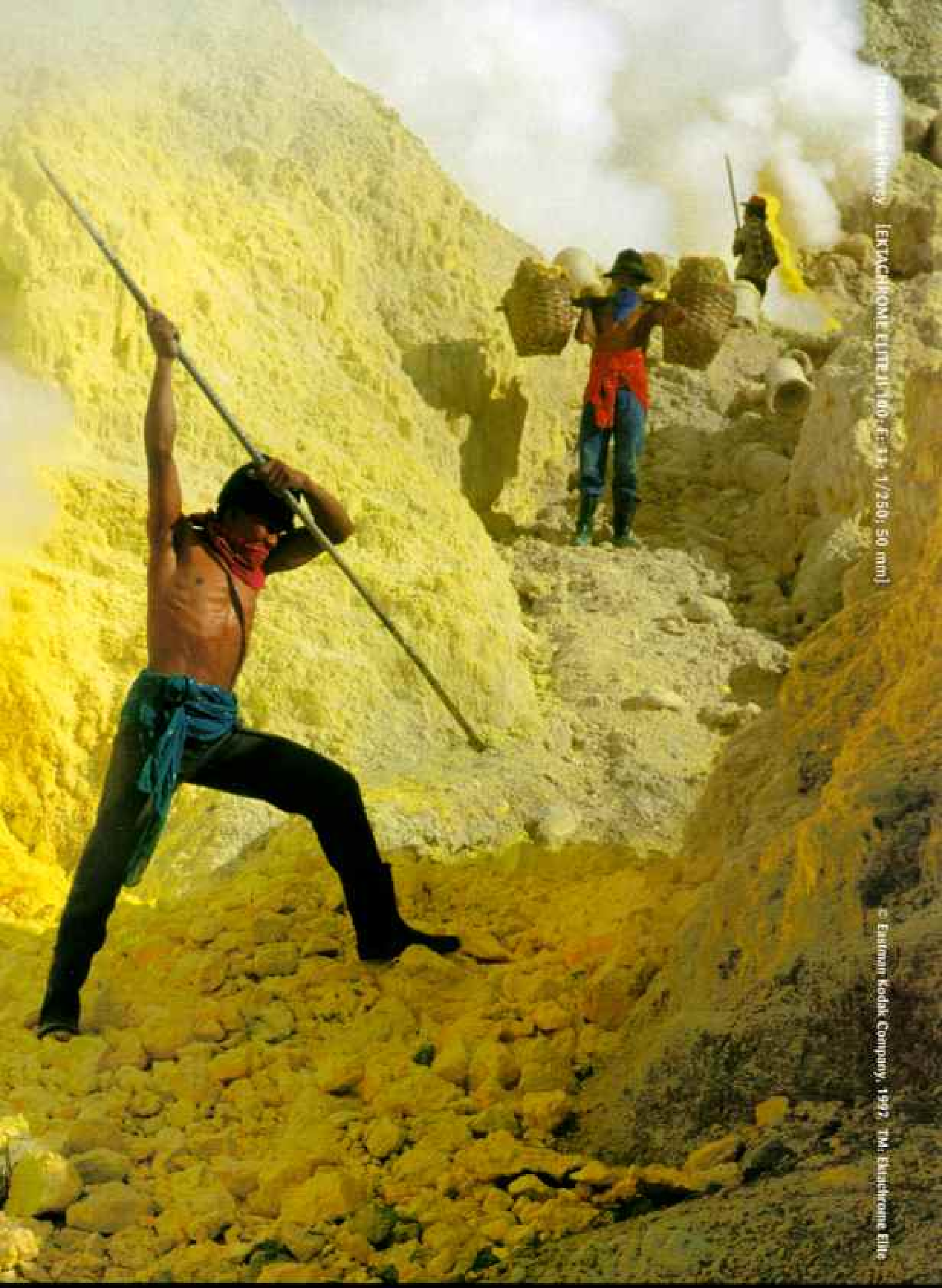

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NATIONAL GEOGRAPHIC

JULY 1997

The Cover

The anthropomorphic machine IT, designed by Artificial Creatures in Boston, can detect human emotions and react with words and gestures. Photograph by George Steinmetz

Cover printed on recycled-content paper.

Sulawesi Crested Black Macaque *(Macaca nigra)* **Size:** Head and body length, 44 - 57 cm; tail, 2 cm. **Weight:** Approx. 10 kg. **Habitat:** Tropical rain forest in north Sulawesi, Indonesia. **Surviving number:** Estimated at 5,000.
Photographed by Tui De Roy

WILDLIFE AS CANON SEES IT

A female Sulawesi crested black macaque and a group of youngsters rest and groom during a mid-morning break from foraging. Within their complex social order, these monkeys communicate with a wide array of facial expressions—a smile can signify friendly or nervous submission, or aggression, depending on the context. Crested black macaques once occurred in high densities, but are now restricted to a few patches of forest. In the past 15 years, populations have declined by 75 percent, a result of habitat disturbance and continued pressure from illegal hunting. As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

Behind the Scenes

ABBY NOONAN, NGS (ALL)

Gone South: The Grosvenor Council Visits Antarctica

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On Her Toes

A limited-edition print of Karen Kuehn's photograph of a kitten and a dancer (June 1997, pages 68-9) is available for $29.95, postage paid. (Please add appropriate tax for orders sent to CA, DC, FL, MD, MI, PA, and Canada.) Printing will begin September 15, and we will produce only as many 24-by-36-inch posters as we receive orders for by that date. Each will be hand-numbered and embossed with the NGS seal.

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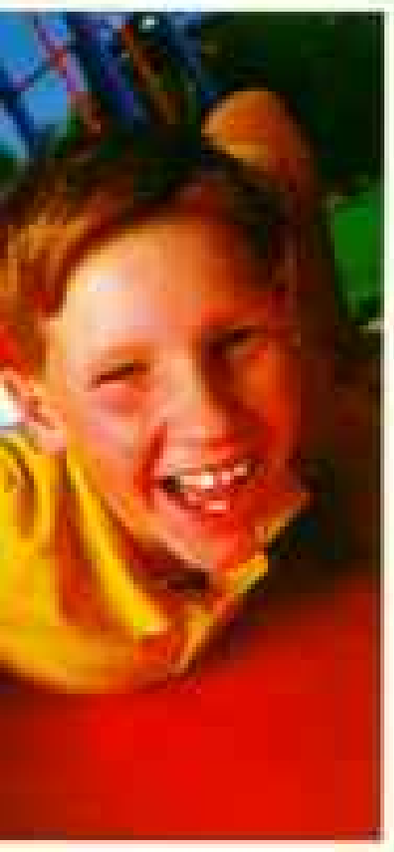

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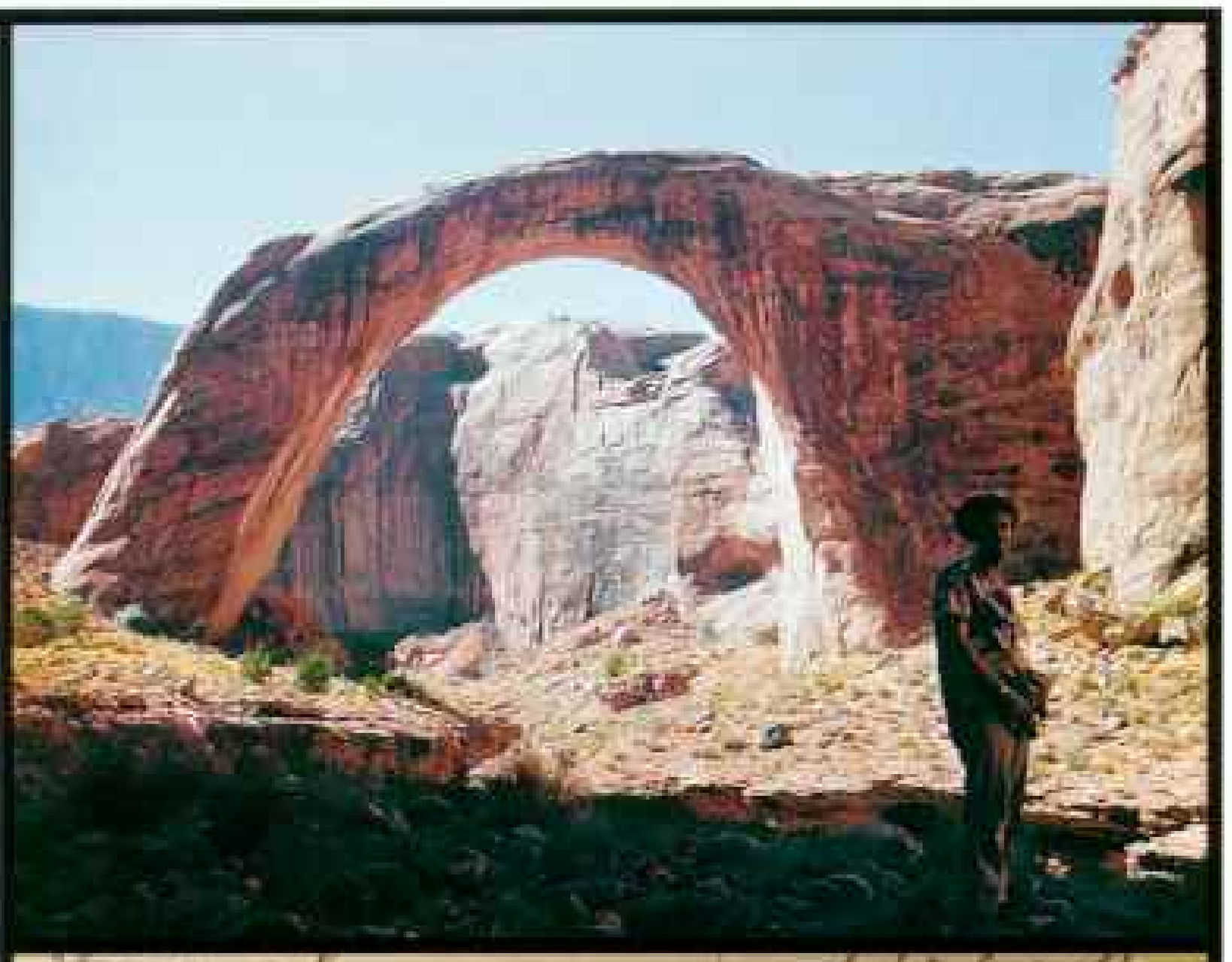
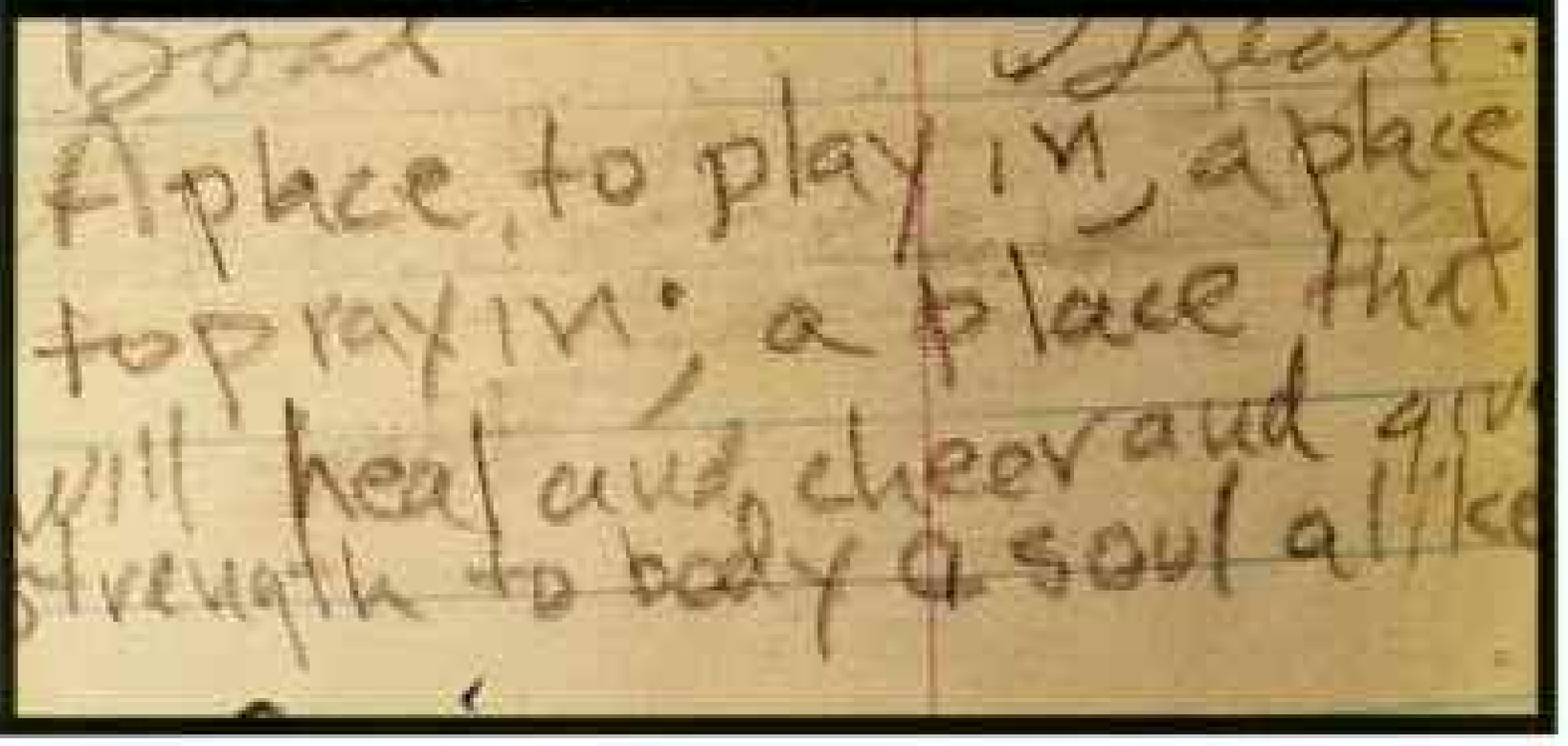
Déjà View in Utah

When Peter Essick photographed Rainbow Bridge National Monument for this issue (pages 132-3), he followed in his father's footsteps. In 1957 John Essick (right) made the arduous trip to see the bridge—now a leisurely boat ride on Lake Powell. John was in a thoughtful mood when he wrote in the park's visitors book. His wife, Rose—then in no shape to trek to off-road attractions—has different memories of that vacation 40 years ago. "I was six months pregnant with Peter, in the desert summer, with no air-conditioning! I remember that trip!"





