

VOL. 130, NO. 6

DECEMBER, 1966

NATIONAL GEOGRAPHIC

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COVER: Arab tends sheep in the Jordan Valley, where flocks have grazed since the time of Abraham (page 739).

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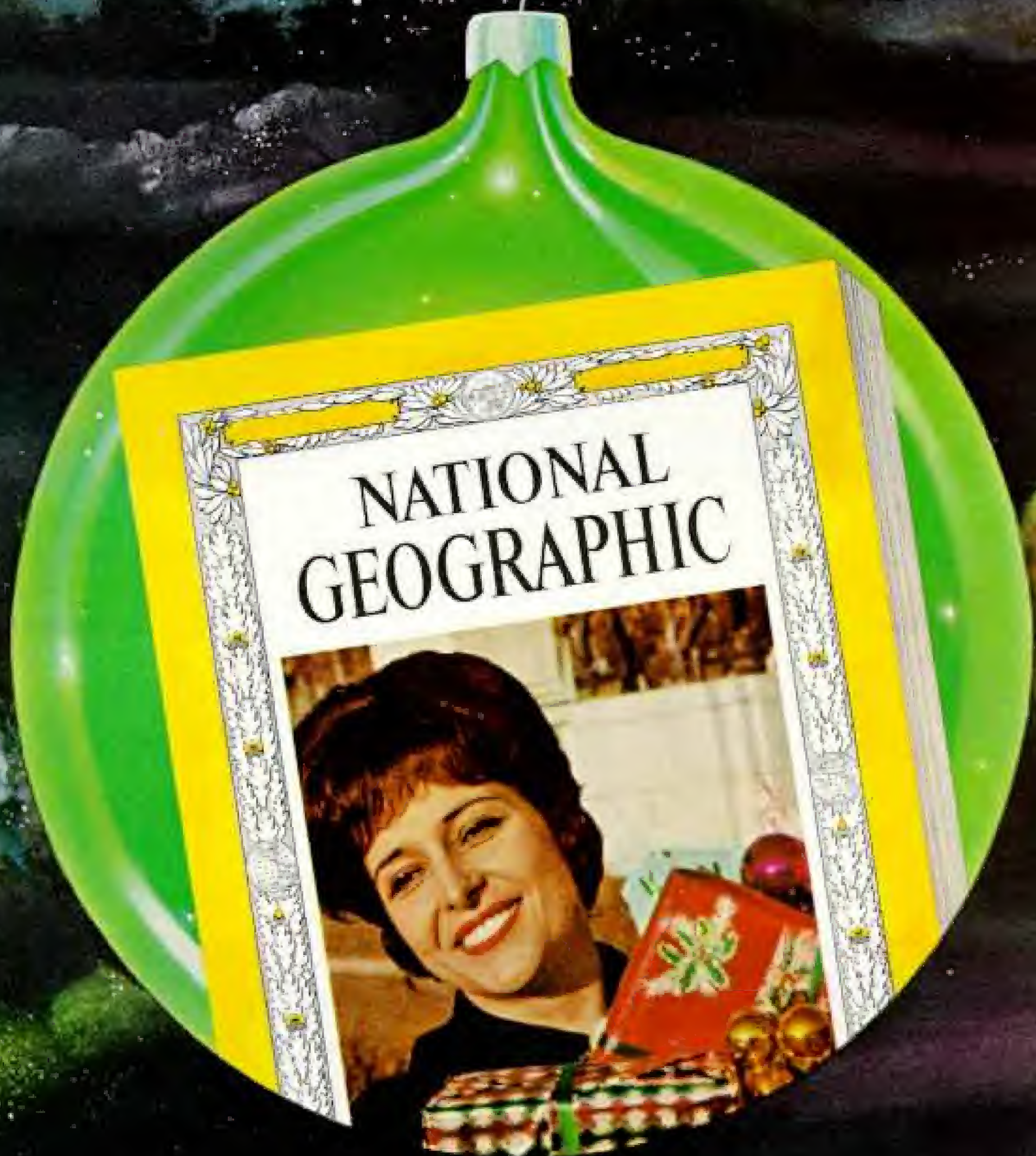
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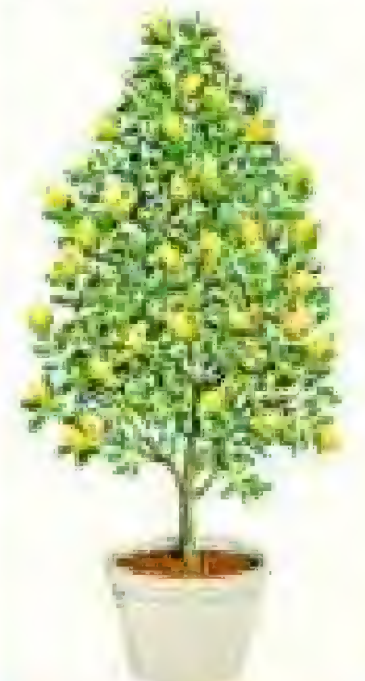
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Now these are the generations of Terah: Terah beget Abram, Nahor, and Haran. . . . And Haran died . . . in the land of his nativity, in Ur. . . . GENESIS 11:27, 28

THE night train from Baghdad pulls into Ur Junction at about three o'clock in the morning, if the roadbed is in good shape. No one gets off. At that hour there is no sight or sound of human life at the lonely station in the Iraq delta.

The train rumbles away toward Basra and the Persian Gulf. When its clamor fades in the desert stillness, other sounds replace it. A nesting stork clatters its beak, a donkey brays, a bat shrills, a wolf howls, and a sheep dog answers. The voices of the Mesopotamian night have not changed since Ur began, more than 5,000 years ago.

Ur Junction is the last living expression of Ur—capital of Sumer, earth's first great civilization—whose ruins lie a mile and a half to the west. In the cold light that follows night, the topeless hulk of its ziggurat tower, called "Hill of Heaven" by its builders, looms on the dead-level horizon (next two pages).

It was at just such an hour that we approached Ur, bouncing along baked ruts in an elderly dust-drenched sedan. We had come 6,000 miles over the curve of the world to this silent spot. For tradition holds it to be the birthplace of a man named Abram, son of a herdsman from the upper Euphrates and destined to be known in later life and forever after as Abraham, the Friend of God.



December
1966

NATIONAL GEOGRAPHIC

THE NATIONAL GEOGRAPHIC MAGAZINE VOL. 120, NO. 12
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Abraham, the Friend of God

By KENNETH MACLEISH

Assistant Editor

*Illustrations by
National Geographic photographer
DEAN CONGER*



Silhouette from the ages, a wayfarer treads Mesopotamia, where Abraham began his quest for one true God 4,000 years ago.

ILLUSTRATION © N.G.S.

739

Here at Ur began the epic journey of this wayfarer who lived as long before Christ's coming as we live after it. Abram walked with his clan up the sun-ridden valley of Mesopotamia to what is now Turkey. Later, in obedience to a divine command, he traveled to the Judean highlands of Jordan. He grazed his flocks in the Negev. Once, in a time of drought, he went down into the lush lands of Egypt.

We would follow the course of this inspired pilgrimage from the dust of Ur to the mist of the Nile's green delta. In so doing we would pursue a legend that is history, a folk tale that is truth, a myth that was in all probability a man. As such, this modest person who never aspired to wealth or power could be called today the most widely venerated human being who ever lived. For in his wanderings across the ancient world, Abraham the Patriarch conceived a great and simple idea: the idea of a single, almighty God.

Half the world now cherishes that concept: Judaism, then Christianity, then Islam espoused it, the last two deriving from the first,

and the first born of the old man's dream. For the God of Abraham became the God of his Hebrew descendants, worshiped in spoken prayers and doctrines handed down from generation to generation. Centuries later, Hebrew scribes put these sacred oral traditions into writing. Thus the first Bible came into being.

I STARED at the ziggurat, thinking that no journey could have a more imposing point of departure. NATIONAL GEOGRAPHIC photographer Dean Conger stared at the eastern sky, cloudless but disappointingly pallid.

"Dust in the air," said Dean. "Kills color like a brown filter." Mr. Hatim, our escort from Iraq's Department of Antiquities, smiled apologetically.

Beside the ziggurat stood a little barracks, home of the two government guards who kept treasure seekers out of the vast ruin field. Here our driver Hamid stopped and let go a skull-splitting blast of his big American horn. I winced and remonstrated. "Is O.K., sir," he



murmured sleepily, and loosed another one.

In a moment the guards were with us, small brown men with heavy rifles, dressed in the corded headcloths and robes of desert Arabs. Our escorts explained our presence. Then the older of the two made us welcome and offered us all Ur with a generous gesture.

We went at once to the ziggurat and climbed its main stairway. I commented on its fine condition (page 743).

"The steps themselves are not old," Mr. Hatin explained. "The ziggurat was built by Ur Nammu more than 4,000 years ago, when the glory of Ur was at its height. But the steps were retreaded by Nabonidus of Babylon, who ruled in the sixth century B.C."

At the top of the "recent" 2,500-year-old steps lay the rubble of what had once been a second level, on which had stood a third, on which in turn had rested the temple of Ur's special deity, Sin, god of the moon. Weather, brick thieves, and amateur archeologists had laid waste the upper levels.

From this ruined eminence the land that

Temple to a vanished god, the hulking remains of a ziggurat, or stepped tower, loom against the sunrise at Ur, capital of ancient Sumer. In the surrounding region, the delta of present Iraq's Tigris and Euphrates Rivers, man's first great civilization flourished. The vast ruin field of today summons to mind Isaiah's words: "O Lord our God, other herds beside thee have had dominion over us. They are dead."

At Ur, author MacLeish and photographer Conger began following in the footsteps of Abram, son of Terah, a Semitic herdsman whose people probably camped outside the city's walls. Abram accompanied his clan on their long wanderings from Ur to an eventual Promised Land.

ILLUSTRATION BY JAMES H. HARRIS



was Sumer stretched away like the sea to a horizon as flat as an ocean's. Laid down by the twin rivers, Tigris and Euphrates, from which Mesopotamia got its name (Between the Rivers), its deep, rich soil gave the country's first farmers their first crops. But here, where cultivation first fostered civilization, no fields remain. The old plantations have vanished into the desert as the city they supported has vanished into the earth.

A few foundations show. Old diggings are filled in. Low mounds remain, smooth with age, hiding fallen walls. This is all the eye sees of the dead capital.

WHAT might we find of Abram—to use his original name—in the dust of Ur? Only a picture in the mind's eye, backed by a phrase in Genesis. No written record, of the many found at Ur, refers to

“Abram, son of Terah.” But that is not surprising. Terah and his clan were not people of Ur, but probably Semitic herdsmen from far up the valley of the Tigris and Euphrates.

They were foreigners and sojourners, speaking a strange tongue and living outside the city wall. This was to be the pattern of Abram's life. Never until the day he died did he lie in land of his own.

What kind of city was this Ur in which Abram grew to manhood and married? Our grandfathers could not have found an answer to that question, or any shred of scientifically verified information about the places and peoples he visited in his later life. Until the past few years no one could have guessed what manner of man the Patriarch might have been or how he might have lived.

But in our time a generation of archeologists has dug evidence from the ancient earth, as-



PAINTING BY JOHN BEYERHOFF, PHOTOGRAPH BY DEAN CONGER © N.A.S.

sembled and interpreted it.* Objects of many kinds have spoken their mute lines. Inscribed clay tablets by the tens of thousands have revealed the history of their day. We know far more now about the age of Abram than anyone has ever known before, including the Hebrew priests of a few centuries before Christ who first wrote down the sacred spoken stories of the doings of the Patriarchs. For Abram lived in the early 18th century B.C., as nearly as scholars can fix his date, a millennium and more before the priests put brush to leather; and they had neither recollection nor record of that early age.

Ur was old when Abram was young, a bustling, prosperous commercial center somewhat past its prime. Priest-ruled and merchant-ridden, it offered luxury to the privileged and

*See "Bringing Old Testament Times to Life," by G. Ernest Wright, *GEOGRAPHIC*, December, 1957.