Only the Photographer Blew His Top

Waiting for the volcano to explode on the island of Montserrat—at press time, it still hadn't—writer Ann Williams and photographer Vince Musi played Trivial Pursuit to pass time. Vince accused perpetual winner Ann of cheating when she pulled the card below. Answer? The National Geographic Society. —MAGGIE ZACKOWITZ

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PHILIPS MAGNAVOX

Forum

Responding to the March 1997 issue, most correspondents focused on the controversies surrounding "Our National Forests." A few found the article "blatantly pro-environmental" and some found it biased "in favor of the Forest Service," but most felt it was balanced. The report on Kaliningrad, one reader wrote, "rediscovered a forgotten land."

Our National Forests

The caption for the opening photograph showing clear-cuts in the Targhee National Forest talks about heavy logging under the doctrine of multiple use but neglects to mention that this area was salvage logged from 1958 to 1988 to remove trees killed during a massive mountain pine beetle epidemic. The resulting mosaic has more diversity than the adjacent forest of mature trees in Yellowstone Park. The North Fork fire, which started just north of this photo, burned 200 times as many acres as the clear-cuts visible in the aerial. A portion of the same fire went out shortly after encountering the clear-cuts. The regeneration now provides the best cover for wildlife on the 17,000-acre burn.

JIM GERBER
St. Anthony, Idaho

The photo caption of the logger on page 61 does not explain that the old-growth cedar being cut is a sick tree. This is evident by the absence of the outer bark. Removal of such old-growth trees improves the survival of the residual stand.

J. KENNETH HAMMONS
Pineville, Louisiana

Can it be that only four million board feet of timber is cut annually in national forests as indicated in the graph on page 66? Or as the text suggests, is it more like four billion board feet?

MICHAEL PARKER
Westfield, Massachusetts

Four billion is correct.

The article was interesting and informative without placing blame or making outright accusations against those responsible for the apparent mismanagement of our forests. It would be interesting to have author John Mitchell travel to Europe and compare forest-management techniques there with ours. For example, Germany's Black Forest has been maintained for hundreds of years, supplying timber, recreation, and wildlife habitat.

H. DONALD BLAIR
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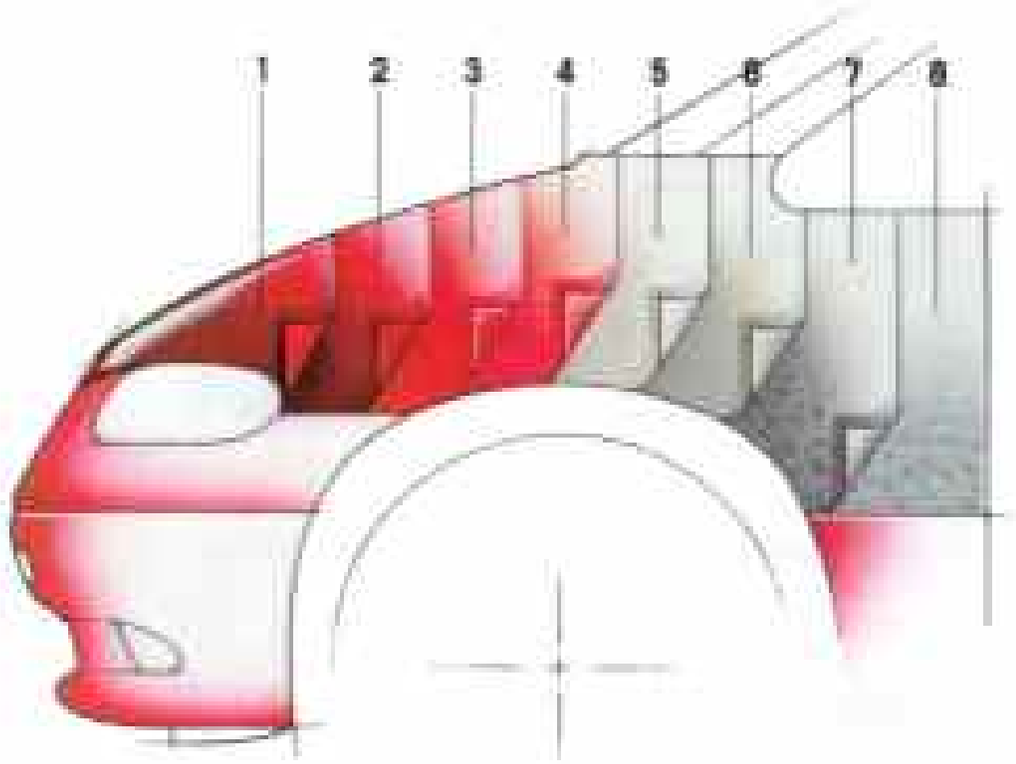

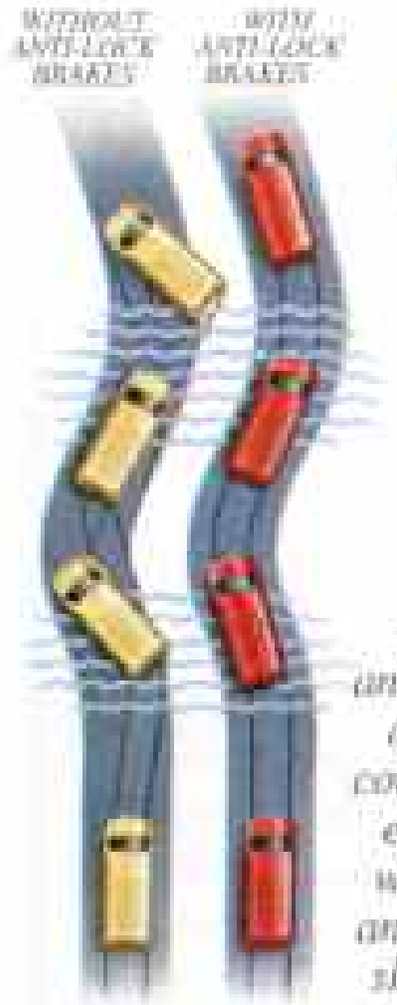

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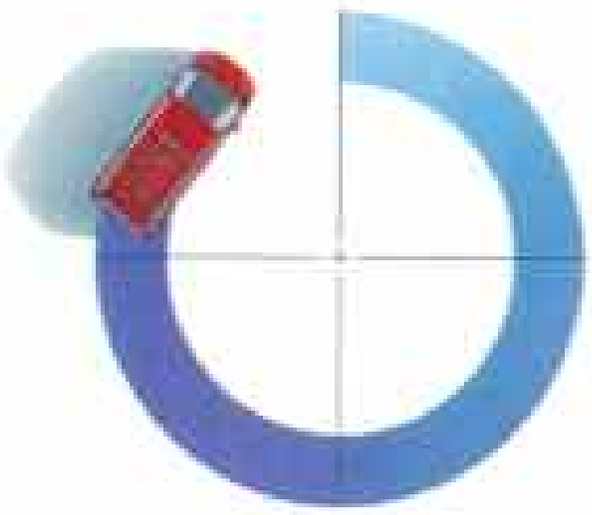

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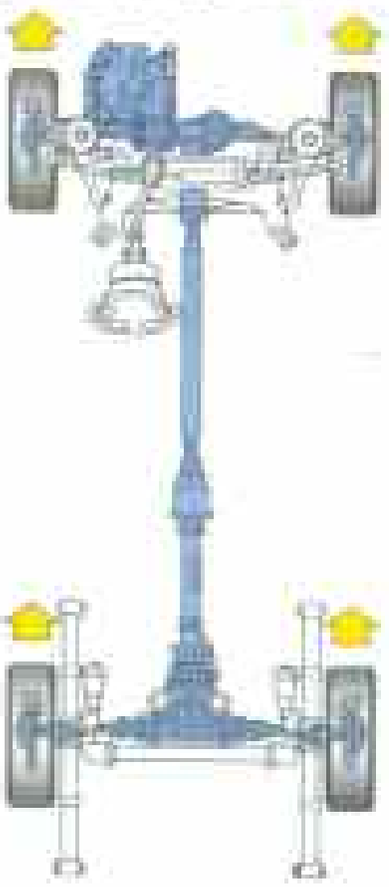

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As a nonlogger who spends time in our upper Midwest national forests, I would like to share a different view of clear-cut harvesting. Done correctly, it is the best method to ensure large, healthy populations of ruffed grouse, white-tailed deer, elk, turkey, American woodcock, and other birds and furbearers. The dense growth in 5-to-20-year-old aspen and oak clear-cuts provides the food, cover, and habitat that wildlife thrives on. The ten-year-old "looks like hell clear-cut" that you refer to is where the majority of wildlife in this area lives.

LARRY BEDNARZ
Muskegon, Michigan

We in Wyoming are well aware of the pro-timber industry bias of the Forest Service. The clear-cutting of national forests here has been as severe as anywhere in the nation. There may now be a new twist. The Coalition for Sustainable Resources, based in Walden, Colorado, is planning a lawsuit against the Forest Service to force more clear-cutting. They assert that it has failed to manage its lands in the North Platte River watershed to ensure higher water runoffs and that more clear-cutting will increase the runoff. The coalition states this is needed for increased water upstream to help the recovery of endangered bird species.

HUGH McGINLEY
Laramie, Wyoming

The concept of clear-cutting as healthy "forest management" is never challenged scientifically. Instead we get comments from an environmental lawyer concerned with visual devastation, and while aesthetics is reason enough to be outraged, it hardly constitutes a scientific rebuttal. There is nothing in the story about the complex relationship of soil bacteria, fungi, and trees, which is destroyed by clear-cutting. We currently do not have the technology to put a forest back together the way it was.

JOHN KASTNER
Rochester, New York

It saddens me to see NATIONAL GEOGRAPHIC support the Forest Service's public relations campaign perpetuating the myth that forests cannot thrive without man's divine intervention.

STEVE KELLY
Swan Lake, Montana

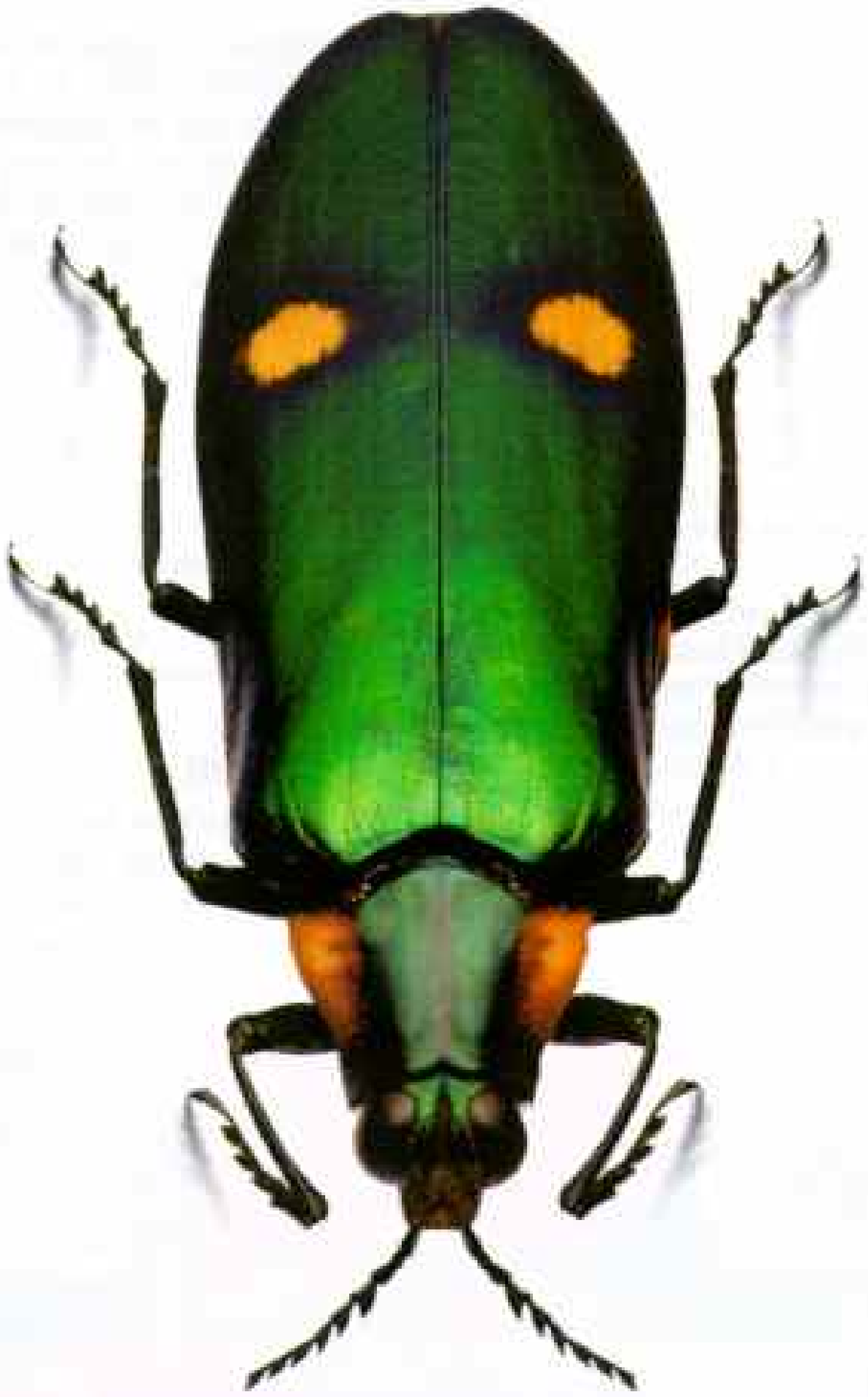
On page 66 the last paragraph says that 830 million visitors were tallied in national forests last year: 8.3 million perhaps, 83 million doubtful. That 830 million would exceed the number of human beings in the entire Western Hemisphere.