Pagan splendor at New Year awes a merchant, his wife, and daughter at the ziggurat of Ur, in a scene from the time of Abraham. Prayerfully they watch parading priests and musicians restore a gilded statue of the moon god Sin to his temple atop this "Hill of Heaven," reminiscent of the Tower of Babel. In a days-long festival, Ur praised its patron deity with prayers like that on a tablet unearthed at Nineveh: "Thy brightness has filled the broad land. The people are radiant, they take courage at seeing thee."

The artist based his painting on archeological detective work, museum artifacts, and wall paintings found in the ruined cities of ancient Mesopotamia—present-day Iraq and parts of Syria and Turkey.

Rifles slung and curved knives sheathed, two guards protect the dead city of Ur from treasure seekers and brick thieves. Pitch stains the ziggurat steps. Lacking wood and stone, the ancients built enduring works with clay bricks bonded by bituminous "slime."





With a son to gladden his age, a village chieftain welcomes guests to the hospitality house of his farm community. Since time unknown, such houses of rush mats laid over arching palm fronds have sheltered people in southern Iraq. The proud elder leaves use of the bicycle to boys and schoolteachers.

Bent under brush, women trudge along a road between Ur and Baghdad. A valuable commodity in a land where little grows without irrigation, brush kindles fires of dung, provides camel fodder, reinforces adobe, and casts a cooling shadow.



subsistence to its slaves and peasants. Artisans plied their crafts with skills unequalled in all the world save Egypt. Astrologists applied the mathematics invented here by their ancestors. In temple rooms scribes practiced another art which Sumer had created: writing.

"Ama-sukkal, the daughter of Ninurta-mansum, has been taken in marriage by Enlil-izzu, the high priest of Enlil . . . Ama-sukkal has brought nineteen shekels of silver to Enlil-izzu, her husband. . . ." Signed, witnessed, dated.

But other people wrote differently, alone, and in the peace of evening:

*The gods of the land and the goddesses of the land . . .
have betaken themselves to sleep in heaven.
They are not pronouncing judgment;
They are not deciding things.
Veiled is the night;
The temple and the most holy places are
quiet and dark.
The traveler calls on his god.*

So read tablets of the times.
Narrow streets ran crookedly between windowless build-

ings of baked and unbaked brick. In each, the street entrance led to a court into which opened six or seven rooms. Often a second story offered additional rooms accessible via a wooden gallery supported on posts. They were pleasant houses, well suited to the life in the sun-seared delta country—so well suited, in fact, that their like can still be found in the towns of Iraq.

A wall circled the city. Along it, on the west, lay the Euphrates. Ships up from the sea unloaded goods of India and the East on crowded quays. Canals carried smaller vessels to other centers and water to the fields; for without irrigation there would be no crops in this cloudless country where rain fell only in the winter months.

"How it has changed," said Mr. Hatin, beside me on the broken ziggurat. "No people,

no beasts, no fields, no trees, no living thing. Even the river has gone away."

In truth, where the great Euphrates had held the shipping of the Eastern World, there was only a grassless plain, salt-poisoned and sterile. The river had made itself a new channel three miles to the east.

Beyond, on the dust-dimmed horizon, the sun rose dull as a counterfeit coin. Our friends the guards led us into their barracks, put before us oiled, sugar-sprinkled flat bread and powerful coffee, then watched us consume what was to have been their breakfast.

AND TERAH took Abram his son, and Lot the son of Haran his son's son, and Sarai his daughter in law . . . and they went forth with them from Ur . . . and they came unto Haran, and dwelt there."

EPICHRONE (LELTON) AND CONCHERONE © N.C.A.







PAINTING BY TOM LOVELL © 1993

Abraham's World of 3,700 years ago

Biblical and ancient names along Abraham's route in brown

Modern names in black

Brown line shows Abraham's probable route

• Ruins

Drawings based on ancient bas-reliefs and wall paintings



Beginning epic wanderings, a strapping young Abram takes a place beside Terah, his father, and other elders who lead their clan up the Euphrates Valley from Ur. On donkeyback, Abram's dark-haired bride Sarai admires the infant of a friend who rides beside her. A slave girl tags behind. Other servants bear water jar, provisions, and the few belongings needed by the nomadic herders. Lot, Abram's nephew and traveling companion for years to come, tends a mixed flock of goats and sheep. The women guide their bridleless mounts with the slap of a stick. Not for several centuries will man break the camel to his needs.

Searching for the Almighty in a world that trembled before many gods, the Abraham of Genesis roamed the breadth of the Fertile Crescent about 1800 B.C. His travels led from Mesopotamia—the land “Between the Rivers” Euphrates and Tigris—to the land of the Pharaohs. The way led past splendid cities, shimmering palaces, and masterworks of irrigation that transformed desert to granary. But in the harsh wilderness of Canaan, now divided by Jordan and Israel, the wanderer found his concept of one God. Today, Christian, Moslem, and Jew—each in his way—worship the God of Abraham.

Before the sun rose high enough to scorch the shadeless plain, we too left Ur to follow the Euphrates northwest to Haran, almost 600 miles away in the southern edge of Turkey. Genesis tells us nothing of the trip, it takes Terah and his clan from Ur to Haran in a single sentence. Still, men bound from Ur to Haran would probably follow the Euphrates.

Traveling by donkey (the camel had not yet been domesticated) and driving flocks of sheep and goats, Terah and his followers could cover little more than twenty miles a day (painting, preceding pages). They would set off in spring, before the coming of the nine cloudless months that would strip every blade of grass from the land.

The modern Euphrates road, rough and partially unpaved as it is, serves as the main highway through southern Iraq. More than a highway, it is an umbilical cord of communication from Baghdad to the Persian Gulf,

where railroad, powerline, irrigation ditches, and auto tracks run side by side. The towns and villages of the region attach to this main artery like buds to a stem.

The towns of Iraq reflect the past; the villages perpetuate it. Here in the delta, now as in antiquity, mud and date palms are the only building materials. The date groves that make Iraq the world's first-ranking date producer supply leaves for matting, frond stems for framework. Clay pits provide adobe.

These materials dictate the form of a house such as Abram might have known: thick-walled, almost windowless, opening into an enclosed court and roofed with mats laid over arches of frond stems. To complete the picture, tall water pots stand in ring frames beside each doorway, and domed ovens, fueled by brush and dried dung, smoke in the courtyards. Add donkeys, dogs, frisking lambs, cavorting children, and straight-backed women



Timeless as the land, a young herder's sheep prod, with its knob of hardened pitch, resembles the mace of a Babylonian soldier.

Desert dust rides the wind, clouding the air of Baghdad. Neon tubes spangle a minaret balcony, where a stork perches beside a loudspeaker; no longer does a muezzin climb the tower to sound the call to prayer. In the marketplace (left), coppersmiths raise a clatter with their mauls while plying a trade millenniums old.



balancing burdens on their heads, and you have the scene that met the eyes of Abram as he passed by.

We stopped at one such village and stood at a respectful distance waiting to be invited in. One does not approach a village of the fellahin (peasants) or the black tents of the Bedouin without proper welcome and escort. The people would resent it; the dogs would prevent it. Soon the sheik of the village came up to us. After an exchange of formal greetings, he led us to the village guesthouse. On the way a young teacher in Western dress turned to me and asked:

750 "Why do you take pictures here? This is only a village of poor people living in the old

way. In the towns you can see cement buildings with many glass windows and modern furniture, as in your country. All that is much more interesting! Do not show old ways."

The theme was to become a familiar one.

"But the old ways interest people in our country," I told him. "Besides, the old ways are the ways of the man we follow."

"What man is that?"

"Abraham. In Arabic, *Ibrahim Khalil*—'Abraham the Friend' The Friend of God."

In the guesthouse court our host offered us a big bowl of fermented sheep's milk and watched with pleasure as we drank deeply from it. Arab hospitality is both formal and genuine, and is not to be refused.



Between villages, few people appeared in the land: Half a dozen cultivators, directing irrigation water into fields of green wheat. A solitary horseman, rifle in hand. A file of women bearing brush bundles five times their size (pages 744-5). A herdsman leading camels to pasture. A tribe of gypsies in tattered splendor, mocking us with reckless grins:

A dusty wolf trotted over the wasteland and an eagle circled, watching.

When Terah and Abram passed through central Mesopotamia, Babylon was the capital of all the land. It was one of the greatest walled cities ever built and the seat of Hammurabi, the giver of laws.

Following the west bank of the Euphrates

EDUCATION BY JEAN COUZER © N.E.A.



northwestward, Terah would not have entered the city, which lies across the water. But he would have seen the eight-storied ziggurat, greater than that of Ur, and marveled at it. Today the ziggurat is gone, razed by warfare and weather. The ruins that remain are those of the Babylon built by Nebuchadnezzar, more than a thousand years later.

SINCE "all roads meet at Baghdad," according to ancient tradition, ours turned briefly away from the Euphrates at Babylon and headed for that city's modern equivalent. Baghdad is well situated. It straddles the Tigris at the point where it and the Euphrates come closest together. With a population of almost a million, it is Iraq's major city and contains most of the nation's industry (pages 748-9).

Yet, in this land of ancient towns, Baghdad is a scant twelve hundred years old. It does not relate to Abram's day or route; and so we resumed the Euphrates road in pursuit of the party that had passed this way almost four millenniums before, headed for Haran.

The ancient landscape has been altered by a water project at Ar Ramādī, where floodwaters that once devastated the delta are diverted into a natural depression now called Habbāniyah Lake. This is one of the new projects through which revenue from Iraq's oil-rich substrata is being used to improve its water-poor surface.

Still, the level lands along the river look much as they did in the time of Terah's travels (following pages). The fields between water and wasteland are green with wheat and barley in the early spring, or red-brown from recent plowing. Such fields are called Al Sawad, meaning "the dark lands," contrasting them with the pallid desert on whose edge they lie like elongated oases.

At Hit, 400 miles upstream from the sea but less than a hundred feet above sea level, the delta of the Euphrates ends. Here the bluffs close in. Here, too, an oddity must have caught the eyes (and nose) of Abram and his companions as it did ours: a natural tar pit, stirred by a bubbling flow of noxious gas,

"A dry and thirsty land"—as the Psalmist sang—still drinks from the Euphrates. River current turns the creaking water wheels at Hit; pottery jars lashed along the rims splash dollop after dollop into an aqueduct. The chocolate water, flowing to riverside fields, turns gardens green. Boys use a crude net to comb the river for fish.



from which bitumen for the building of Babylon was gathered. An amiable citizen of the town accompanied us to this odorous spot and demonstrated that a well-thrown match will set its gases afire.

Passing then from the infernal to the celestial, he led us to another of Hit's spectacles, its antique water wheels. Arranged in pairs, set in a stone dike which projects into the stream from a glade as green as Surrey in

spring, these ingenious machines are turned by the river's force and so made to lift the river's water in pottery jars lashed to their rims (pages 750-51). As the ten tall wheels turn, they empty jar after jar into an aqueduct, from which high point it flows ceaselessly, and at no cost, to the gardens of Hit.

Above Hit the river narrows and hurries, cocoa-colored, between high banks. The road is forced up out of the constricted valley at



4 HERBERTS © K.S.L.

times and cuts across a broad, steppelike upland, rolling, rock-studded.

In this poor country, too high to irrigate and too dry for rain-fed crops, are clusters of the black tents of the Bedouin. We drove cross-country to a small encampment. The sheik came forward, beating back his dogs, and escorted us to his dwelling. Here small, powerful women were transferring skins of water from a truck to a tent (above, right).

Shy but strong, a daughter of Ishmael unloads skins of water, relieving Bedouin men of the indignity of manual labor. Thus do these desert roamers—sired, according to tradition, by Abram's first born—divide responsibilities. Robed women (left) pass the hilltop tomb of a holy man as they lead donkeys beside a green flank of the Euphrates in northern Iraq. The river's gift of life reaches no farther than irrigation ditches zigzagging across the foreground.

TOM
LOVELL





The men who had brought in the load stood at ease and watched. Manual labor is beneath the dignity of a desert Arab, whose functions are to stand guard, fight, breed livestock, and welcome guests.

The water-bearing women eyed us bashfully. They would not address us, nor would we appear to notice them. When their work was done they would disappear, leaving the men to entertain the strangers. And this the men would do as naturally as they would mount a raid or repel attackers. Two thoughts struck me: The Arab world is a man's world, and nowhere so much so as among the Arabs of the desert. And, of all the earth's present people, none are so close in customs to the Patriarchs as are these nomad herdsmen.

A MAN who would follow Abram's route today needs documents and formal authorizations to cross half a dozen frontiers. As we approached the first of these—Syria's—it occurred to me that the situation was not greatly different in Abram's day, when kings and chiefs jealously guarded the borders of their territories and forbade passage to unwelcome travelers.

I had sent messages through several channels to notify the border post at Abū Kamāl that we would be passing through that little-used checkpoint on a mission as nonpolitical and innocent as Abram's own. They had not arrived. When the search of our luggage revealed eight cases of photographic equipment, including such sinister-seeming devices as long lenses and tape recorders, the Syrian guards exchanged meaningful glances.

The political officer summarized his suspicions with a pithy question: "Where are your transmitters?"

Our earnest assurances that we were not spies, but simply followers in the footsteps of Abram, evoked a sad, reproachful smile.

Haughty beauty, Sarai disdains a cloth merchant of Mari who defends the value of a bolt of goods. She leaves the crass haggling to her slave girl. Abram's way from Ur to Haran passed this royal city of Northern Mesopotamia, a prosperous commercial center in 1800 B.C. In its ruins, near Abū Kamāl, Syria, modern excavators found tablets reporting incursions of Semitic nomads—among them the Habiru, perhaps the Hebrew tribe of Abram. Behind the cloth merchant, a carpenter shapes a board while a maker of instruments plays a lyre. Fruit stall at right sells melons and grapes.



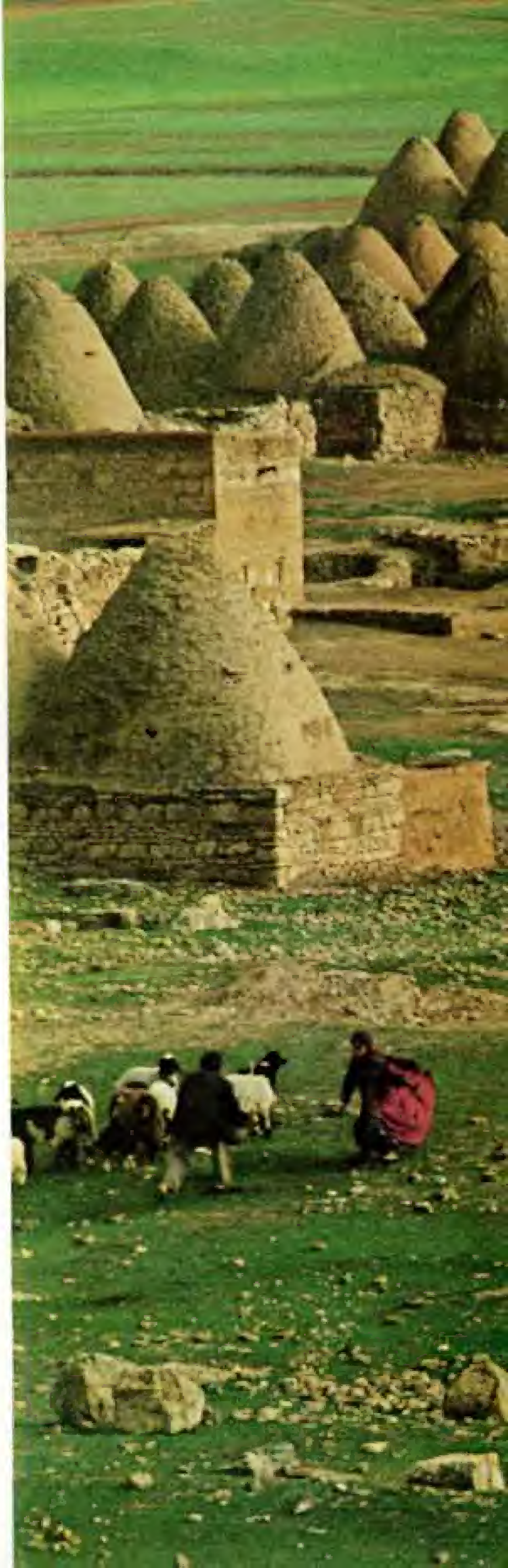
REPRODUCED BY ARNOLD WAGNER (ABOVE) AND MARK LINDER © 1988

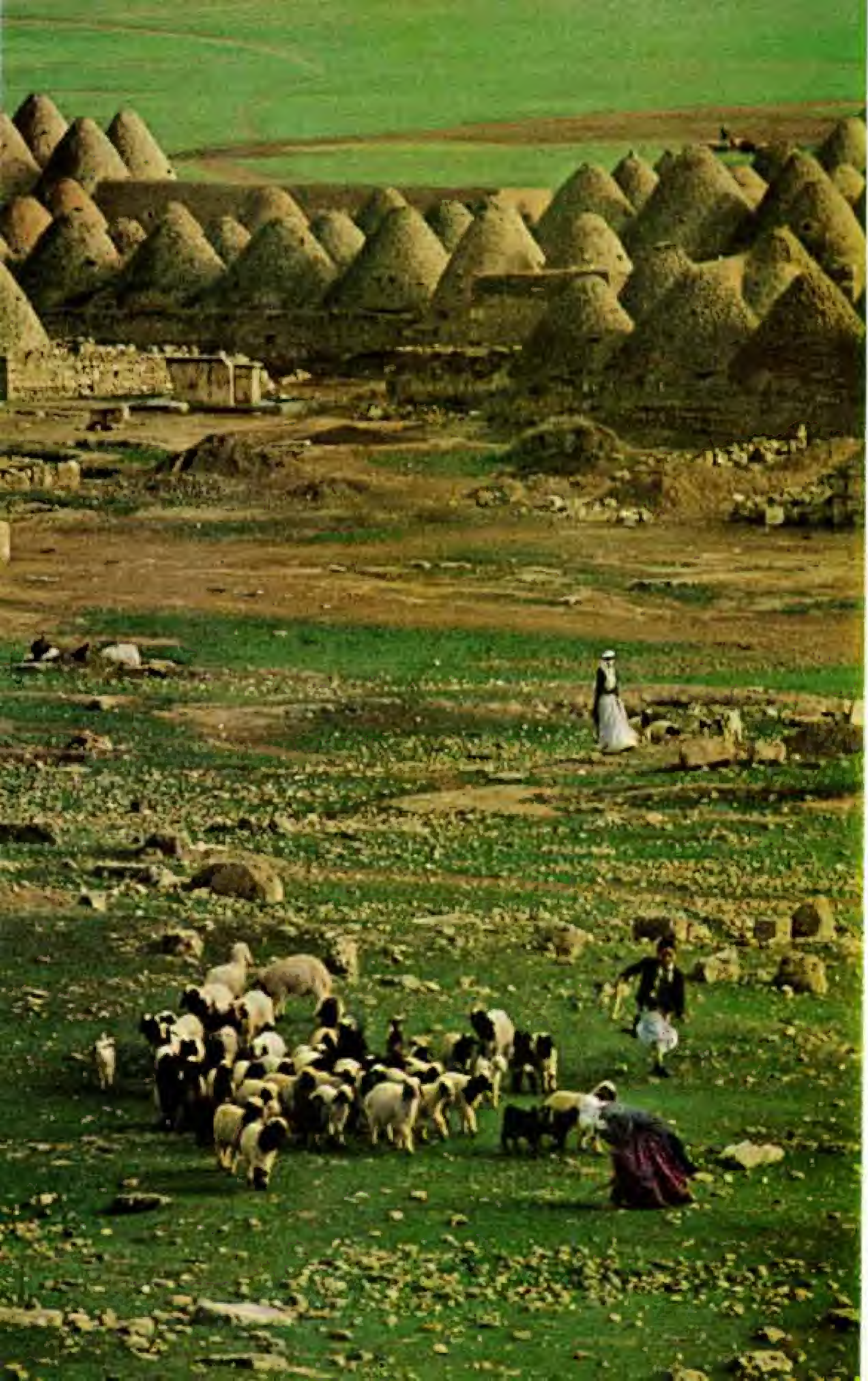
"My country . . . my kindred"; Thus spoke Abram of the region and people of Haran, where he dwelt and prospered until the prime of manhood. The Patriarch knew this Turkish village close by the Syrian border as a bustling city commanding an important junction of caravan routes.

Tablets from Mari relate that the Benjaminites, possible relatives of Abram, signed a treaty with the king of Haran in a temple of Sin. Future excavation may expose a ziggurat hidden in the hill of Haran. Today a crumbled citadel only 1,000 years old stands beside the prominence; a youth with his sheep (above) grins from its heights.

Stones from the wasting fortress find practical use in the domed homes of Haran clustered at the foot of the hill (right). The houses, shaped like beehives, differ little from dwellings of Abram's day.

After family leadership fell to Abram on the death of Terah, God dispatched him "unto a land that I will shew thee." Abram unhesitatingly forsook stability and security to set out for the unknown land of Canaan.







PAINTING BY TOM LOVELL © R.C.S.

Our interrogation lasted late into the evening. At length our baggage was impounded and we were escorted to the village rooming house. We slept fitfully as hooded figures peered in at us through the window in our bedroom door. Outside, crisp flags of the Syrian Arab Republic rattled and snapped in the cold night wind from the desert.

Morning brought what appeared to be our release. Our Iraqi driver was sent home, weak with relief, and we were installed, bag and baggage, in a Syrian car with a French-speaking driver and a ferocious-looking young man wearing an imitation suede jacket and an imperfectly concealed Browning automatic pistol. We were, presumably, on our way to the Turkish border and Haran. En

route, we stopped a few miles northwest of Abû Kamâl to see what remained of Mari, the greatest city of Northern Mesopotamia in the time of the Patriarchs. I hoped also to meet the famed archeologist André Parrot, who had worked the site for 30 years.

LOW mounds and mud-brick foundations evoked no picture of the great trade center young Abram saw as his father's caravan approached Mari's walls. The river ran beside the town in those days. There was a tall ziggurat and a palace of 300 rooms. Mari was ruled by sophisticated Babylonian Semites, many generations out of the desert, who spoke the refined Akkadian tongue. But large numbers of western Semites were in the city

and its lands. These semi-nomads, more recently arrived from the wilderness, were of Abram's kind and spoke his language.

One of the most notable finds at Mari was a collection of more than 20,000 clay tablets inscribed with cuneiform writing. Some of them described the doings of the troublesome nomads, and so fixed the date of their stay (and Abram's) in Northern Mesopotamia, a region which then included Haran. Among the wandering groups, the tablets tell us, were the Habiru. Some scholars believe that these were the original Hebrews and, as such, not only Abram's kind but his kin.

I found Professor Parrot directing a crew of chanting Arabs as they hauled dirt from the excavations. A workman hurried to him with a tablet he had just unearthed. Parrot leaned eagerly over the find, but did not touch it.

"This is the first of the new season," he told me. "It is only raw clay, you see, and must be dried for several days. Then we can brush it clean and read what it has to say."

Our escort signaled sternly and tapped his watch. As we drove on farther northwest, I wondered uneasily why he was in such a hurry. At Dayr az Zawr, capital of an eastern Syrian province, I found out.

Our car turned in through a guarded gate. All our baggage was unloaded. Then it and we were delivered into a large room, in which several solemn gentlemen in plain clothes waited to interrogate us. We had simply been turned over to higher authority, and higher

authority still wanted to know what we were really doing in Syria.