FERD WILDER
Jensen Beach, Florida

The Forest Service counts as a visitor anyone who steps or drives into a national forest. This includes return visits and drivers on highways simply passing through.

In boiling down my comments to him (pages 74-5), Mr. Mitchell ignored a little known aspect of forest management: The Forest Service pioneered scenery

BUG CATCHERS



HELPING IMPROVE YOUR BUSINESS PERFORMANCE

ARTHUR ANDERSEN

AS ONE OF THE WORLD'S LEADING BUSINESS ADVISORS AND CONSULTANTS, WE'VE LEARNED A THING OR TWO ABOUT IMPROVING BUSINESS PERFORMANCE. SO WE CAN HELP YOU TAKE CARE OF YOUR BUSINESS FROM THE TINIEST GLITCH, TO HANDLING ISSUES OF GLOBAL PROPORTIONS.

management more than 25 years ago, recognizing scenery as a resource to be managed in concert with other forest resources. Proposed timber-cutting projects are analyzed in the field and with computer imaging to determine potential visual impact and appropriate mitigation and trade-offs.

MELINDA Mc WILLIAMS
Custer, South Dakota

Paper

As I sit in my office managing a three-year-old facility devoted to papermaking and book arts, I am reflecting on Jon Luoma's article. I leave this afternoon to teach at a similar facility in San Antonio, Texas. I agree that the Japanese have a love of paper we are only beginning to approach. But there are many hundreds of us who teach thousands of students, artists, and enthusiasts to love the dance of water and the song of the fiber right here in the U.S. Take note, take a course, and you too may catch the passion for papermaking.

MARILYN SWARD
Chicago Center for Book and Paper Arts
Chicago, Illinois

While the North American paper industry is exploring alternatives to chlorine bleaching, the rest of the world has already moved ahead. In Finland and Sweden no chlorine gas has been used in pulp bleaching for several years. The main bleaching chemical is chlorine dioxide, but totally chlorine-free bleaching using biodegradable chemicals accounts for some 20 percent of the total output.

ILKKA POLLARI
Espoo, Finland

Half the article was devoted to the challenges that timber-based paper production presents to the world's forests and waterways. The story touched on possible solutions, but it failed to mention the well-documented ecological advantages offered by large-scale use of hemp in paper production.

WILLIAM YARCHIN
Huntington Beach, California

In the picture of paper mementos (pages 96-7) was a receipt from Alban L. Parker for piano tuning. Mr. Parker was my paternal grandfather. In business with him was his son, my father, Paul Parker. The receipt was typed on the typewriter on which I played when visiting my grandparents and is in my home today, a reminder of a family business that spanned almost a hundred years.

SHARON DEHAAS
Colorado Springs, Colorado

Our organization, with wide support, is preserving and restoring the site of America's first papermaking industrial village, which was begun in 1690 by William Rittenhouse near Germantown, outside Philadelphia.

ANDREW A. ZELLERS-FREDERICK
Executive Director, Historic Rittenhouse Town
Philadelphia, Pennsylvania

Kaliningrad

Journalists seem to believe that history starts in this area only with the year 1255. Nobody mentions the fact that before the Teutonic Knights invaded in the name of Christianity and killed the original

inhabitants, the area was inhabited by a Baltic-speaking people. That small nation was wiped out and the land settled by German invaders. Centuries later these invaders were dispersed by others, from the east. As a member of one of the remaining Baltic nations, I cannot possibly sympathize with any invaders of that Baltic corner of the world. It seems quite right that no invaders may live happily ever after on that land.

ILGA HERMAN
Lamontzie-Saint-Martin, France

Your article was fascinating and informative. Although the author didn't mention it, I can now better understand the Russian concern over NATO expansion—given Kaliningrad's importance to Russia, its location between NATO candidate Poland and the Baltic States, and its tenuous national identity.

N. DAVID TEEGARDEN
St. Paul, Minnesota

I wish my father were alive to see this article. You have validated an oral history that brought both pride and confusion after our family fled to America prior to World War II. Schoolmates could never understand that we weren't Russian, Polish, or German, and not Nazis. Königsberg was a city of culture—grand opera, stiff silks, and high top hats. It was a seaport with proud houses of Hanseatic League families, blowing sand dunes, and beaches where amber washed ashore. It was a city full of life—of fishwives on their stools by the docks, of little boys who threw firecrackers into piles of fish to watch them jump and dance as if they still had life. This wasn't a society of dissolute nobility but rather of landed gentry.

MARGARET KANNOWSKI EASTON
Elkhart, Indiana

Behind the Scenes

The picture from the marine exhibit is not a sea anemone. It is the coral *Tubastrea* with its polyps extended for feeding. The tentacles contain stinging cells used to catch prey, which is then conveyed to the mouth at the center of the disk.

ANNE SEARS
Concord, Massachusetts

Letters for FORUM *should be sent to National Geographic Magazine, Box 98198, Washington, D.C. 20090-8198, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and space.*

You'd give your life for them.
But that's not what they want.

They just want you
to stay healthy.

The fact is, you could be at risk of having a first heart attack, if you have high cholesterol.

PRAVACHOL is proven to help prevent a first heart attack.

PRAVACHOL is the only cholesterol-lowering drug of its kind proven to help prevent a first heart attack. And the grim fact of the matter is, up to 33% of people do not survive their first heart attack.

Improving your diet and exercise is important, but may not be enough. So, ask your doctor about Pravachol. It may help you live a longer, healthier life.

PRAVACHOL, when used with diet, is proven to reduce the risk of a first heart attack, lower the risk of death from heart disease, and lessen the risk of heart surgery, based on a new landmark five-year study including over 6,500 males with high cholesterol and no evidence of heart disease. PRAVACHOL is a prescription drug, so you should ask your doctor or healthcare professional if PRAVACHOL is right for you. Some side effects, such as slight rash or mild stomach upset, occur in about 2–4% of patients. PRAVACHOL should not be taken by women who are pregnant or nursing, people who are allergic to any of its ingredients or by anyone with liver disease. Your doctor may perform blood tests to check your liver function before and during treatment. Tell your doctor right away if you experience any muscle pain or weakness, as it may be a sign of a rare, but serious side effect. Be sure to mention any medications you are taking so any possible serious drug interactions can be avoided. Please see important information on the next page.

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PRAVACHOL helps prevent first heart attacks.