In the end we and our effects were stuffed into another car with an English-speaking driver and a non-English-speaking man in an imitation suede jacket, ostensibly free to go where we pleased. The Suede Jacket declared that his name was Elias, and he was our brother. The driver said *his* name was Elias too, and *he* was our brother. I said we were all brothers, and should take our next right for the Turkish frontier. We went straight ahead.

Elias in the back explained through Elias in the front that we had to go to Aleppo first. Night fell. We rushed westward along the river, stopping often at police checkpoints. Where the road bears right for Aleppo, we bore left. I looked at our brother at the wheel. He looked straight ahead.

After much unbrotherly conversation, it developed that we were being taken to Damascus, the capital, many hours away. We

Anxious student in the painting at left offers his copybook of damp clay for approval by a "school father." With lunch bag between his feet, he could be the hero of a popular Sumerian essay that queried, "What did you do in school?" A boy replied, "I recited my tablet, ate my lunch, prepared my new tablet, wrote it, finished it." Sons of the Mesopotamian well to do learned cuneiform, the Sumerian system of writing, in schools remarkably like those of rural America a few generations ago. Their practice tablets, from the first half of the second millennium B.C., yield knowledge of the epoch to archeologists.

Here the schoolmaster's assistant, called "big brother," monitors the rear of the class. The student at left cribbs from a benchmate. On some faculties "a man in charge of the whip" meted out discipline.

As in a modern Syrian schoolroom (right), no girlish giggles disrupt proceedings. Ancient educators accepted only male students, Arabic tradition keeps boys and girls separated in this contemporary school.



REPRODUCED BY NEAL DOBNER © N.E.C.

"Use hospitality one to another without grudging" (I Peter 4:9). Dignity born in the desert eons ago set rules of hospitality proudly observed by fellahin, Arab peasants, in the village guesthouse at Al Hammām, Syria. They will go without necessities to offer refreshment to a guest. Unlike the wandering Bedouin, fellahin live in permanent communities and till the soil.

were to be delivered to national security headquarters in the morning.

In Damascus, after further interrogation, we were told that we could work in Syria under escort but without our cameras. Awaiting further clearances, we left the country.

Five days and a thousand miles later, Dean and I stood on the hill of Haran in Turkey, not 75 miles from the road we had followed on the night of the Syrian brothers. We had arrived by a succession of cars, taxis, jeeps, and large and small airplanes, and were now in the hands of a cheerful green-eyed Turk named Aziz, who possessed a good Thames Minibus and a small but curious collection of English words picked up on an American airbase: "Yeah," "no sweat," "chow," and "vitamin-B complex."

UNLIKE Ur, Babylon, and Mari, Haran is a living town as well as a dead city. Of the two, the former relates more closely to the age of Abram than the latter: Its beehive huts are not very different from dwellings of 4,000 years ago, while its imposing ruins are those of an Islamic citadel no more than 1,000 years old (pages 756-7).

The hill of Haran is man-made, a layer cake of human habitation. Its lowest levels have never been exposed, but scientists believe that a temple to the moon god Sin, contemporaneous with Ur's ziggurat, lies under the wasted walls of the ancient Moslem fort.

The Turkish *sharif* who served as administrator for the Arab village of Haran led us around the ruins of the mosque and the fortified palace. From the palace walls we looked out over the rolling plain the Patriarchs called Paddam Aram, meaning "Field of Aram," and the small streams that give it its other name, "Aram of the Two Rivers."

Here Abram stayed until his father Terah died. He lived perhaps as he had at Ur, outside the walls. Haran was not a Semitic town, but one founded by Hurrians, a little-known people from the northern hills. Established at the crossing of two great caravan routes, one east-west, one north-south, Haran was a place



where people of different races and languages lived together in peace. The Mari tablets tell us that the Benjaminite tribe, possible relatives of Abram's, "signed a treaty with the King of Haran in the temple of Sin at Haran." The ways of the Hurrians became part of Abram's cultural heritage.

No tablets dating from Terah's days have been discovered at Haran, since the levels in which they may lie are still unexplored. But an Egyptian record provides a description of life in the region at that time. Sinuhe, an Egyptian official who lived for many years in



© 1953

exile somewhere in the area, had this to say about it: "It was a good land. Figs were in it, and grapes. It had more wine than water. Plentiful was its honey, abundant its olives. Every fruit was on its trees. Barley was there, and emmer [a hard, red wheat]. There was no limit to any cattle. . . ."

We left the ramparts, followed by small, noisy boys who pulled and poked at us and offered for sale fistfuls of coins from the ruins. The sharif shooed them away with a good-natured roar and added fondly: "Arabi boy no good. Chatterbox lazy boy!"

I commented on the small automatic he carried. He laughed. "American sheriff have two big guns, rides horse, Wild West, Chicago. Turki sharif have only one little gun, no horse."

For a few days we explored and photographed Haran, followed by larger and larger crowds of youngsters whose horseplay grew rougher and rougher. We sought peace in the guesthouse, where grown men sat each morning in quiet conclave. Here we sat too, backs to a windowless wall, on strips of carpeting laid out across hard-packed earth.

Coffee was served from long-spouted pots



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heated over charcoal. The ritual was precise: We were each given a minuscule cup into which a splash of bitter black fluid was poured. Should we refuse to drink, the cup would be emptied on the ground. Coffee is costly, but pride is priceless; and a man cannot accept that which another man has rejected.

We drank. The cups were refilled until we wagged them to indicate that we had had enough. To accept three servings was proper, showing appreciation but falling short of greed. After the coffee ceremony, there being no common words between us, Dean and I smiled politely and the others sat back for a long, interested stare. Then Dean quietly set up his lights and cameras.

“**N**OW the Lord had said unto Abram, Get thee out of thy country, and from thy kindred, and from thy father’s house, unto a land that I will shew thee.”

With Abram’s acceptance of God’s order, the foundation was laid for the covenant between God and man on which great religions of the future would be based.

Abram mustered his clan, “and they went forth to go into the land of Canaan, and into the land of Canaan they came.” The Bible tells us nothing of their itinerary, but we can make some valid assumptions about the manner of their going.

As a trader and stockman, Abram would know the routes available and their condi-

tions at various times of the year. He would likely leave in spring, when the high pastures ahead would still be green from winter rains. He would cross the Syrian border (map, pages 746-7), turn up the Euphrates Valley, then head cross-country toward Aleppo. From there, he would follow the southward swing of the Anti-Lebanon mountains in order to water his flocks in the streams that flowed from them.

For Dean and me, no such direct route was possible. One experience with remote border-control posts was enough. We circled widely through northern Turkey, then over the Mediterranean and across Canaan itself to Amman, Jordan. There, thanks to the good offices of the United States Embassy in Damascus and the Syrian Ministry of Information, we received clearance to return to Syria and take up our trail from Haran onward.

Our new escort, Mr. Saqr, was well qualified to aid us in our pursuit of Abram. Even his given name suited his assignment. Ibrahim, Arabic for Abraham. He had connections everywhere, and a fondness for the fellahin rare in a city Arab.

The lands along the Euphrates, like most of Syria’s arable lands, were owned until recently by wealthy landlords and worked by fellahin who were little better off than serfs. Today that feudal picture is fading. Great holdings have been broken up. Agrarian reform is far from accomplished, but a beginning

"He that tilleth his land shall be satisfied with bread" (Proverbs 12:11). Rhythmic motion breaks the sun-baked soil of northeast Syria. One man plunges a shovel into the dirt; a partner scoops up its load by tugging on a rope. A child sleeps (below) as her mother waits for the men to lunch on unleavened bread, boiled wheat, onions, and fermented goat's milk that she brought to them from the village.

763

EDDACHORRE BY JEAN DUBOIS © S.S.S.





764



ESTABLISHED BY KENNETH WILSON (1910-87) AND NEAL WILSON © 2011





Mud-brick townhouses walling a street in Safirah, a village of western Syria, reminded the author of brown eggs in a carton. Such villages probably greeted Abram as he made his way toward Canaan. Of ancient design, the homes open onto enclosed courts, protected from dust and noise.

A woman hurries her donkey down the street, since decorum demands that she keep her distance from men, especially strangers. But a curious lass (top left) cannot resist a backward glance while fleeing the author's approach. A ring in her nose shows her family holds to old-time customs.

Syria, bent on becoming a modern state, hopes to eradicate these beehive villages that the government considers backward. But author MacLeish found the distinctive homes handsome, admirably suited to terrain and climate, and comfortably furnished with rugs, cushions, and bolsters.

Prized steed, proud master: A prosperous villager exercises his mare in the cool of late afternoon on a sweeping prairie south of Aleppo. In the distance a shepherd returns home with his flock across the blood-hued earth. The rich soil yields bountiful crops of grain and cotton.

has been made. The average fellah may not yet have land, but he has hope.

Tractors were working the fields, readying them for small grain and cotton. Farmers sat at ease on the fresh-tilled earth, eating their lunch of boiled wheat, bread, and onions, washed down with fermented milk from greenish goatskins.

Power-driven pumps throbbled in every adobe village, raising water from the river to the fields. We stopped at one such village near sundown and were welcomed by a clan of big brown-haired, blue-eyed men. Their guest-house was smaller than that of Haran, but bright with Persian rugs which covered the floor, and colored bolsters. The sheik himself poured the coffee, the cups hidden in his heavy hand. No labor-loathing Bedouin, this man was a cultivator and proud of it.

RETRACING the route down which our police escorts had taken us weeks before, we arrived at the fork where the Aleppo road leads to the right and we had turned left for Damascus. This time we took the direction of our choice and found our way into one of Syria's biggest cities.

Aleppo existed in Abram's day. Like Haran, it straddled a caravan route and doubtless catered to the caravan trade. But nothing is visible in modern Aleppo of the buildings of that time, for a living town builds on its own foundations.

The huge citadel, riding a rock in Aleppo's center, is the town's only salute to comparative antiquity. Its massive walls commemorate the relatively recent drama of the Crusades. Ironically, the conflicting philosophies that sparked the bloody battles between Christian and Moslem both grew from the revelation that the herdsman of Haran was to seek and find in the high places of Canaan.

Although Genesis makes no mention of Aleppo, Moslem tradition does. According to an Arab legend, Abram passed through the town and found its inhabitants ill and underfed. He therefore milked his white cow and gave the milk to the poor, restoring them miraculously to health. From this act comes the city's Arabic name, Halab Shahba'. It means "to milk the white cow."

From Aleppo the modern road, like the ancient caravan track, turns south and holds to that general heading. On the right are the Anti-Lebanons and other mountains, some snow-capped even in summer, that separate the high Syrian plateau from the Mediterranean coastal plain. Where the mountains end, in northern Israel, the Great Rift Valley deepens and runs southward to form the Sea of Galilee, the Jordan Valley, and the Dead Sea.* The Bible calls this caravan route the King's Highway.

How far down the King's Highway Abram traveled before crossing the Jordan to go up into Canaan, we do not know. The best guess is that he turned westward between the Sea of Galilee and the Dead Sea. But he must first have come close to Damascus, a sizable city at that time. And on his way to Damascus, he may have camped on the cool Orontes River where Hamāh now stands.

Part of the prairie country between Aleppo and Hamāh is so riddled with rock as to be fit only for pasture, but great expanses are rich, red soil, capable of making fine grain and cotton crops. Near Aleppo the peasant villages are of the ancient beehive form, functional, handsome, and wonderfully distinctive.

Where wood is scarce, what better way to get a roof over one's head than to make a dome of bricks? The long rows of smooth-contoured plastic shapes stand on the plain like natural outgrowths of the Syrian earth. They have somewhat the appearance of brown eggs in a carton (preceding pages).

At our insistence Mr. Saqr directed us to one of these villages. "Such houses are a sign of backwardness," he said. "In a few years, our government tells us, all will be replaced."

"Replaced by what?" I asked.

"Nice little square cement houses."

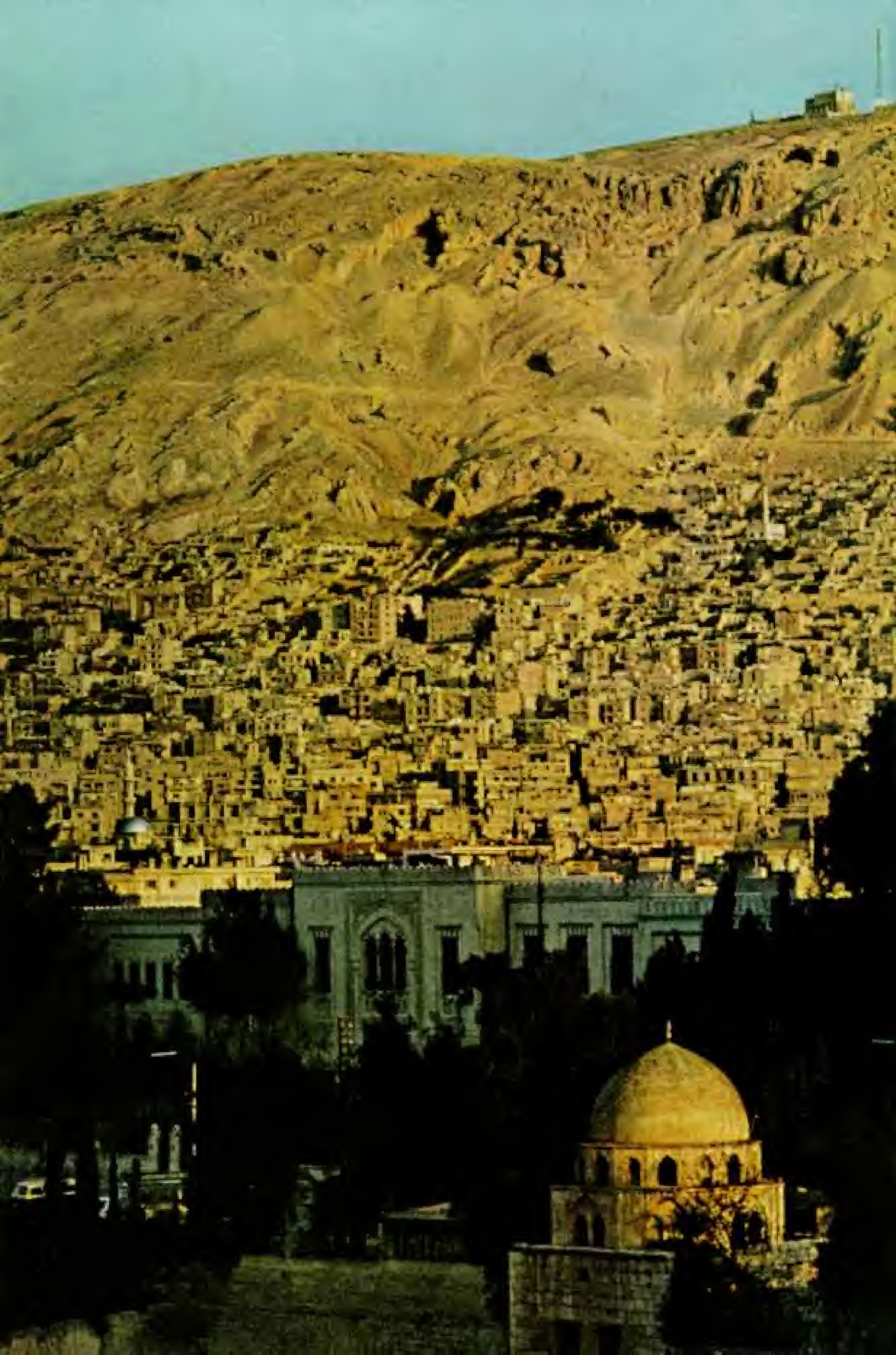
"But they will be like houses everywhere, without character."

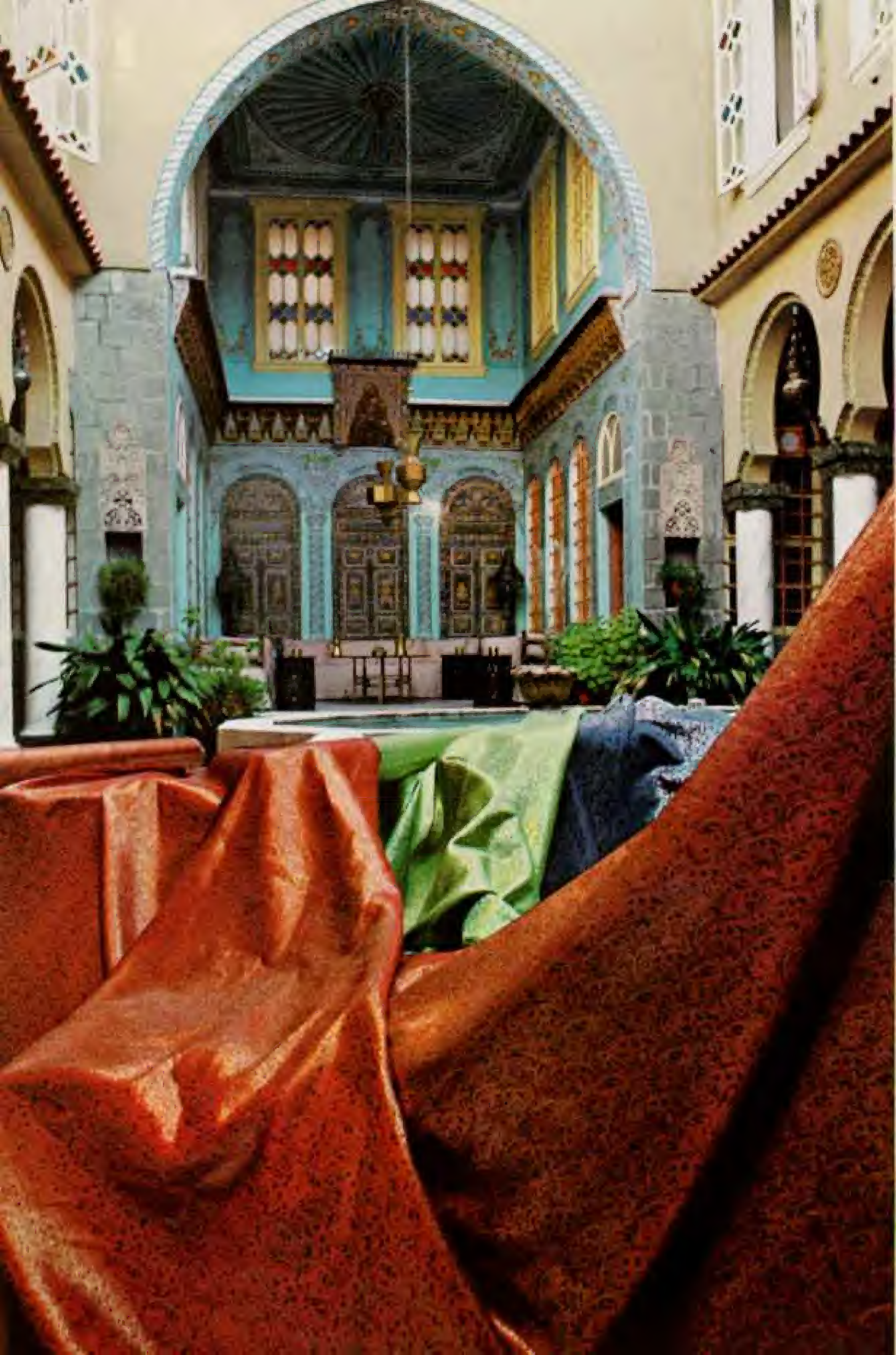
"They will be modern," said Mr. Saqr sternly. "That is best."

The young lieutenant in charge of the village's administration seemed less convinced of that, though equally bent on improvement

*Helen and Frank Schreider described this part of the Rift Valley in "Journey Into the Great Rift," NATIONAL GEOGRAPHIC, August, 1965.

Delight at the desert edge, Damascus cheers dusty travelers with city comforts, architectural beauties, and rich bazaars, legendary even in patriarchal days. A modern quarter of Syria's capital—the world's oldest continuously inhabited city—climbs Jebel Kasyūn, a spur of the Anti-Lebanon range topped by a television transmitter.





which, in terms of clean water, sewers, streets, and schools, is badly needed.

He led us to a well-kept beehive. "You might think that such a place would be ugly inside, but it is lovely. Come in. You will see."

The house consisted of two rectangular dome-topped rooms. Their interiors were white-painted, rug-floored, and far roomier than seemed possible. Cushions and bolsters served as furniture. Small windows let in light, and holes at the top let out smoke.

"These are warm in winter because of the thick earth walls and cool in summer because of the high dome. They keep out the dust that comes on the wind and they are easy to repair. Also they cost nothing."

"But they must all be destroyed," reminded Mr. Saqr.

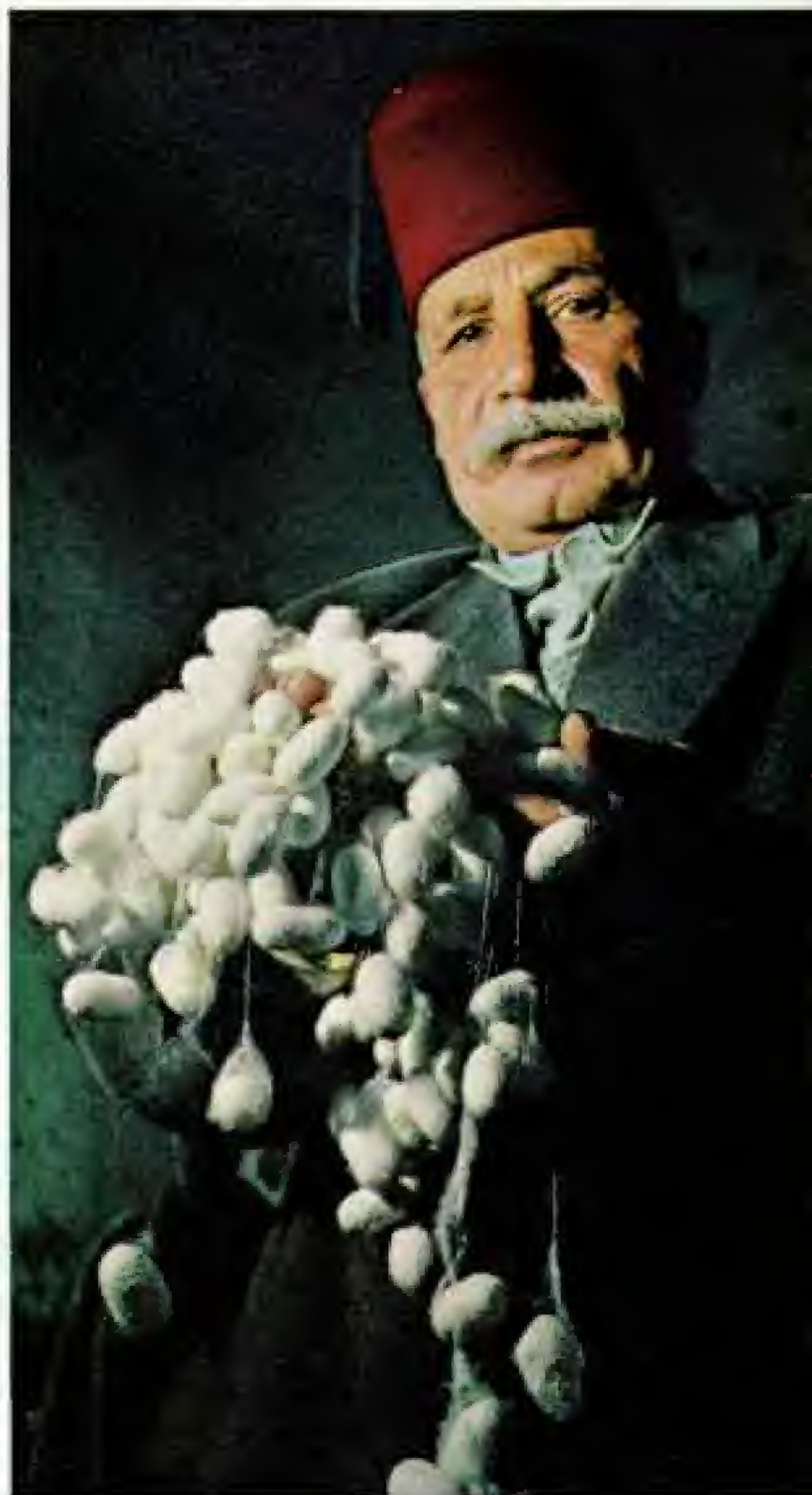
"Of course," said the lieutenant.