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Pravastatin Sodium Tablets

CONTRAINDICATIONS: Hypersensitivity to any component of this medication. Active liver disease or unexplained, persistent elevations in liver function tests (see **WARNINGS**). Pregnancy and lactation. Atherosclerosis is a chronic process and discontinuation of lipid-lowering drugs during pregnancy should have little impact on the outcome of long-term therapy of primary hypercholesterolemia. Cholesterol and other products of cholesterol biosynthesis are essential components for fetal development (including synthesis of steroids and cell membranes). Since HMG-CoA reductase inhibitors decrease cholesterol synthesis and possibly the synthesis of other biologically active substances derived from cholesterol, they may cause fetal harm when administered to pregnant women. Therefore, HMG-CoA reductase inhibitors are contraindicated during pregnancy and in nursing mothers. **Pravastatin should be administered to women of childbearing age only when such patients are highly unlikely to conceive and have been informed of the potential hazards.** If the patient becomes pregnant while taking this class of drug, therapy should be discontinued and the patient apprised of the potential hazard to the fetus. **WARNINGS: Liver Enzymes —** HMG-CoA reductase inhibitors, like some other lipid-lowering therapies, have been associated with biochemical abnormalities of liver function. Increases of serum transaminase (ALT, AST) values to more than 3 times the upper limit of normal occurring on 2 or more (not necessarily sequential) occasions have been reported in 1.3% of patients treated with pravastatin in the US over an average period of 18 months. These abnormalities were not associated with cholestasis and did not appear to be related to treatment duration. In those patients in whom these abnormalities were believed to be related to pravastatin and who were discontinued from therapy, the transaminase levels usually fell slowly to pretreatment levels. These biochemical findings are usually asymptomatic although worldwide experience indicates that anorexia, weakness, and/or abdominal pain may also be present in rare patients. **It is recommended that liver function tests be performed before the initiation of treatment, at 6 and 12 weeks after initiation of therapy or elevation in dose, and periodically thereafter (e.g., semiannually).** Patients who develop increased transaminase levels should be monitored with a second liver function evaluation to confirm the finding and be followed thereafter with frequent liver function tests until the abnormality(ies) return to normal. Should an increase in AST or ALT of three times the upper limit of normal or greater persist, withdrawal of pravastatin therapy is recommended. Active liver disease or unexplained transaminase elevations are contraindications to the use of pravastatin (see **CONTRAINDICATIONS**). Caution should be exercised when pravastatin is administered to patients with a history of liver disease or heavy alcohol ingestion (see **CLINICAL PHARMACOLOGY: Pharmacokinetics/Metabolism**). Such patients should be closely monitored, started at the lower end of the recommended dosing range, and titrated to the desired therapeutic effect. **Skeletal Muscle — Rare cases of rhabdomyolysis with acute renal failure secondary to myoglobinuria have been reported with pravastatin and other drugs in this class.** Uncomplicated myalgia has also been reported in pravastatin-treated patients (see **ADVERSE REACTIONS**). Myopathy, defined as muscle aching or muscle weakness in conjunction with increases in creatine phosphokinase (CPK) values to greater than 10 times the upper normal limit, was rare (< 0.1%) in pravastatin clinical trials. Myopathy should be considered in any patient with diffuse myalgias, muscle tenderness or weakness, and/or marked elevation of CPK. Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. **Pravastatin therapy should be discontinued if markedly elevated CPK levels occur or myopathy is diagnosed or suspected. Pravastatin therapy should also be temporarily withheld in any patient experiencing an acute or serious condition predisposing to the development of renal failure secondary to rhabdomyolysis, e.g., sepsis; hypotension; major surgery; trauma; severe metabolic, endocrine, or electrolyte disorders; or uncontrolled epilepsy.** The risk of myopathy during treatment with another HMG-CoA reductase inhibitor is increased with concurrent therapy with either erythromycin, cyclosporine, niacin, or fibrates. However, neither myopathy nor significant increases in CPK levels have been observed in three reports involving a total of 100 post-transplant patients (24 renal and 76 cardiac) treated for up to two years concurrently with pravastatin 10-40 mg and cyclosporine. Some of these patients also received other concomitant immunosuppressive therapies. In one single-dose study, pravastatin levels were found to be increased in cardiac transplant patients receiving cyclosporine. Further, in clinical trials involving small numbers of patients who were treated concurrently with pravastatin and niacin, there were no reports of myopathy. Also, myopathy was not reported in a trial of combination pravastatin (40 mg/day) and gemfibrozil (1200 mg/day), although 4 of 75 patients on the combination showed marked CPK elevations versus one of 73 patients receiving placebo. There was a trend toward more frequent CPK elevations and patient withdrawals due to musculoskeletal symptoms in the group receiving combined treatment as compared with the groups receiving placebo, gemfibrozil, or pravastatin monotherapy (see **PRECAUTIONS: Drug Interactions**). **The use of fibrates alone may occasionally be associated with myopathy. The combined use of pravastatin and fibrates should be avoided unless the benefit of further alterations in lipid levels is likely to outweigh the increased risk of this drug combination. PRECAUTIONS: General —** Pravastatin may elevate creatine phosphokinase and transaminase levels (see **ADVERSE REACTIONS**). This should be considered in the differential diagnosis of chest pain in a patient on therapy with pravastatin. *Homozygous Familial Hypercholesterolemia:* Pravastatin has not been evaluated in patients with rare homozygous familial hypercholesterolemia. In this group of patients, it has been reported that HMG-CoA reductase inhibitors are less effective because the patients lack functional LDL receptors. *Renal Insufficiency:* A single 20 mg oral dose of pravastatin was administered to 24 patients with varying degrees of renal impairment (as determined by creatinine clearance). No effect was observed on the pharmacokinetics of pravastatin or its 3α-hydroxy isomeric metabolite (SQ 31,906). A small increase was seen in mean AUC values and half-life ($t_{1/2}$) for the inactive enzymatic ring hydroxylation metabolite (SQ 31,945). Given this small sample size, the dosage administered, and the degree of individual variability, patients with renal impairment who are receiving pravastatin should be closely monitored. **Information for Patients —** Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. **Drug Interactions —** *Immunosuppressive Drugs, Gemfibrozil, Niacin (Nicotinic Acid), Erythromycin:* See **WARNINGS: Skeletal Muscle**. *Antipyrine:* Since concomitant administration of pravastatin had no effect on the clearance of antipyrine, interactions with other drugs metabolized via the same hepatic cytochrome isozymes are not expected. *Cholestyramine/Colestipol:* Concomitant administration resulted in an approximately 40 to 50% decrease in the mean AUC of pravastatin. However, when pravastatin was administered 1 hour before or 4 hours after cholestyramine or 1 hour before colestipol and a standard meal, there was no clinically significant decrease in bioavailability or therapeutic effect. (See **DOSAGE AND ADMINISTRATION: Concomitant Therapy**.) *Warfarin:* In a study involving 10 healthy male subjects given pravastatin and warfarin concomitantly for 6 days, bioavailability parameters at steady state for pravastatin (parent compound) were not altered. Pravastatin did not alter the plasma protein-binding of warfarin. Concomitant dosing did increase the AUC and Cmax of warfarin but did not produce any changes in its anticoagulant action (i.e., no increase was seen in mean prothrombin time after 6 days of concomitant therapy). However, bleeding and extreme prolongation of prothrombin time has been reported with another drug in this class. Patients receiving warfarin-type anticoagulants should have their prothrombin times closely monitored when pravastatin is initiated or the dosage of pravastatin is changed. *Cimetidine:* The $AUC_{0-12\,hr}$ for pravastatin when given with cimetidine was not significantly different from the AUC for pravastatin when given alone. A significant difference was observed between the AUC's for pravastatin when given with cimetidine compared to when administered with antacid. *Digoxin:* In a crossover trial involving 18 healthy male subjects given pravastatin and digoxin concurrently for 9 days, the bioavailability parameters of digoxin were not affected. The AUC of pravastatin tended to increase, but the overall bioavailability of pravastatin plus its metabolites SQ 31,906 and SQ 31,945 was not altered. *Cyclosporine:* Some investigators have measured cyclosporine levels in patients on pravastatin, and to date, these results indicate no clinically meaningful elevations in cyclosporine levels. In one single-dose study, pravastatin levels were found to be increased in cardiac transplant patients receiving cyclosporine. *Gemfibrozil:* In a crossover study in 20 healthy male volunteers given concomitant single doses of pravastatin and gemfibrozil, there was a significant decrease in urinary excretion and protein binding of pravastatin. In addition, there was a significant increase in AUC, Cmax, and Tmax for the pravastatin metabolite SQ 31,906. Combination therapy with pravastatin and gemfibrozil is generally not recommended. In interaction studies with aspirin, antacids (1 hour prior to PRAVACHOL), cimetidine, nicotinic acid, or probucol, no statistically significant differences in bioavailability were seen when PRAVACHOL (pravastatin sodium) was administered. *Other Drugs:* During clinical trials, no noticeable drug interactions were reported when PRAVACHOL was added to: diuretics, antihypertensives, digitalis, ACE inhibitors, calcium channel blockers, beta-blockers, or nitroglycerin. **Endocrine Function —** HMG-CoA reductase inhibitors interfere with cholesterol synthesis and lower circulating cholesterol levels and, as such, might theoretically blunt adrenal or gonadal steroid hormone production. Results of clinical trials with pravastatin in males and post-menopausal females were inconsistent with regard to possible effects of the drug on basal steroid hormone levels. In a study of 21 males, the mean testosterone response to human chorionic gonadotropin was significantly reduced ($p < 0.004$) after 16 weeks of treatment with 40 mg of pravastatin. However, the percentage of patients showing a ≥ 50% rise in plasma testosterone after human chorionic gonadotropin stimulation did not change significantly after therapy in these patients. The effects of HMG-CoA reductase inhibitors on spermatogenesis and fertility have not been studied in adequate numbers of patients. The effects, if any, of pravastatin on the pituitary-gonadal axis in pre-menopausal females are unknown. Patients treated with pravastatin who display clinical evidence of endocrine dysfunction should be evaluated appropriately. Caution should also be exercised if an HMG-CoA reductase inhibitor or other agent used to lower cholesterol levels is administered to patients also receiving other drugs (e.g., ketoconazole, spironolactone, cimetidine) that may diminish the levels or activity of steroid hormones. **CNS Toxicity —** CNS vascular lesions, characterized by perivascular hemorrhage and edema and mononuclear cell infiltration of perivascular spaces, were seen in dogs treated with pravastatin at a dose of 25 mg/kg/day, a dose that produced a plasma drug level about 50 times higher than the mean drug level in humans taking 40 mg/day. Similar CNS vascular lesions have been observed with several other drugs in this class. A chemically similar drug in this class produced optic nerve degeneration (Wallerian degeneration of retinogeniculate fibers) in clinically normal dogs in a dose-dependent fashion starting at 60 mg/kg/day, a dose that produced mean plasma drug levels about 30 times higher than the mean drug level in humans taking the highest recommended dose (as measured by total enzyme inhibitory activity). This same drug also produced vestibulocochlear Wallerian-like degeneration and retinal ganglion cell chromatolysis in dogs treated for 14 weeks at 180 mg/kg/day, a dose which resulted in a mean plasma drug level similar to that seen with the 60 mg/kg/day dose. **Carcinogenesis, Mutagenesis, Impairment of Fertility —** In a 2-year study in rats fed pravastatin at doses of 10, 30, or 100 mg/kg body weight, there was an increased incidence of hepatocellular carcinomas in males at the highest dose ($p < 0.01$). Although rats were given up to 125 times the human dose (HD) on a mg/kg body weight basis, serum drug levels were only 6 to 10 times higher than those measured in humans given 40 mg pravastatin as measured by AUC. The oral administration of 10, 30, or 100 mg/kg (producing plasma drug levels approximately 0.5 to 5.0 times the human drug levels at 40 mg) of pravastatin to mice for 22 months resulted in a statistically significant increase in the incidence of malignant lymphomas in treated females when all treatment groups were pooled and compared to controls ($p < 0.05$). The incidence was not dose-related and male mice were not affected. A chemically similar drug in this class was administered to mice for 72 weeks at 25, 100, and 400 mg/kg body weight, which resulted in mean serum drug levels approximately 3, 15, and 33 times higher than the mean human serum drug concentration (as total inhibitory activity) after a 40 mg oral dose. Liver carcinomas were significantly increased in high-dose females and mid- and high-dose males, with a maximum incidence of 90 percent in males. The incidence of adenomas of the liver was significantly increased in mid- and high-dose females. Drug treatment also significantly increased the incidence of lung adenomas in mid- and high-dose males and females. Adenomas of the eye Harderian gland (a gland of the eye of rodents) were significantly higher in high-dose mice than in controls. No evidence of mutagenicity was observed in vitro, with or without rat-liver metabolic activation, in the following studies: microbial mutagen tests, using mutant strains of *Salmonella typhimurium* or *Escherichia coli*; a forward mutation assay in L5178Y TK +/- mouse lymphoma cells; a chromosomal aberration test in hamster cells; and a gene conversion assay using *Saccharomyces cerevisiae*. In addition, there was no evidence of mutagenicity in either a dominant lethal test in mice or a micronucleus test in mice. In a study in rats, with daily doses up to 500 mg/kg, pravastatin did not produce any adverse effects on fertility or general reproductive performance. However, in a study with another HMG-CoA reductase inhibitor, there was decreased fertility in male rats treated for 34 weeks at 25 mg/kg body weight, although this effect was not observed in a subsequent fertility study when this same dose was administered for 11 weeks (the entire cycle of spermatogenesis, including epididymal maturation). In rats treated with this same reductase inhibitor at 180 mg/kg/day, seminiferous tubule degeneration (necrosis and loss of spermatogenic epithelium) was observed. Although not seen with pravastatin, two similar drugs in this class caused drug-related testicular atrophy, decreased spermatogenesis, spermatocytic degeneration, and giant cell formation in dogs. The clinical significance of these findings is unclear. **Pregnancy: Pregnancy Category X. —** See **CONTRAINDICATIONS**. Safety in pregnant women has not been established. Pravastatin was not teratogenic in rats at doses up to 1000 mg/kg daily or in rabbits at doses of up to 50 mg/kg daily. These doses resulted in 20x (rabbit) or 240x (rat) the human exposure based on surface area (mg/meter²). However, in studies with another HMG-CoA reductase inhibitor, skeletal malformations were observed in rats and mice. There has been one report of severe congenital bony deformity, tracheo-esophageal fistula, and anal atresia (Vater association) in a baby born to a woman who took another HMG-CoA reductase inhibitor with dextroamphetamine sulfate during the first trimester of pregnancy. PRAVACHOL (pravastatin sodium) should be administered to women of child-bearing potential only when such patients are highly unlikely to conceive and have been informed of the potential hazards. If the woman becomes pregnant while taking PRAVACHOL (pravastatin sodium), it should be discontinued and the patient advised again as to the potential hazards to the fetus. **Nursing Mothers —** A small amount of pravastatin is excreted in human breast milk. Because of the potential for serious adverse reactions in nursing infants, women taking PRAVACHOL should not nurse (see **CONTRAINDICATIONS**). **Pediatric Use —** Safety and effectiveness in individuals less than 18 years old have not been established. Hence, treatment in patients less than 18 years old is not recommended at this time. **ADVERSE REACTIONS:** Pravastatin is generally well tolerated; adverse reactions have usually been mild and transient. In 4-month long placebo-controlled trials, 1.7% of pravastatin-treated patients and 1.2% of placebo-treated patients were discontinued from treatment because of adverse experiences attributed to study drug therapy; this difference was not statistically significant. In long-term studies, the most common reasons for discontinuation were asymptomatic serum transaminase increases and mild, non-specific gastrointestinal complaints. During clinical trials the overall incidence of adverse events in the elderly was not different from the incidence observed in younger patients. **Adverse Clinical Events —** All adverse clinical events (regardless of attribution) reported in more than 2% of pravastatin-treated patients in the placebo-controlled trials are identified in the table below; also shown are the percentages of patients in whom these medical events were believed to be related or possibly related to the drug:

	All Events		Events Attributed to Study Drug	
Body System/Event	**Pravastatin (N = 900) %**	**Placebo (N = 411) %**	**Pravastatin (N = 900) %**	**Placebo (N = 411) %**
Cardiovascular				
Cardiac Chest Pain	4.0	3.4	0.1	0.0
Dermatologic Rash	4.0*	1.1	1.3	0.9
Gastrointestinal				
Nausea/Vomiting	7.3	7.1	2.9	3.4
Diarrhea	6.2	5.6	2.0	1.9
Abdominal Pain	5.4	6.9	2.0	3.9
Constipation	4.0	7.1	2.4	5.1
Flatulence	3.3	3.6	2.7	3.4
Heartburn	2.9	1.9	2.0	0.7
General				
Fatigue	3.8	3.4	1.9	1.0
Chest Pain	3.7	1.9	0.3	0.2
Influenza	2.4*	0.7	0.0	0.0
Musculoskeletal				
Localized Pain	10.0	9.0	1.4	1.5
Myalgia	2.7	1.0	0.6	0.0
Nervous System				
Headache	6.2	3.9	1.7*	0.2
Dizziness	3.3	3.2	1.0	0.5
Renal/Genitourinary				
Urinary Abnormality	2.4	2.9	0.7	1.2
Respiratory				
Common Cold	7.0	6.3	0.0	0.0
Rhinitis	4.0	4.1	0.1	0.0
Cough	2.6	1.7	0.1	0.0

*Statistically significantly different from placebo.