As we talked, a tiny girl of perhaps eight years walked in from next door, surprisingly unafraid of the male strangers. Her name was Aziza, which means "dear," and she had the serenity of a seraph. Instead of hiding at the sight of a camera, she posed willingly at Dean's request, settling herself on a cushion, all plump poise and grace. When we left, she gave me an old-fashioned Arab salutation, taking my hand, kissing it, pressing her forehead upon it, and kissing it again. Syria would do well to think carefully before abolishing all its ancient ways.

Evening brought us to Hamāh, where the wonderful water wheels that make the place a fresh-smelling oasis snored and splashed through the night. In the morning we drove on to Damascus.

EVERY traveler on the ancient north-south caravan route knew Damascus. It was the finest town in all the western country, famed for its arts and crafts. Its snow-fed, seven-branched Barada River gave it greater and greener fields than any to be found for hundreds of miles around. Its groves were legendary along the dusty trail. Its women were famed for their beauty. Its very name—Esh Sham—connoted loveliness: It means "beauty spot." Abram, trail-weary and no doubt curious, might well have gone into the rich bazaars of Damascus to trade or tarry.

There is reason to think he did. We learn from Genesis 15 that in his later years Abram had a servant, a sort of honored lieutenant and major-domo, who appeared also to have been an adopted son, for he was to inherit all Abram's wealth should Abram die childless. This man was called Eliezer of Damascus.



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Silk cocoons dangle from the hands of Khe-rallah Sammam. His factory in Homs, Syria, supplies thread to brocade makers.

Metallic threads of silver and gold mingle with silk in brocades spread in the showroom of S. G. Nassan and Company in Damascus. Nassan artisans also fashion rugs, inlaid furniture, and brassware—famed products of Damascus from antiquity.

"Day of darkness and of gloominess," like the doomsday prophesied by Joel, dims serene hills east of the River Jordan (next pages). But sunshine warms camels setting out to graze a patch of the Promised Land. The King's Highway, followed by Abram, parallels the Jordan Valley, center, as it plunges 1,296 feet below sea level to the Dead Sea.







"And Abram said, Lord God, what wilt thou give me, seeing I go childless, and the steward of my house is this Eliezer of Damascus . . . mine heir." Perhaps Abram acquired Eliezer on this, his only visit to the town.

There is no finer link between present and past than modern Damascus, the oldest continuously inhabited city in the world. As elsewhere, even at ancient Mari, the walls that stood when Abram passed this way are buried under later levels. But for all its modern buildings and clamorous traffic, a feeling of antiquity pervades this sprawling, slope-climbing city of half a million, whose population reflects as many succeeding cultures as

do its structures (page 767). Mosques and monuments, even whole streets, present the patterns of a thousand years ago. Here and there a foundation or a tomb or some other precious vestige harks back to a still earlier time. In the Christian quarter, a crypt marks the house of Ananias, who restored the sight of Saul of Tarsus (St. Paul). It is a simple subterranean room of rough stone, where candles still flicker in the dimness.

But there is more than silent stone to recall the ways of earlier ages. Damascus is still famed for its handicrafts, in which the traditions if not the patterns of the distant past are perpetuated. Glass and mosaics are worked



COURTESY BY DEAN TUNER (2) 2012

with rare skill. Woodworking has reached a level of intricacy unrivaled elsewhere. Copper and brass are etched, inlaid, and engraved to produce pieces famed throughout the world. Native silk and threads of silver and gold are woven on foot-powered hand looms into rich brocades (page 768). Indeed, the patterned silk called damask bears the name of its place of origin.

To us, as no doubt to Abram, the empty, unbroken plain south of Damascus stretched in dreary contrast to the life and color of the city. We crossed it in two hours, passing into Jordan at Dar'ā. Abram would have journeyed a week or more, if, as we suppose, he

By the walls of Shechem, on whose rubble two boys play, Abram paused after entering Canaan. "Unto thy seed," the Lord promised Abram, "will I give this land." Atop Mount Gerizim, right, Samaritans still make burnt offerings; as did Abram, who "bullded . . . an altar unto the Lord."

followed the King's Highway well south of the Sea of Galilee (pages 770-71) before turning westward down one of the many wadis to the low-lying Jordan River.

We ourselves, bound by the road's present course, crossed at the head of the Dead Sea, 1,296 feet below sea level, and came up to the warm golden limestone and dark cedars of Old Jerusalem—Jordanian sector—at the edge of the hill country, 2,000 feet above. We stood now in Canaan.

ABRAM knew Jerusalem as Uru Salem. The little walled town was never his home, but he passed it on his southward way. We would return to Jerusalem, to find among its antiquities the few, far more ancient sites that existed in the Uru Salem of patriarchal times, before the shrines of three religions made the simple citadel a city of God. But first we must rejoin Abram's route at Shechem, where he settled when he reached the new-found land.

"And Abram passed through the land unto the place of Sichem [Shechem], unto the plain of Moreh."

The fine sweeping valley of Shechem remains, accented by massive ruins, recently excavated, whose walls were standing when Abram entered the valley from the depths of the gulch called Wādī al Fārī'ah. They are thick walls, stone-built, for the hill country is a country of stones (left).

But probably they never sheltered Abram's tribe, for here as elsewhere he pitched his tent in the open, built an altar to his one true God, and lived at peace with those who were there before him.

Abram was no hot-eyed fanatic but a tolerant man, respectful of the gods of others. In Ur and at Haran he doubtless worshiped Sin, the moon god. In Canaan, he probably followed the form if not the spirit of Canaanite religion, sharing with the Canaanites the practice of sacrificing living animals and worshipping El, their chief god.

Yet there was a vast difference between his faith and theirs. Abram's El was personal, demanding, forgiving, jealous, and generous—omnipotent and omnipresent. The El of the





CHRISTOPHER D. HILL



Fire flickers in a Bedouin camp by the Dead Sea as dusk glows above Judean hills climbing toward Jerusalem. Like Abram, these wanderers live in a tent of woven goat hair.

Brown stripes on a green carpet laid by winter rain: A Jordanian farmer plods behind a wooden plow and tills his soil.

Canaanites was impersonal, too lofty to be approachable, mild, well-meaning, requiring only a modest pay-off in burnt offerings to assure his placid benevolence.

But Abram was a wise and wondering man, a god-hungry man who sought something more worthy of his deep devotion than a celestial source of guaranteed good luck. Somewhere in Canaan, perhaps in Shechem, perhaps in his later wanderings, he found what he sought. His revelation was the concept of “covenant”—a binding commitment between God and man. There was no such idea in the religion of Canaan.

THE hill country of Canaan was not only a land of revelation, where the elemental forces of nature were exposed to the searching mind; it was also the only part of Canaan where a semi-nomad could move freely with his flocks. In the Jordan Valley to the east and the coastal plain to the west, planted fields would have blocked the herdsman’s way.

We do not know how long Abram camped at Shechem, but only that in time he left to pitch his tents in a spot with “Bethel on the west, and Hai [Ai] on the east.” The place is unmarked, for it has never been precisely located. In this land of shrines, I thought, a solitary hilltop would be particularly evocative. We set out half-seriously to find it.

Bethel poses no problem of location. Archeology, which



Roped like tow horses, men pull naggars whose sails hang loose in faltering wind. The broad-beamed vessels, filled until nearly awash with produce of the Biblical land of Goshen, inch to market along the canals lacing the United Arab Republic's Nile Delta.

Abram went down to Egypt to escape a "famine in the land," Genesis relates. Scholars believe Abram sought water and fodder for his flocks in Goshen, where decades later his descendants came to live with Joseph, the Patriarch's great-grandson, who rose from slave to vizier of Egypt.



more and more frequently supports Biblical statements with scientific fact, proved Bethel to be the modern village of Baytān. The ruins of Ai are thought to lie under the houses of Et Tell, about two miles southeast of Baytān. Both are hilltop sites, visible from a distance. Both are natural points of reference, serving even today as local landmarks:

We left our car at Baytān and walked east through a fig grove. Ahead were hills, red-earthed and littered with pale rock, where sheep and goats grazed.

The first was not high enough. Abram had built an altar on a high place. Surely then it was the highest place in the vicinity. But another, farther hill looked promising. From its top we could see many miles in all directions. Bethel lay to the west. To the east was Ai.

A small boy who had followed us up the hill now pointed out and named all the towns and villages around us. Jerusalem and the hills beyond it stood within the circle of our sight.

Gilded hour of dawn lights the way for a donkey-borne traveler in the Nile Delta. Brush-topped atobe towns, surrounding Islamic minarets, stand on the canal banks every few hundred yards in this thickly populated region between Cairo and Suez. A land of honey since the Pharaohs ruled it, the flat, well-watered delta supports plantations of cotton, fruit, vegetables, and grain.

Comely as Hagar, Egyptian handmaid of Sarai, a young woman pauses during her work in a Nile Delta cotton field. Ten years after they re-entered Canaan, a barren Sarai implored her husband to "go in unto my maid . . . that I may obtain children by her." And Hagar bore Ishmael, from whom Arabs reckon their lineage.



KISSACK-HOMER © N. S. R.





The hilltop had been leveled long ago. Stones were piled in rows to expose a little earth. Had some of them once formed a rough altar? Without the slightest hint of proof, the scene suggested that this was so. In the quiet of this place, with a long view of the land about me, I felt closer to the questing wanderer than I had at any point along his trail.

The boy said: "Come now to my house. Drink milk. Is only small house made of"—he pointed to a goat cropping a nearby shrub—"his hair. But good milk."

We came down the slope of the hill that could have been Abram's and approached the black tent. A blanket was spread for us. A pretty young woman in brilliant reds and blues milked the ewes, peeking shyly over their backs. A cheerful crone with tattooed chin and a headband of gold coins watched us with frank fascination.

The boy brought hot sheep's milk and stood before us, ragged and wonderfully courteous, proud to act out the tradition of hospitality which Abram also honored.

“AND ABRAM journeyed, going on still toward the south. And there was a famine in the land: and Abram went down into Egypt to sojourn there.”

Where in Egypt? We are not told. But since he was going there to escape the drought, he would go no farther than was necessary. The eastern delta country would provide fodder and water. And it was this same region, known as Goshen, that Abram's descendants frequented a century or two after his death. The great center of the area was Tanis, and to Tanis we went.

The land of Goshen today is flat, lush, well-watered, and thickly populated. Camels pace its roads. Cows and buffaloes turn its water wheels—for here all depends on irrigation—and pull its plows. Brush-topped adobe houses line wide canals where men and children tow slack-sailed barges (pages 776-7). Pigeons clatter in mud coops as tall as African anthills.

Cotton is the cash crop, but everything grows here. Our guide, a venerable dragoman named Mohammed Sharaby, pointed out mango plantations ("In summer, you get dozen for one shilling") and even cactus thickets ("They eat it, the fruit").

After a short, unhappy interlude in a crowded market, where a petulant camel bit me thoughtfully on the thigh and soldiers arrested us for taking pictures, we came to Tanis.

The Tanis exposed by the excavators' shovels has nothing in common with the Tanis of the 18th century B.C. that Abram knew about and perhaps visited. The handsome broken monuments are the work of Ramesses II, who made the town a show place of the Egyptian world five centuries later.

The walls of the older structures are hidden and the gardens are gone. But from the heights of the shard-covered mound I could sense how the land of Goshen must have looked to travelers from Canaan. To the east the dust-gray desert lies lifeless. But to the west, palms fringe moist fields of living green.