In the Pravastatin Primary Prevention Study (West of Scotland Coronary Prevention Study) (see **CLINICAL PHARMACOLOGY: Clinical Studies**) involving 6595 patients treated with PRAVACHOL (pravastatin sodium) (N = 3302) or placebo (N = 3293) the adverse event profile in the pravastatin group was comparable to that of the placebo group over the median 4.8 years of the study. The following effects have been reported with drugs in this class; not all the effects listed below have necessarily been associated with pravastatin therapy: *Skeletal:* myopathy, rhabdomyolysis, arthralgia. *Neurological:* dysfunction of certain cranial nerves (including alteration of taste, impairment of extra-ocular movement, facial paresis), tremor, vertigo, memory loss, paresthesia, peripheral neuropathy, peripheral nerve palsy, anxiety, insomnia, depression. *Hypersensitivity Reactions:* An apparent hypersensitivity syndrome has been reported rarely which has included one or more of the following features: anaphylaxis, angioedema, lupus erythematosus-like syndrome, polymyalgia rheumatica, dermatomyositis, vasculitis, purpura, thrombocytopenia, leukopenia, hemolytic anemia, positive ANA, ESR increase, eosinophilia, arthritis, arthralgia, urticaria, asthenia, photosensitivity, fever, chills, flushing, malaise, dyspnea, toxic epidermal necrolysis, erythema multiforme, including Stevens-Johnson syndrome. *Gastrointestinal:* pancreatitis, hepatitis, including chronic active hepatitis, cholestatic jaundice, fatty change in liver, and, rarely, cirrhosis, fulminant hepatic necrosis, and hepatoma; anorexia, vomiting. *Skin:* alopecia, pruritus. A variety of skin changes (e.g., nodules, discoloration, dryness of skin/mucous membranes, changes to hair/nails) have been reported. *Reproductive:* gynecomastia, loss of libido, erectile dysfunction. *Eye:* progression of cataracts (lens opacities), ophthalmoplegia. *Laboratory Abnormalities:* elevated transaminases, alkaline phosphatase, and bilirubin; thyroid function abnormalities. **Laboratory Test Abnormalities —** Increases in serum transaminase (ALT, AST) values and CPK have been observed (see **WARNINGS**). Transient, asymptomatic eosinophilia has been reported. Eosinophil counts usually returned to normal despite continued therapy. Anemia, thrombocytopenia, and leukopenia have been reported with HMG-CoA reductase inhibitors. **Concomitant Therapy —** Pravastatin has been administered concurrently with cholestyramine, colestipol, nicotinic acid, probucol and gemfibrozil. Preliminary data suggest that the addition of either probucol or gemfibrozil to therapy with lovastatin or pravastatin is **not** associated with greater reduction in LDL-cholesterol than that achieved with lovastatin or pravastatin alone. No adverse reactions unique to the combination or in addition to those previously reported for each drug alone have been reported. Myopathy and rhabdomyolysis (with or without acute renal failure) have been reported when another HMG-CoA reductase inhibitor was used in combination with immunosuppressive drugs, gemfibrozil, erythromycin, or lipid-lowering doses of nicotinic acid. Concomitant therapy with HMG-CoA reductase inhibitors and these agents is generally not recommended. (See **WARNINGS: Skeletal Muscle** and **PRECAUTIONS: Drug Interactions**.) **OVERDOSAGE:** To date, there are two reported cases of overdosage with pravastatin, both of which were asymptomatic and not associated with clinical laboratory abnormalities. If an overdose occurs, it should be treated symptomatically and supportive measures should be instituted as required.

CAUTION: Federal (USA) law prohibits dispensing without prescription.

Consult package insert before prescribing PRAVACHOL® (pravastatin sodium).

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NATIONAL GEOGRAPHIC

Geographica

THOMAS PFLAUM, VISUM

Mirror Images to Peer Far Into the Universe

In an apt reflection on their efforts, workers at Schott Glaswerke's plant near Frankfurt, Germany, put final touches on one of four colossal telescope mirrors—perhaps "the most stupendous work in glass ever done," wrote GEOGRAPHIC's William S. Ellis in December 1993 as the first was begun.

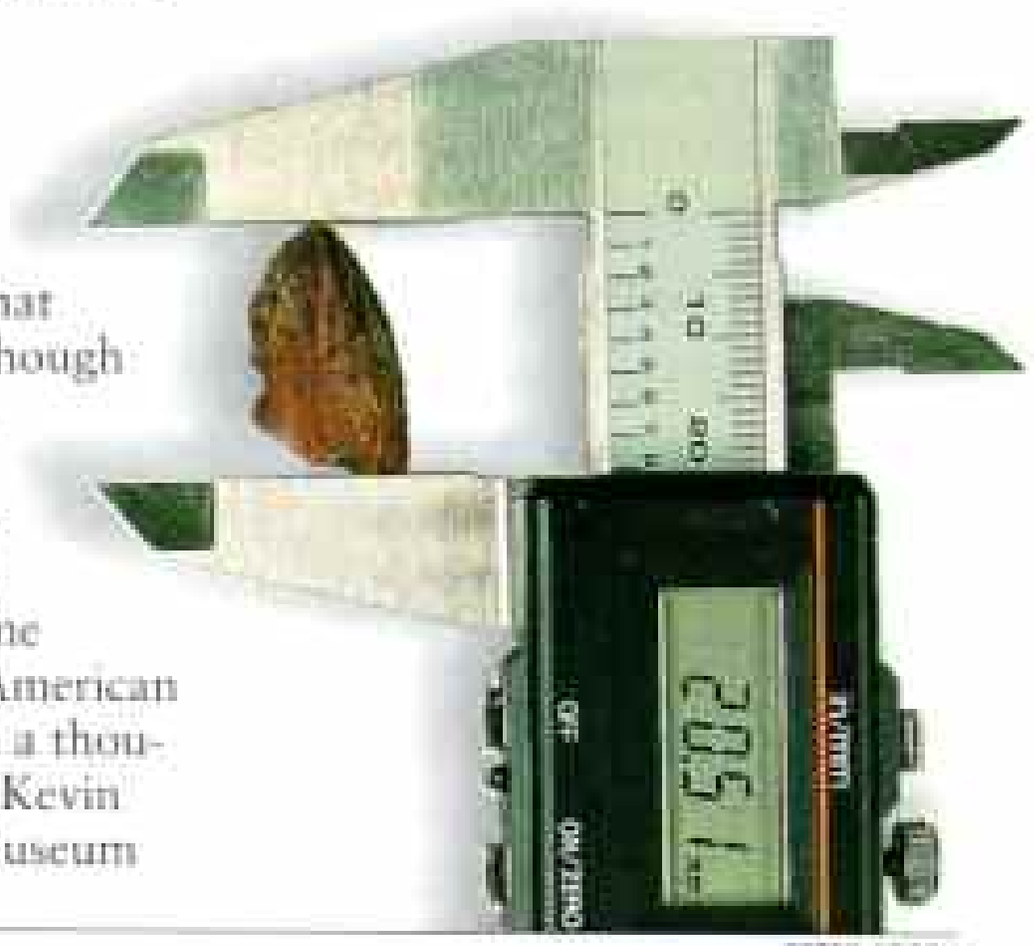
Destined for the European Southern Observatory's Very Large Telescope in Chile, each of the seven-inch-thick, 27-foot-diameter mirrors was fabricated from 45 metric tons of glass melted at 2,900°F. All four were shipped to Paris to be ground and polished for 12 to 18 months. The first will sail to Chile later this year; then it will be trucked more than 90 miles, at three miles an hour, up a specially built road to the 8,740-foot summit of Cerro Paranal. The telescope, designed to detect objects more than ten billion light-years away, goes into full operation in 2000.

Did Exploration's Trail Run West to East?

Since Viking days Europeans have sailed westward to explore the Americas. But did some Native Americans move in the opposite direction far earlier?

This jasper core (right), from which tiny, razorlike blades were flaked, suggests that may have happened. Though discovered by Society-funded researchers on a tenth-century Viking site in western Iceland, it closely resembles stone cores from the North American Arctic made more than a thousand years earlier, says Kevin Smith of the Buffalo Museum of Science. Chemical analysis shows that the core was made of Icelandic stone, indicating that it was not brought back by Vikings who visited North America.

"Maybe there was a settlement, or maybe a few nomadic hunters somehow got stranded and made this tool to repair their weapons," Smith muses.



PETER ARNOW

Shown with available equipment. †J.D. Power and Associates 1997 Automotive Performance, Execution and Layout (APEAL) Study.℠ Study based on a total 25,402 consumer responses. ††Excludes other GM vehicles.

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CHRISTOPH BAUMER

Murals Outlast Upheaval, Time

Painted on the stone walls of a nine-story Tibetan Buddhist monastery tower, in a room whose roof leaks, this serene likeness of Buddha Ratnasambhava and other murals have survived since the 13th century. Now they have been photographed, apparently for the first time.

Swiss explorer Christoph Baumer visited the paintings late last year in the isolated village of Serkar Guthok, near the Bhutanese border in southern Tibet. The tower was built in the 11th century, tradition says, by a reformed sorcerer named Milarepa, who became a revered ascetic. He and his guru, Marpa, appear in one of the murals. The last known Western visitor, in 1950, made only one exterior photograph. The paintings' existence was known, but it was unclear whether they had survived China's invasion of Tibet and the Cultural Revolution, Baumer adds.

Baumer and his party spent six days negotiating the 300 miles from Lhasa to Serkar Guthok after wangling permission from security officials. But they were allowed only two hours in the monastery in the "pitch-dark room" with the murals. They held flashlights to light it for photography.

Antarctic First: Alone Across a Frozen Land

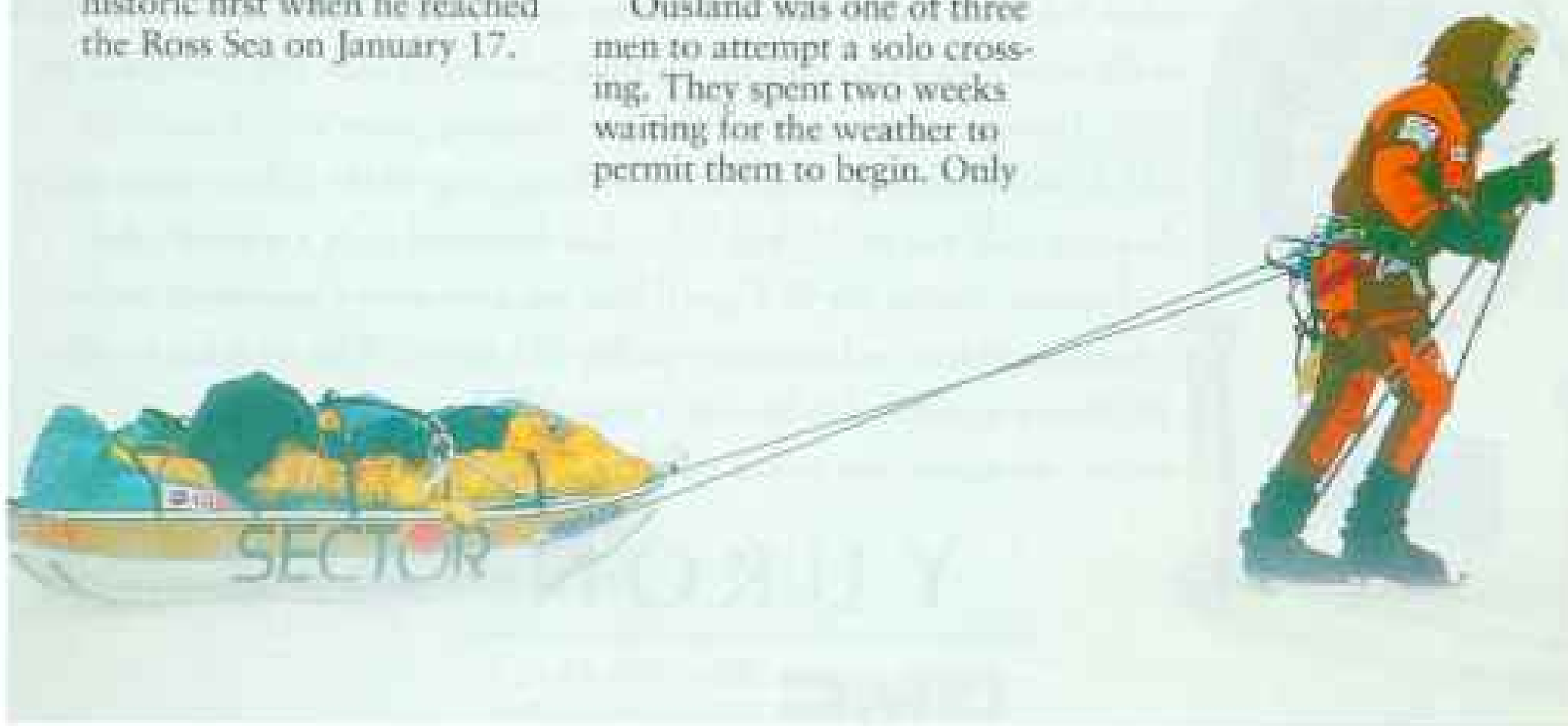
The hardest part of skiing across Antarctica unsupported and alone, says Borge Ousland, is just going on, day after day, through an unvarying, all-white world.

After a 64-day journey in which he covered 1,764 miles and braved temperatures that plunged as low as minus 69°F, Ousland recorded a historic first when he reached the Ross Sea on January 17. The 34-year-old Norwegian hauled a sled that held nearly 400 pounds of food and gear when he set off from Berkner Island in the Weddell Sea. When howling winds permitted, he attached a sail to his waist to speed his way, one day covering an incredible 140 miles. Mostly, though, he just put one ski ahead of the other: "Hard work, step by step, long hours," he says.

Ousland was one of three men to attempt a solo crossing. They spent two weeks waiting for the weather to permit them to begin. Only Ousland completed the trek.

This was Ousland's latest in a series of remarkable journeys. He reached the North Pole unsupported in 1990 with fellow Norwegian Erling Kagge, returned alone in 1994, and in a failed 1995 attempt at an Antarctic crossing made it as far as the South Pole.