Abram came out of Egypt a rich man, a fact which Genesis attributes to his own human frailty and the loyalty of God to His friend. We read that "[Abram] said unto Sarai . . . thou art a fair woman to look upon . . . Therefore . . . the Egyptians . . . shall say, This is his wife: and they will kill me, but they will save thee alive. Say, I pray thee, thou art my sister: that it may be well with me . . ."

As a result, Pharaoh took Sarai into his harem and bestowed wealth upon her "brother" Abram. God was angry, but instead of punishing Abram, He "plagued Pharaoh and his house with great plagues." The miserable Egyptian then sent Abram away, wife, wealth, and all (painting, opposite).

The meaning of this questionable episode was certainly not clear to the priest who first set it down in writing. To his credit, he wrote it more or less as he heard it, understood or not. It was this respect for the old spoken verses that makes the Bible we have inherited the amazingly historical work it is.

"Now therefore behold thy wife, take her, and go thy way," Pharaoh commands as Sarai departs his palace to rejoin Abram's retinue. Earlier, fearing covetous men might kill him to win the beautiful Sarai, Abram implored her, the Bible records, "Say, I pray thee, thou art my sister: that it may be well with me for thy sake: and my soul shall live because of thee." She does so, and Pharaoh soon claims her for his harem.

When Abram's wrathful God visits "Pharaoh and his house with great plagues," the monarch learns the true situation and indignantly ends the affair. "And Abram went up out of Egypt, he, and his wife, and all that he had."

But here again scholars of our time have new-found knowledge with which to interpret Abram's behavior. The late Professor E. A. Speiser, one of the leading authorities on the Old Testament and Middle Eastern civilization,* did so by studying recently discovered tablets which describe certain Hurrian customs: Haran, Abram's old home, was a Hurrian city. Dr. Speiser points out in his brilliant volume on Genesis in the Anchor Bible series that, in Hurrian society, men sometimes conferred special status on their wives by adopting them as sisters.

As a man of prestige and importance, Abram would have adopted Sarai and become legally her brother. Since sistership was a point of prestige for Sarai, he would have stressed it in presenting her to important personages such as Pharaoh.

This much the scribe recorded faithfully. But some editor along the way seems to have invented an explanation for this misunderstood matter by attributing a deceitful motive to Abram and an unjust reaction to God.

If Abram called Sarai his sister it was because, in his Hurrian-influenced mind, she was. No devious purpose need be sought. And if he left Egypt a wealthy man, it was perhaps because he prospered there, as elsewhere.

When Abram left Egypt, he went by stages back to his hilltop in Bethel. Dean and I could not cross the Sinai Peninsula into Palestine as he had, for today no passage from Egypt into Israel is permitted. Mohammed guided us along the little delta roads to Cairo, whence we would fly to Jordanian Jerusalem.

AND Abram said unto Lot, Let there be no strife . . . between me and thee, and between my herdmen and thy herdmen. . . . Is not the whole land before thee? separate thyself, I pray thee, from me."

It was at Bethel that Abram and his nephew Lot separated, for their herds and followers were becoming numerous. Lot, given the first choice, chose the rich-looking Jordan

*See "Ancient Mesopotamia: A Light That Did Not Fail," by E. A. Speiser, *GEOGRAPHIC*, January, 1951.

Valley and followed it down to Sodom, south of the Dead Sea.

When he had gone, God said to Abram, "Lift up now thine eyes, and look from the place where thou art. . . . For all the land which thou seest, to thee will I give it, and to thy seed for ever. . . . Then Abram removed his tent, and came and dwelt in the plain of Mamre, which is in Hebron, and built there an altar unto the Lord." Later translations change "plain" to "terebinth" or "oak."

The terebinths of Mamre are gone, though an elderly local tree serves as a tourist attraction. The grove became the closest thing to a permanent home Abram had ever known.



Hidden from prying eyes, behind a gay veil, a woman at Hebron clutches her white headdress—badge of a successful pilgrimage to Mecca. Moslems believe Abraham with Ishmael built their most sacred shrine, the Ka'ba of Mecca. Five times a day, followers of Islam bow toward it in prayer.

Despite God's gift, he owned no land in the eyes of other men, or any house. But he spent much time in his camp at Mamre.

From here he went out with 318 retainers to conquer the Kings of the East who had sacked Sodom and carried off his nephew Lot, receiving the blessings and congratulations of the King of Salem (Jerusalem) on his return.

In the narrative of these events—Genesis 14—he is called "Abram the Hebrew," a term which no Hebrew writer would use, suggesting that this famous chapter was not set down by priests who were themselves Hebrews, but by a foreign, outside source reporting on a truly historical individual.

Abram was old and favored by God, but he lacked what he wanted most: a son to ensure his succession and to people the land God had repeatedly promised him. Sarai being barren, she gave him her Egyptian maid Hagar as concubine—another Hurrian custom mentioned in tablets of the times and in the laws of Hammurabi.

Hagar became pregnant and proud. The jealous Sarai could not legally drive her away, but she could, and did, abuse her. In the end, Hagar fled. But an angel ordered her to return, saying: "Thou art with child, and shalt bear a son, and shalt call his name Ishmael. . . . And he will be a wild man; his hand will

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PAINTING BY TOM LOVELL © B.B.S.

be against every man, and every man's hand against him." Thus the first Bedouin.

When Abram was 99 years old, God spoke to him and promised him a second son, to be born of his wife Sarai, who was 90. Abram smiled at this thought and the forthright Sarai laughed aloud when she heard of it (painting, above). But God expanded his covenant with Abram: Through this second son, to be named Isaac, he would become "a father of many nations." And this covenant was to be symbolized by circumcision.

God changed Abram's name to Abraham, which, according to Professor Speiser, means "the father is exalted," and Sarai's to Sarah, which means "princess."

Abraham and his tribe apparently migrated

often into the Negev, for it was there, near Beersheba, that Sarah grew jealous of Hagar's son Ishmael and said to Abraham, "Cast out this bondwoman and her son: for the son of this bondwoman shall not be heir with my son, even with Isaac."

Sarah had her way. But "God was with the lad; and he grew, and dwelt in the wilderness, and became an archer." And he too became a father of nations, for the Arabs are his get.

My own visit to the Negev was perforce postponed until the end of my stay in Jordan. Once I had crossed into Israel there could be no return. But when the time came, that passage through the Mandelbaum Gate from Jerusalem, Jordan, to Jerusalem, Israel, was easy. I walked alone across no man's land.

Soldiers on rooftops watched quietly. At the Israeli barrier a man took my bags.

Half an hour later I was settled in an Israeli hotel which afforded a fine view of the Jordanian hotel I had just left, a mile away and in another country.

Chaim Zelniker, a third-generation *sabra* (native-born Israeli) drove me through orange groves and fields of ripe wheat toward Beer-sheba, a new industrial community on the edge of the desert. It is a raw-looking town, hard-striving and efficient.⁶ It suggests nothing of the place Abraham knew.

There is a fouled well of Roman date called Abraham's Well: "to keep the tourists happy."

⁶See "Israel: Land of Promise," by John Seefeld, NATIONAL GEOGRAPHIC, March, 1965.

Chaim explained. The most colorful thing in town is the stockpile of a ceramic concern which manufactures bathroom fixtures in dazzling shades from materials taken from the Dead Sea.

A day's donkey ride northwest of Beer-sheba—or half an hour by car—is a mound called Tel Abu Hureira, which is thought to contain the ruins of Gerar, a town well known to Abraham. Its chief, one Abimelech, had had several encounters with the Patriarch, for the latter had flocks in Abimelech's territory. One altercation between the two had to do with water rights. Another concerned precisely the same wife-sister situation that occurred when Abraham was in Egypt.

Getting directions along the way, we found 783

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Unworldly guests, three strangers welcomed by elderly Abraham in the grove of Mamre at Hebron, deliver a startling message "... and, lo, Sarah thy wife shall have a son" (Genesis 18:10). The Patriarch realizes that he entertains no ordinary men.

God pledged to Abram: "Thy name shall be Abraham; for a father of many nations have I made thee." Now, eavesdropping in the tent, his 90-year-old wife, rechristened Sarah, chuckles at the idea of bearing a child.

"Wherefore did Sarah laugh...? Is any thing too hard for the Lord?" demands the spokesman, now recognized by Abraham as the Lord himself.

Sarah conceived. "And Abraham was an hundred years old, when his son Isaac was born unto him."

Youngsters scamper along a wall overgrown by fig trees at Hebron. They know the Jordanian city as Al Khalil—"The Friend"—after its association with Abraham, the Friend of God.





BARON, H. FERRA COLLECTION, THE HIGH MUSEUM OF ART, ATLANTA, GEORGIA

Put to a test of faith, Abraham prepares to sacrifice his son Isaac as directed by God. But an intervening angel stays his hand at the last moment. This interpretation of Abraham's ordeal came from the brush of Italian artist Baciccio, who decorated many churches and palaces in the 17th-18th centuries.

formed an altar. A Bedouin's white headcloth was stretched above it.

As I stepped back, I noticed that the corner of the building was splashed and smeared with congealed blood. The embers of a recent fire lay nearby. Here on the mound of Gerar were age-old elements of a burnt offering: altar, blood, fire. The Bedouin had not forgotten the old ways.

Abraham knew the ritual well. Often he had set up an altar to his God, killed an animal upon it, and burned its flesh. And it was here in the northern Negev, perhaps at Gerar, perhaps at Beersheba, that he was ordered to sacrifice his own son. Dr. Speiser's moving and exact translation reads:

"God put Abraham to the test. . . . He said, 'Take your son, your beloved one, Isaac whom you hold so dear, and go to the land of Moriah, where you shall offer him up as a burnt offering on one of

the mound in the rich country north of the desert line where orchards and wheat fields and vineyards shone in the glow of evening. The road through the fields was impassable. We walked in, and I made my way alone up the brushy side of the hill to its level top, where galaxies of flowers bloomed in response to recent rain.

There were no prehistoric walls, only potsherds to prove the site's antiquity. A small half-ruined Arab shrine stood empty and forlorn in the rank grass.

As I passed the old tomb, I glanced into its dim interior and froze. Fresh green branches

the heights that I will point out to you.'"

No greater trial could have been conceived by God for the measuring of His friend's faith. Abraham saddled a donkey, took two servants, some split wood, his son, and traveled for three days to "the place that God had indicated to him."

That place can never be located precisely, since nothing is there to mark it. Tradition places it on Mount Moriah in the Old City of Jerusalem—later the site of Solomon's Temple and the present Dome of the Rock.

Abraham left the servants and walked in silence with his son to the hilltop. Isaac carried

Hallowed Dome of the Rock, a seventh-century mosque in Jerusalem, shelters the stone (next pages) revered as the site of Isaac's near sacrifice. Here Solomon placed his temple and Jesus frequented another, raised by Herod. From here, Moslems believe, Mohammed ascended to heaven on a magic steed.

the wood and Abraham the cleaver. After a time the boy asked his father, "... where is the sheep for the burnt offering?" Abraham answered that God would see to it.

As Professor Speiser puts it, "The boy must by now have sensed the truth. The short and simple sentence, 'And the two of them walked on together,' covers what is perhaps the most poignant and eloquent silence in all literature."

At the last moment—but only at the last moment—an angel stayed Abraham's hand as he raised his cleaver to destroy his son and all his hopes. The awful ordeal was over (painting, opposite).

Thanks to the cooperation of the Awqaf Office, the Jordanian agency of religious affairs, Dean and I were given the run of the mosque that now stands on the Rock. It is a sight to delight the eye. But the naked stone it enshrines speaks more directly to the heart (pages 786-7). As I looked at it, the magnificence around me faded, and I saw only an old man and a boy standing in silent despair on a lonely hill in Canaan.

SOON AFTER his torment on the heights of Moriah, Abraham went back to his home at Hebron. "And Sarah died in ... Hebron in the land of Canaan: and Abraham came to mourn for Sarah, and to weep for her."