—BORIS WEINTRAUB



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CONTRAINDICATIONS ZYRTEC is contraindicated in those patients with a known hypersensitivity to it or any of its ingredients or hydroxyzine. **PRECAUTIONS** Activities Requiring Mental Alertness: In clinical trials, the occurrence of somnolence has been reported in some patients taking ZYRTEC; due caution should therefore be exercised when driving a car or operating potentially dangerous machinery. Concurrent use of ZYRTEC with alcohol or other CNS depressants should be avoided because additional reductions in alertness and additional impairment of CNS performance may occur. **Drug-drug Interactions:** No clinically significant drug interactions have been found with theophylline at a low dose, azithromycin, pseudoephedrine, ketoconazole, or erythromycin. There was a small decrease in the clearance of cetirizine caused by a 400 mg dose of theophylline; it is possible that larger theophylline doses could have a greater effect. **Carcinogenesis, Mutagenesis and Impairment of Fertility:** No evidence of carcinogenicity was observed in a 2-year carcinogenicity study in rats at dietary doses up to 20 mg/kg/day (approximately 10 times the maximum recommended human daily oral dose on a mg/m^2 basis). An increased incidence of benign liver tumors was found in a 2-year carcinogenicity study in male mice at a dietary dose of 10 mg/kg/day (approximately 4 times the maximum recommended human daily oral dose on a mg/m^2 basis). The clinical significance of these findings during long-term use of ZYRTEC is not known. Cetirizine was not mutagenic in the Ames test, and not clastogenic in the human lymphocyte assay, the mouse lymphoma assay, and *in vivo* micronucleus test in rats. No impairment of fertility was found in a fertility and general reproductive performance study in mice at an oral dose of 64 mg/kg/day (approximately 26 times the maximum recommended adult human daily oral dose on a mg/m^2 basis). **Pregnancy Category B:** Cetirizine was not teratogenic in mice, rats and rabbits at oral doses up to 96, 225, and 135 mg/kg/day (or approximately 40, 180, and 215 times the maximum recommended adult human daily oral dose on a mg/m^2 basis), respectively. There are no adequate and well-controlled studies in pregnant women. Because animal studies are not always predictive of human response, ZYRTEC should be used in pregnancy only if clearly needed. **Nursing Mothers:** Retarded pup weight gain was found in mice during lactation when dams were given cetirizine at 96 mg/kg/day (approximately 40 times the maximum recommended adult human daily oral dose on a mg/m^2 basis). Studies in lactating dogs indicate that approximately 3% of the dose is excreted in milk. Cetirizine has been reported to be excreted in human breast milk. Because many drugs are excreted in human milk, use of ZYRTEC in nursing mothers is not recommended. **Geriatric Use:** In placebo-controlled trials, 166 patients aged 65 to 94 years received doses of 5 to 20 mg of ZYRTEC per day. Adverse events were similar in this group to patients under age 65. Subset analysis of efficacy in this group was not done. **Pediatric Use:** The safety of ZYRTEC, at daily doses of 5 or 10 mg, has been demonstrated in 375 pediatric patients 6-11 years of age in placebo-controlled trials lasting up to four weeks and in 254 patients in a non-placebo-controlled 12 week trial. The effectiveness of ZYRTEC for the treatment of seasonal and perennial allergic rhinitis and chronic idiopathic urticaria in this pediatric age group is based on an extrapolation of the demonstrated efficacy of ZYRTEC in adults in these conditions and the likelihood that the disease course, pathophysiology and the drug's effect are substantially similar between these two populations. The recommended doses for the pediatric population are based on a cross-study comparison of the pharmacokinetics and pharmacodynamics of cetirizine in adults and pediatric subjects and on the safety profile of cetirizine in both adults and pediatric patients at doses equal to or higher than the recommended doses. The cetirizine AUC and C_{max} in pediatric subjects 6-11 years of age who received a single dose of 10 mg of cetirizine syrup was estimated to be intermediate between that observed in adults who received a single dose of 10 mg of cetirizine tablets and those who received a single dose of 20 mg of cetirizine tablets. **ADVERSE REACTIONS** Controlled and uncontrolled clinical trials conducted in the United States and Canada included more than 6000 patients aged 12 years and older with more than 3000 receiving ZYRTEC at doses of 5 to 20 mg per day. The duration of treatment ranged from 1 week to 6 months, with a mean exposure of 30 days. Most adverse reactions reported during therapy with ZYRTEC were mild or moderate. In placebo-controlled trials, the incidence of discontinuations due to adverse reactions in patients receiving ZYRTEC 5 mg or 10 mg was not significantly different from placebo (2.9% vs. 2.4%, respectively). The most common adverse reaction in patients aged 12 years and older that occurred more frequently on ZYRTEC than placebo was somnolence. The incidence of somnolence associated with ZYRTEC was dose related, 5% in placebo, 11% at 5 mg and 14% at 10 mg. Discontinuations due to somnolence for ZYRTEC were uncommon (1.0% on ZYRTEC vs. 0.4% on placebo). Fatigue and dry mouth also appeared to be treatment-related adverse reactions. There were no differences by age, race, gender or by body weight with regard to the incidence of adverse reactions. Table 1 lists adverse experiences in patients aged 12 years and older which were reported for ZYRTEC 5 and 10 mg in controlled clinical trials in the United States and that were more common with ZYRTEC than placebo. **Table 1. Adverse Experiences Reported in Patients aged 12 years and older in Placebo-Controlled United States ZYRTEC Trials (Maximum Dose of 10 mg) at Rates of 2% or Greater (Percent Incidence), ZYRTEC (N=2934) vs Placebo (N=1612) respectively:** Somnolence (13.7% vs 6.3%); Fatigue (5.9% vs 2.6%); Dry Mouth (5.0% vs 2.3%); Pharyngitis (2.0% vs 1.9%); Dizziness (2.0% vs 1.2%). In addition, headache and nausea occurred in more than 2% of the patients, but were more common in placebo patients. Pediatric studies were also conducted with ZYRTEC. More than 1300 pediatric patients (6 to 11 years) with more than 900 treated with ZYRTEC at doses of 1.25 to 10 mg per day were included in controlled and uncontrolled clinical trials conducted in the United States. The duration of treatment ranged from 2 to 12 weeks. The majority of reported adverse reactions reported in pediatric patients (6 to 11 years) with ZYRTEC were mild or moderate. In placebo-controlled trials, the incidence of discontinuations due to adverse reactions in pediatric patients receiving up to ZYRTEC 10 mg was uncommon (0.4% on ZYRTEC vs 1.0% on placebo). Table 2 lists adverse experiences which were reported for ZYRTEC 5 and 10 mg in pediatric patients (6 to 11 years) in placebo-controlled clinical trials in the United States and were more common with ZYRTEC than placebo. Of these, abdominal pain was considered treatment-related and somnolence appeared to be dose related, 1.3% in placebo, 1.5% at 5 mg and 4.2% at 10 mg. **Table 2. Adverse Experiences Reported in Pediatric Patients (6 to 11 years) in Placebo-Controlled United States ZYRTEC Trials (5 or 10 mg dose) Which Occurred at a Frequency of ≥ 2% in Either the 5 mg or the 10 mg ZYRTEC Group, and More Frequently Than in the Placebo Group. ZYRTEC 5 mg (N=161), 10 mg (N=215) vs Placebo (N=209):** Headache (11.0%, 5 mg: 14.0%, 10 mg: 12.9%, placebo); Pharyngitis (6.2%, 5 mg: 2.8%, 10 mg: 2.9%, placebo); Abdominal pain (4.4%, 5 mg: 5.6%, 10 mg: 1.9%, placebo); Coughing (4.4%, 5 mg: 2.8%, 10 mg: 3.3%, placebo); Somnolence (1.9%, 5 mg: 4.2%, 10 mg: 1.5%, placebo); Diarrhea (3.1%, 5 mg: 1.9%, 10 mg: 1.3%, placebo); Epistaxis (3.7%, 5 mg: 1.9%, 10 mg: 2.9%, placebo); Bronchospasm (3.1%, 5 mg: 1.9%, 10 mg: 1.9%, placebo); Nausea (1.9%, 5 mg: 2.8%, 10 mg: 1.9%, placebo); Vomiting (2.5%, 5 mg: 2.3%, 10 mg: 1.0%, placebo). The following events were observed infrequently (less than 2%), in either 3962 adults and children 12 years and older or in 668 pediatric (6 to 11 years) patients who received ZYRTEC in U.S. trials, including an open adult study of six months duration; a causal relationship with ZYRTEC administration has not been established. **Autonomic Nervous System:** anorexia, urinary retention, flushing, increased salivation, dry mouth. **Cardiovascular:** palpitation, tachycardia, hypertension, cardiac failure. **Central and Peripheral Nervous Systems:** paresthesia, confusion, hyperkinesia, hypertonia, migraine, tremor, vertigo, leg cramps, ataxia, dysphonia, abnormal coordination, hyperesthesia, hypoesthesia, myelitis, paralysis, ptosis, twitching, visual field defect, syncope, dizziness. **Gastrointestinal:** increased appetite, dyspepsia, abdominal pain, diarrhea, flatulence, constipation, vomiting, ulcerative stomatitis, aggravated tooth caries, stomatitis, tongue discoloration, tongue edema, gastritis, rectal hemorrhage, hemorrhoids, melena, abnormal hepatic function, eructation. **Genitourinary:** polyuria, urinary tract infection, cystitis, dysuria, hematuria, micturition frequency, urinary incontinence. **Hearing and Vestibular:** earache, tinnitus, deafness, otoscopy. **Metabolic/Nutritional:** thirst, dehydration, diabetes mellitus. **Musculoskeletal:** myalgia, arthralgia, arthrosis, arthritis, muscle weakness. **Psychiatric:** insomnia, sleep disorder, nervousness, depression, emotional lability, impaired concentration, anxiety, depersonalization, paranoia, abnormal thinking, agitation, amnesia, decreased libido, euphoria. **Respiratory System:** epistaxis, rhinitis, coughing, bronchospasm, dyspnea, upper respiratory tract infection, hyperventilation, sinusitis, increased sputum, bronchitis, pneumonia, respiratory disorder. **Reproductive:** dysmenorrhea, female breast pain, intermenstrual bleeding, leukorrhea, menorrhagia, vaginitis. **Reticuloendothelial:** lymphadenopathy. **Skin:** pruritus, rash, dry skin, urticaria, acne, dermatitis, erythematous rash, increased sweating, alopecia, angioedema, furunculosis, bullous eruption, eczema, hyperkeratosis, hypertrichosis, photosensitivity reaction, photosensitivity toxic reaction, maculopapular rash, seborrhea, purpura, skin disorder, skin nodule. **Special Senses:** taste perversion, taste loss, parosmia. **Vision:** blindness, loss of accommodation, eye pain, conjunctivitis, ophthalmitis, glaucoma, ocular hemorrhage. **Body as a Whole:** increased weight, back pain, malaise, fever, asthenia, generalized edema, periorbital edema, peripheral edema, rigors, leg edema, face edema, hot flashes, enlarged abdomen, nasal polyp, pain, pallor, chest pain, accidental injury. Occasional instances of transient, reversible hepatic transaminase elevations have occurred during cetirizine therapy. A single case of possible drug-induced hepatitis with significant transaminase elevation (500 to 1000 IU/L) and elevated bilirubin has been reported. In foreign marketing experience the following additional rare, but potential severe adverse events have been reported: hemolytic anemia, thrombocytopenia, orofacial dyskinesia, severe hypotension, anaphylaxis, hepatitis, glomerulonephritis, stillbirth, and cholestasis. **DRUG ABUSE AND DEPENDENCE** There is no information to indicate that abuse or dependency occurs with ZYRTEC. **OVERDOSAGE** Overdosage has been reported with ZYRTEC. In one adult patient who took 150 mg of ZYRTEC, the patient was somnolent but did not display any other clinical signs or abnormal blood chemistry or hematology results. In an 18-month-old pediatric patient who took an overdose of ZYRTEC (approximately 180 mg), restlessness and irritability were observed initially; this was followed by drowsiness. Should overdose occur, treatment should be symptomatic or supportive, taking into account any concomitantly ingested medications. There is no known specific antidote to ZYRTEC. ZYRTEC is not effectively removed by dialysis, and dialysis will be ineffective unless a dialyzable agent has been concomitantly ingested. The acute minimal lethal oral doses in mice and rats were 237 and 562 mg/kg, respectively (approximately 55 and 260 times the maximum recommended human daily oral dose on a mg/m^2 basis). In rodents, the target of acute toxicity was the central nervous system, and the target of multiple-dose toxicity was the liver. **DOSAGE AND ADMINISTRATION Adults and Children 12 years and older:** The recommended initial dose of ZYRTEC is 5 or 10 mg per day in adults and children 12 years and older, depending on symptom severity. Most patients in clinical trials started at 10 mg. ZYRTEC is given as a single daily dose, with or without food. The time of administration may be varied to suit individual patient needs. In patients with decreased renal function (creatinine clearance 11-31 mL/min), patients on hemodialysis (creatinine clearance less than 7 mL/min), and in hepatically impaired patients, a dose of 5 mg once daily is recommended. **Children 6 to 11 years:** The recommended initial dose of ZYRTEC in children aged 6 to 11 years is 5 or 10 mg (1 or 2 teaspoons) once daily depending on symptom severity. The time of administration may be varied to suit individual patient needs. 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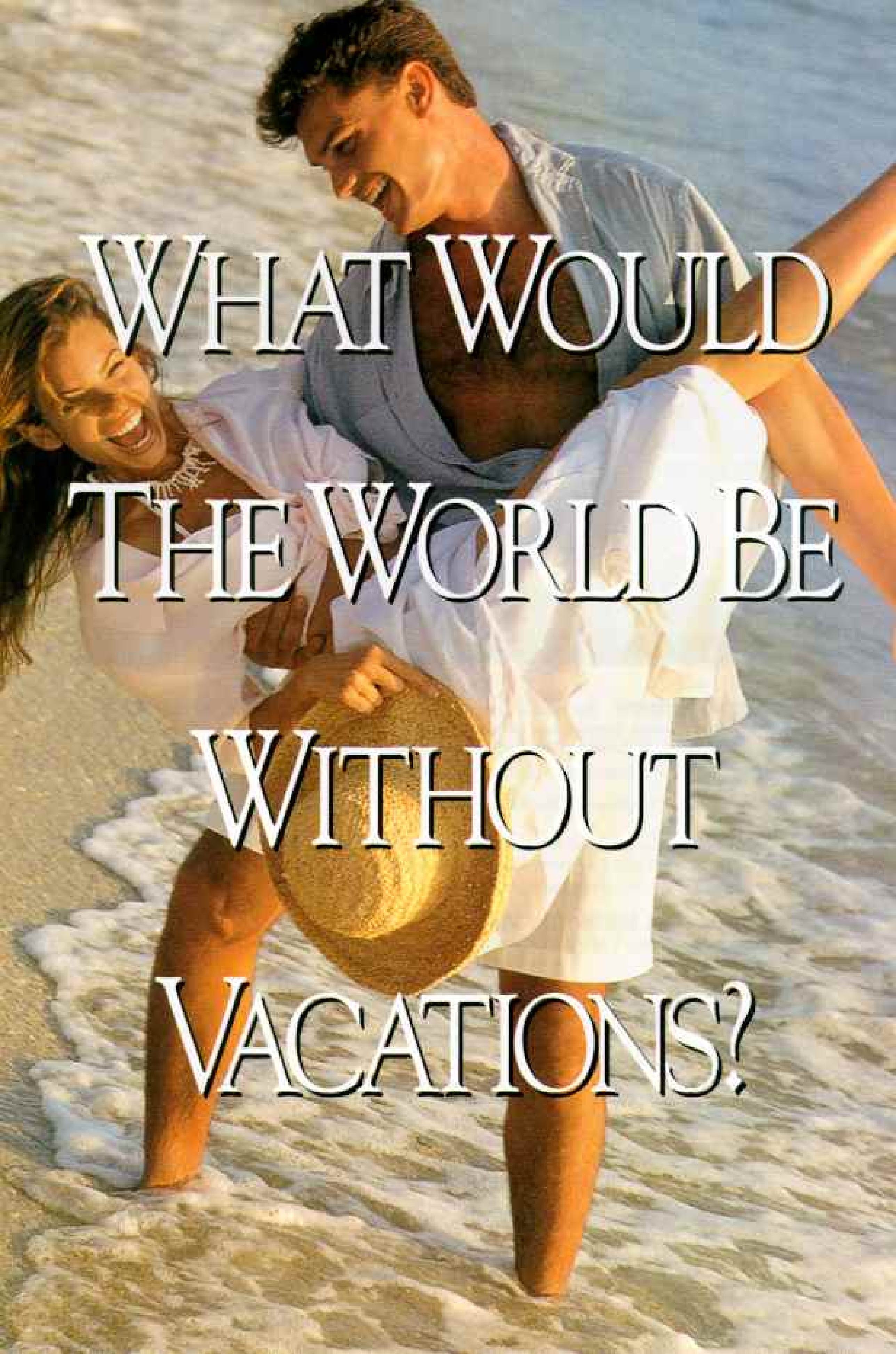
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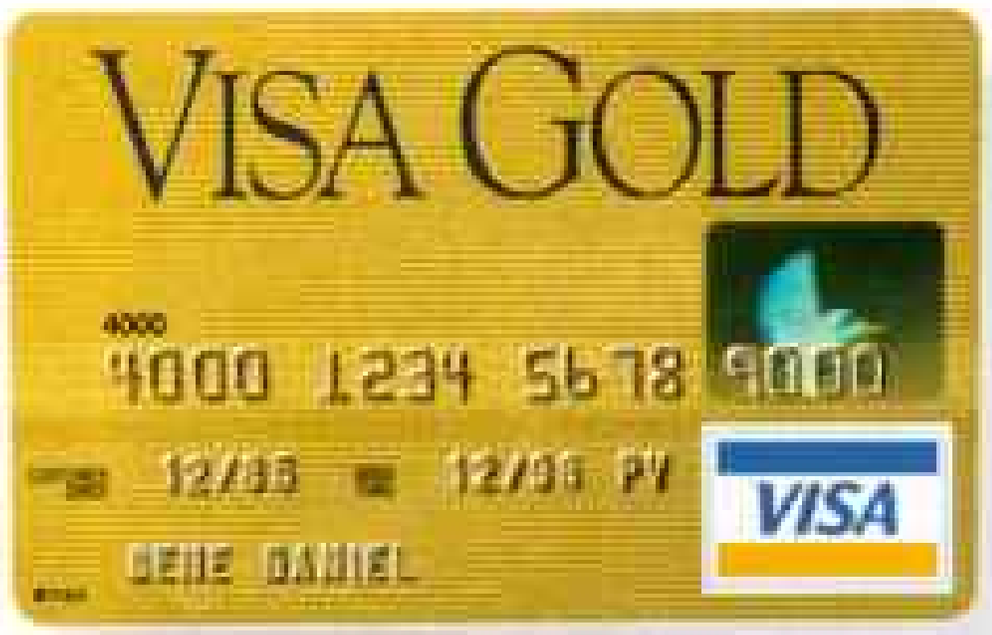

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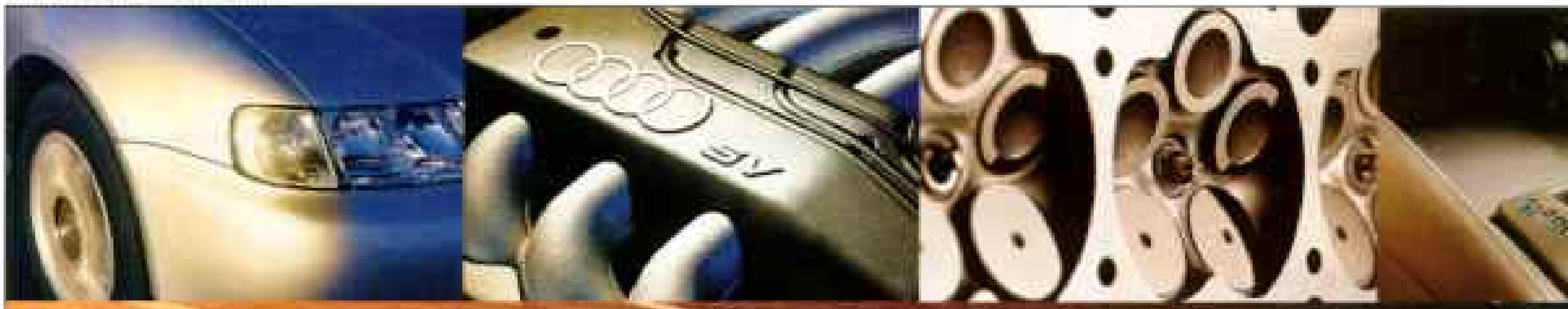

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Photo by Neal Barnes

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Even as you step onto the boat, eager to begin your trip down this famous waterway, you will be embraced by the mystique of the past. As you watch boats of different sizes bobbing gently at the harbour, you can almost picture a quaintly dressed Chinese merchant, sailing in on his barge, ready to trade fine raw silk, brocade and silver coffers, for wares from traders coming from all over the world. You will begin to wonder about the languages, smiles and traditions shared at this meeting point of East and West.

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PHOTOGRAPH FROM MARCAH A. MARSHALL

■ FROM THE GEOGRAPHIC ARCHIVES

Grand Old Flag

Workers rally round the flag they made in the mills of the Amoskeag Manufacturing Company in 1914. The Manchester, New Hampshire, enterprise produced the 95-by-50-foot banner that year for a Chicago firm but borrowed it back in the spring of 1916 to lead New York City's "preparedness parade," an 11-hour procession on the eve of the U.S. entry into World War I. Hundreds of Amoskeag employees numbered among the 125,000 participants.

We first published this photograph in the October 1917 GEOGRAPHIC. That special issue, devoted entirely to flags, was distributed free to thousands of American troops departing for battle in France.

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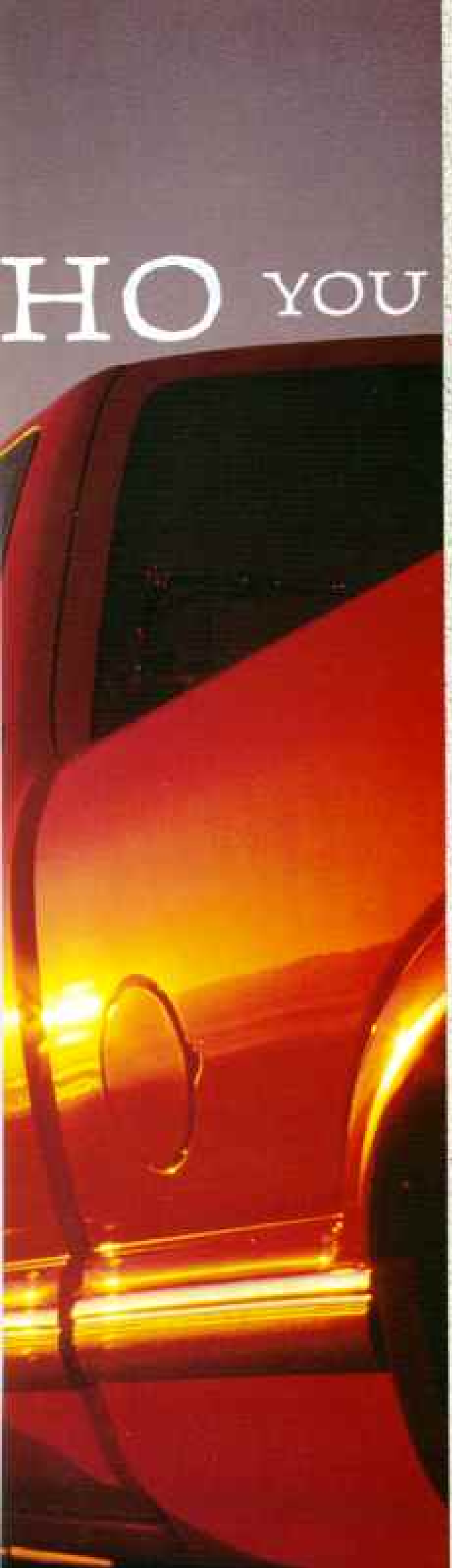
AS DEVOTED TO YOU AS YOU ARE TO IT?

DOES IT KNOW W



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NATIONAL GEOGRAPHIC

On Television

■ EXPLORER, JULY 13, 7 P.M. ET

Have Nose, Will Travel: Dogs to the Rescue

Before flying from California to the bombed federal office building in Oklahoma City, Quasar, whose name is a play on "quality search and rescue," spends time with Robert Macaulay, his owner and trainer. The red-and-white vest, which identifies the seven-year-old golden retriever as a qualified search-and-rescue dog, will be removed prior to his entering the wreckage to prevent its snagging on debris.

A new EXPLORER film, "Rescue Dogs," takes a close look at the world of these highly intelligent, highly trained dogs. From searching for survivors of the Oklahoma City bombing, to tracking lost hikers, to seeking missing persons, the dogs use their phenomenal sense of smell—far more acute than that of humans—to locate victims and save lives.

MARK PYNES, FAIRFIELD DAILY REPUBLIC (ABOVE); ART BY CHRIS FOSS

■ PROGRAM GUIDE

National Geographic Specials
NBC. See local listings.

National Geographic EXPLORER
TBS. Sundays, 7 p.m. ET.

Children's Programming
Really Wild Animals
The Disney Channel. Weekends.

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■ *NATURE STRIKES!* VIDEO COLLECTION

What's Out There That May Be Incoming

A scar is born in a cataclysmic encounter (left). "Asteroids: Deadly Impact" is now available in the home video trilogy *Nature Strikes!* The other two titles in the collection, "Volcano: Nature's Inferno" and "Tsunami: Killer Wave," remind us that there is no dearth of earthly dangers.

THE FINE ART OF MESSING WITH SUCCESS.

February 26, 1992: Chrysler minivans are named top safety choice in the passenger van category in Prevention magazine's Safe Car of the Year Awards.

August 1, 1996: Chrysler Town & Country minivan named top safety choice in the 1995 passenger van category by Prevention magazine. (Anyone see a pattern developing here?)

November 1, 1995: New Dodge Caravan is named Motor Trend's Car of the Year – first time a minivan wins the award. Second straight year that a Chrysler Corporation vehicle has won.

October 11, 1995: Accompanied by the Whetstone HS Marching Band, Chrysler CEO Bob Eaton delivers the five-millionth Chrysler Corporation minivan to the Lombard family of Columbus, Ohio.

Having invented the category, we at Chrysler Corporation knew that tampering with something as popular as our minivan would be a delicate operation. (Of course, introducing it in the first place was a bit chancy too.) But what we finally decided was that the greater risk was resting on our laurels. When making great cars and

Visit our World Wide Web site at http://www.chryslercorp.com, or call toll-free 1-888-GREATCARS. *'Chrysler minivan owner during the '92 second-quarter (January, February, March) sales period. 'Always use seat belts. Remember, a backseat is the safest place for children.*

May 15, 1992:
Multidisciplinary platform team convenes to begin work on the next generation of the minivan.

August 1, 1992:
Dodge and Plymouth minivans get optional sport handling suspension. Car pools across America become approximately 37% less boring.

September 18, 1992:
*Consumer Attitude Research announces that Chrysler minivans have the highest repeat purchase rate of any platform sold in the United States.**

July 15, 1992:
Platform team reads letters from minivan owners asking, "Why not put a sliding door on the driver's side too?"

May 9, 1993:
Sales of Chrysler minivans in Asia pass 2,000. Reports that minivan interior is more spacious than average Beijing apartment are unconfirmed.

March 10, 1995:
Redesigned Chrysler, Plymouth, and Dodge minivans reach dealerships with features including dual front air bags,† optional dual sliding doors, Easy Out Roller Seats,™ and enough storage space for the most acquisitive of families.

April 18, 1994:
Fuel-door problem solved. (Sorry, but if we told you how, we'd have to kill you.)

September 15, 1993:
Problem: How to keep driver's-side sliding door from banging into fuel door.

trucks is your goal, the right decision is usually fairly obvious. Kind of like the idea of putting a sliding door on both sides of your minivan, come to think of it.

loyalty at 63% in compilation of 62,583 new car and light truck buyers conducted

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NATIONAL GEOGRAPHIC

EarthAlmanac

STROMBUS GIGAS; STEPHEN FROHS, THE WATERHOUSE

Returning the Deposed Queen Conch to Royal Status in Florida

Bug-eyed stalks protrude from the gleaming pink shell of a queen conch, irresistible to collectors—one reason the mollusk's numbers have fallen in Florida. Pollution is also suspected. In 1985 the state banned conch harvesting, but it continues in the Caribbean for curios and tasty seafood.

To reestablish the Florida conchs, a hatchery began producing larvae on Long Key in 1990. The project, involving state and private groups and volunteer divers, has released some 5,000 young conchs offshore, though predators such as porcupine fish lurk there. "To see if the conchs survive, divers locate them with a metal detector that picks up an aluminum tag on their shells," says Bob Glazer of Florida's Department of Environmental Protection. Nearly 20 percent of the conchs have made it.

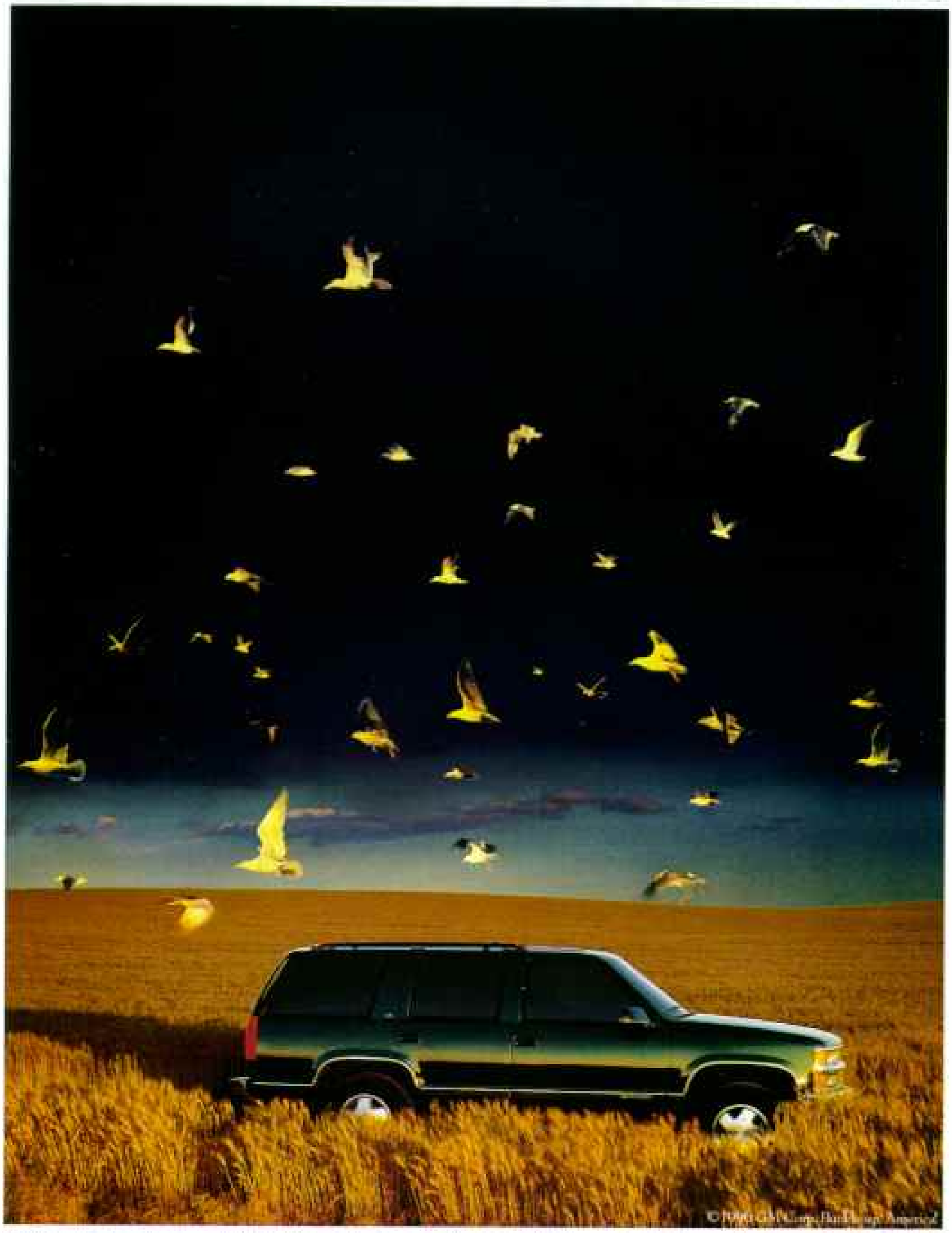
CORVUS MONEDULOIDES; RACHEL TAYLOR

Clever Pacific Crows Make Customized Tools

Sophisticated species such as chimps use tools in food gathering. Now crows on the islands of New Caledonia have been found to be avian mechanics. They make two tools to winkle out insects from their hiding places.

For one tool, shown here, the crow cuts a strip of pandanus leaf with its bill (far left), then uses the barbed edge to search plant leaves or holes for prey and drag it out. The bird makes a second tool by biting twigs to create a hook. The manufacture of hooks by animals is unprecedented, says New Zealand researcher Gavin R. Hunt, who studied the crows for three years.

I FIND THE GREAT THING IN THIS WORLD
IS NOT SO MUCH WHERE WE STAND, AS IN WHAT DIRECTION WE ARE MOVING / Oliver Wendell Holmes, Jr.



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LIKE A ROCK

Little Frogs Get Tender Loving Care in Jamaica

Many frogs are attentive parents, protecting their eggs or the developing tadpoles for days, in part to guard them from predators, including other frogs. But this Jamaican cave frog goes the extra mile. An accomplished backpacker, she totes her young after they develop into froglets. She lays her eggs inside a cave in a rocky crack, then sits among them for weeks until they hatch into froglets a quarter of an inch long. The froglets climb immediately onto her back, and she carries them out of the cave, where they later jump off into a brave new world of light—and danger.

ELEUTHERODACTYLUS CUNEALUS | WINIFRED DENTEL

In the Dwindling Philippine Forest, There's Still Room for Discovery

CRATEROMYS HEANEYI: ROBERT S. KENNEDY, CINCINNATI MUSEUM CENTER

New to science, a furry nocturnal tree-dwelling mammal named the Panay cloudrunner was identified in the Philippines by Pedro C. Gonzales of the Philippine National Museum and Robert S. Kennedy, an ornithologist with the Cincinnati Museum Center who has long studied the Philippine eagle (GEOGRAPHIC, June 1981). Loss of its mountain habitat threatens the 26-inch-long

AETHOPYGA LINARAE: ALLAN SUTHERLAND, CINCINNATI MUSEUM CENTER

cloudrunner, which Kennedy likens to North America's eastern fox squirrel. This cloudrunner was photographed in captivity. When Kennedy's team collected sunbirds, he determined that identical specimens collected in 1965 had been misidentified as a known species. All were, in fact, a new species, which he christened Lina's sunbird (above, on human hand). —JOHN L. ELIOT

Interactive

■ ONLINE

Maps: Earth's Family Album

A multiplicity of maps giving diverse views of places from Australia (left) to Zimbabwe is now available on our National Geographic website. Building on the Society's tradition of cartographic excellence, Map Machine allows users to explore Earth's far reaches by entering the world of maps: www.nationalgeographic.com/resources/maps.

Curious about Eritrea? The Map Machine Atlas contains the latest maps, facts, and profiles of that new African nation, as well as the 190 other countries of the world and the 50 U.S. states. Information is accessible by clicking on a continent or region or by using the index.

Like a cartographic bazaar, Map Machine offers physical and political maps (B and D) as well as composite satellite maps (A), free of cloud cover and marked with borders and place-names for a unique view of the planet.

Netscape users can download software (Macromedia's Shockwave xRes plug-in) and zoom in and out of any country on National Geographic's world map (C). The printed map is also available through the online NGS Store.

Map Resources, a general reference section of Map Machine, provides comprehensive information on cartography, geographic names, government agencies, and map libraries. Its roster of links lists other helpful sites.

■ CD-ROMs

Bursting With Creativity

National Geographic Photo Gallery will make available breathtaking pictures from 11 top photographers—including Chris Johns, here beside an African volcano—for use in designing your own greeting cards, banners, and calendars. Details next month.

■ FOR INFORMATION

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NATIONAL GEOGRAPHIC

On Assignment

■ GRAND MANAGED CANYON

Making a Big Splash on the Colorado

"People always ask if I did dangerous things at the GEOGRAPHIC," says former staff writer Mike Long, whose exploits during his 29-year career at this magazine—he now works as a freelancer—have included landing a 747, canoeing the Allagash, racing through the Baja desert in a Volkswagen bug, and interviewing nudists. Yet nothing was so frightening to Mike (right, at bottom) as being thrown into the deadly churn of the Grand Canyon's Crystal Rapids. "I don't remember being petrified," he says. "I just wanted to save myself." Despite his ordeal, Mike is now ready to brave Crystal Rapids one more time, "but this time I'd like to stay in my boat."

PETER LEICK

■ SUMO

He's the Little Guy in the Middle

What does it take to make a six-foot-tall Texan feel tiny? Photographer Robb Kendrick had to spend some time with Sumo wrestlers, including Kyokkoyama, at right, and Takinooto, to find out. "I like to eat," he says, "but I couldn't keep up with these guys. There's a real good reason why they're that big."

Robb first got interested in photography as a young boy growing up in Hereford, Texas. "My uncle, who had been in Vietnam, gave me a shoe box full of pictures he'd taken there. I guess I got obsessed," says Robb, who soon acquired his own camera but still dreamed of a career as a cross-country truck driver. "It was the only job I could think of where you got paid to travel. As a kid, when my family would go on road trips, I'd insist that my dad fill the tank at truck stops, so I could take pictures of the big rigs."

TOSHI KASAI

Robb went on to major in photography at East Texas State University, and a stint as a NATIONAL GEOGRAPHIC photographic intern followed. Soon he turned pro. It seems that he finally thought of another job where you get paid to travel.

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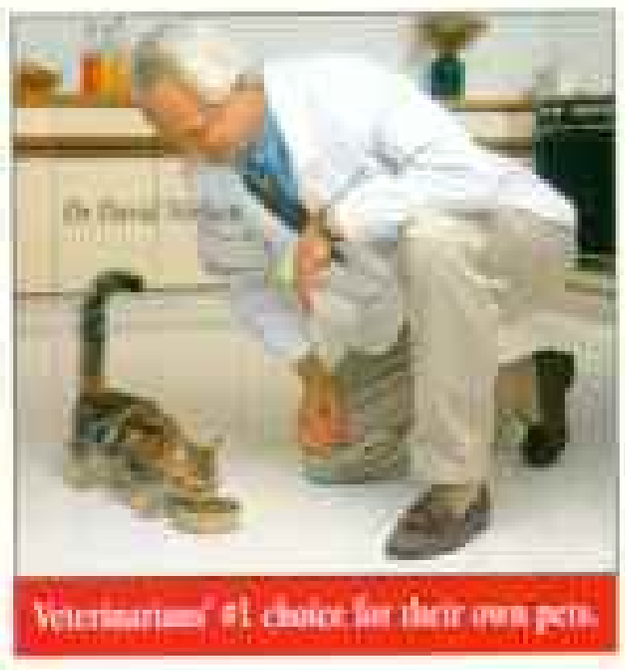

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