For the first time in his life, Abraham purchased a piece of property—the cave of Machpelah—as a tomb in which to bury his dead.

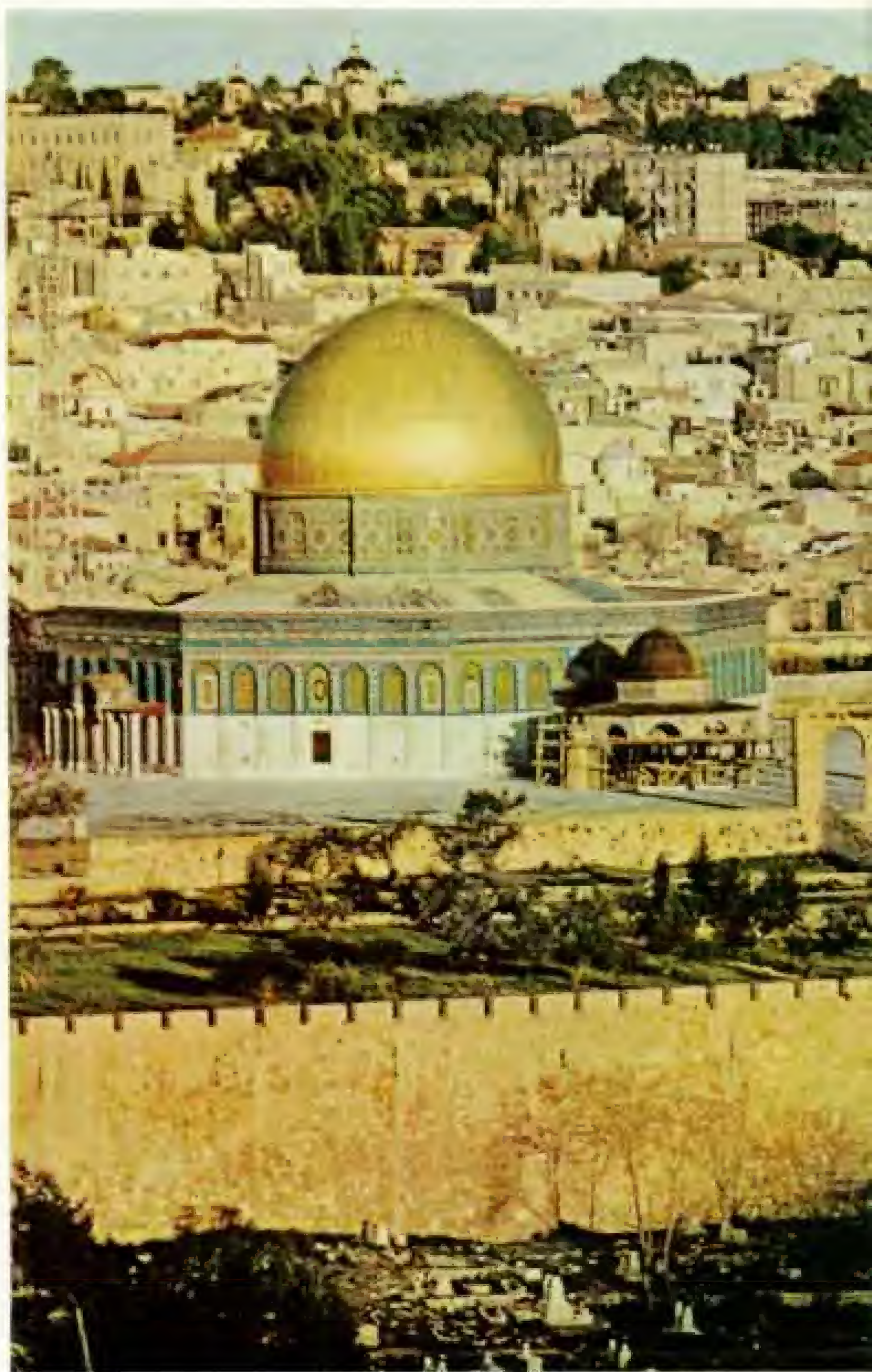
"The living," as Dr. Speiser has observed,

"could get by as sojourners; but the dead required a permanent resting ground."

In time Abraham himself joined Sarah in death. He was "old, and well stricken in age; and the Lord had blessed Abraham in all things." The Patriarch was laid beside his wife in the cave of Machpelah.

The cave exists. Covering and concealing it is a mosque whose foundations date from Herod's day. Later portions were built by Byzantine Christians, still later ones by Arabs.

The surrounding town, now called Al Khalil—The Friend—in honor of Abraham, is entirely Moslem and particularly holy.



ESTABLISHED BY DEAN CURTIS © 1942



—the God of Abraham. Jordan, with aid from other Arab states, recently restored the mosque. Light shines through a round hole from a cave within the rock where the faithful pray.

787

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER DEAN CORNER © N.G.S.





Until recently no non-Moslem was permitted to set foot in the mosque itself, for it is one of the most sacred shrines of Islam. Again, through the kindness of the Jordanian religious hierarchy, we were allowed not only to enter, but to photograph the shrine of the Patriarch. To this end Sheik Ates el-Hamouri, the director of the mosque, led us himself through this sacred place.

Six cenotaphs, or symbolic tombs, stand on its floor, representing those whose bones are believed to lie in the cave below: Abraham and Sarah, Isaac and Rebekah, Jacob and Leah. Abraham's cenotaph and Sarah's stand in enclosures behind silver bars, draped in green silk (opposite).

In the cool gloom, awed pilgrims moved silently on bare feet over carpeted floors. Some knelt immediately to pray, but others, particularly women, approached the cenotaphs to caress their corners, or kiss them.

Nearly an old man prostrated himself over a brass grille set flush with the floor.

"He is looking into the cave itself," the director told me, "through the only aperture that remains open. Come."

The old man bowed and moved away, and I knelt in his place over the grate. A current of moist air rose from the darkness where an oil lamp, suspended far below, revealed no feature of Abraham's resting place or its contents. But one may believe that the mortal



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"And Sarah died in... Hebron in the land of Canaan: and Abraham came to mourn for Sarah, and to weep for her" (Genesis 23:2). Grieved and tottering, Abraham leans on Isaac as father and son lay Sarah to rest in the cave of Machpelah at Hebron. Members of the family and servants bring mortuary gifts of wine, food, ointment, and jewelry. The landless wanderer entreated the children of Heth for "possession of a burying-place with you." Ephron the Hittite sold Abraham the cave for an exorbitant 400 shekels of silver, obviously taking advantage of the mourning widower.

"Then Abraham gave up the ghost... And his sons Isaac and Ishmael buried him in the cave of Machpelah" (Genesis 25:8-9). Today, padlock and gate of silver (below) protect the cenotaphs of Abraham and Sarah in a great mosque above the cave. Other cenotaphs honor Isaac and his wife Rebekah, as well as their son Jacob and his wife Leah.



remains of the Patriarchs are there. Monks who inhabited the shrine in the Crusader period, when the building was a Byzantine church, claimed to have discovered them on the 7th of July, 1119. Since no archeologist may enter the cavern, this claim cannot be confirmed, but neither need it be doubted.

Perhaps it doesn't matter. The darkness beneath the brass bars in the floor of the mosque is enough. The burial cave is below. Here the weary wanderer was laid to rest in the only bit of land he ever owned. Here the long voyage ended. And here we latter-day followers of the half-hidden trail from Ur to Egypt felt sure, for the first time, that our paths and Abraham's had met. THE END



Boston booms anew as the historic capital of Massachusetts marks hundreds of downtown acres for

Massachusetts Builds for Tomorrow

By ROBERT DE ROOS

Illustrations by B. ANTHONY STEWART
National Geographic Chief Photographer





DETAILS AND AERIAL PHOTO BY LAURENCE FURRY; SKETCHING BY JAMES A. HOLLAND © B.A.S.

redemption, focused on the new Government and Prudential Centers (see key, next page).

ONE BRISK AFTERNOON, a typical fall day on Cape Cod, I stood atop a steep sand dune near Provincetown, Massachusetts. The white-flecked, blue-gray Atlantic stretched to the horizon. There was nothing but ocean between me and Portugal.

When Henry David Thoreau stood on a similar Cape Cod height at Nauset Beach, his thought was: "A man may stand there and put all America behind him."

But there is another view, if one turns west

to the Massachusetts main shore! A man may stand here with all America *before* him.

In Provincetown Harbor, which lay below me, the Pilgrims anchored on November 11, 1620. While still aboard ship, they drew up the Mayflower Compact, to "combine our selves together into a Civill Body politick." The Pilgrims soon moved on to Plymouth, but true Provincetowners sniff at the name.

"Plymouth Rock?" they say. "That's a chicken."

New England began in Massachusetts, whether you pinpoint the map at Provincetown or Plymouth (pages 800-802). The ideas and ideals of her settlers went on to permeate the entire country, and Puritanism, a special Massachusetts legacy, left a permanent mark on America's character.

346-year-old Lady Turns Young Again

Massachusetts, full of rum and rectitude in her rebellious youth, sedate and sober in her middle years, is now quite an old lady. She celebrated her 346th birthday this year, and she was in her 155th year when she set off the Revolution. Yet today she kicks up her heels, ready to start all over again.

Every time I return to Massachusetts, it is with a profound feeling of returning to our beginnings. Just the mention of its everyday

place names sets the bells ringing: Lexington, Concord, Plymouth Rock, Nantucket, Salem; and the Boston names—Bunker Hill, Faneuil Hall, the Old North Church, Beacon Hill.

I visited Massachusetts three times in a year—in summer, in red-gold fall, and in white winter. On my first visit Boston slept in midnight darkness, and the city was hidden. I thought fondly of its red-brick buildings, the color of the best salami; the green of weathered copper; the tall spires of the churches; the sunset's glow on gilded weather vanes and Georgian cupolas; and boys sculling on the Charles beneath graceful bridges.

Good, grave, unchanging Boston, I thought. How wrong I was!

The shock came next morning. Outside my hotel window, behind the golden dome of the State House, rose the tick-tack-toe of

MASSACHUSETTS HISTORICAL SOCIETY COURTESY, RESEARCHERS AT NATIONAL GEOGRAPHIC EXCELLENCE CENTER AND ANTHONY STEWART © R.A.S.







Boston's new look

WHERE PURITAN AND PATRIOT, Yankee aristocrat and proud immigrant fashioned a distinctive way of life, a venturesome new generation looks ahead. Resolute redevelopment, sweeping away Boston's decayed areas, stakes out the future with steel-ribbed towers. Mayor John F. Collins, with hard-hatted foreman, inspects progress on



the new City Hall in the 60-acre Government Center.

The Prudential Insurance Company of America helped generate the billion-dollar building program with the 52-story "Pru Tower," the city's tallest skyscraper (center and left). From an observation deck just below a top-floor restaurant, a million visitors a year enjoy the vista of city and bay. Far below them, sailboats spangle the Charles River.

The tower's versatile plaza serves as outdoor restaurant in summer and skating rink in winter; a green rubber mat transforms it into a court for an exhibition by tennis professionals Barry MacKay and Ken Rosewall (foreground) against Batch Buchholz and Rod Laver.

Old Boston, long cherished for its eccentric streets, rousing politics, and educational resources, today throbs with new life; the author found the same spirited confidence throughout Massachusetts. Traveling from Cape Cod's marshes and sand dunes to the Berkshires' blue valleys, he found a people optimistic about the future and proud of their rich past.



structural steel—skeletons for skyscrapers.

Could I be in the wrong town? Boston doesn't build skyscrapers.

"I don't blame you for being surprised," a friend laughed. "So are Bostonians."

To Bostonians, both proper and improper, Boston is like no other city on the globe. Statistically, its greater metropolitan area is seventh largest in the United States, with a 1965 population of 2,590,040. But the city is also many other things: a seaport, a financial center, a manufacturing center, the home of prominent insurance companies, publishers, and educational institutions.

It is not for these alone that Boston ranks as one of America's best-loved cities. It is so because its past also is very much present.

Cobblestones Mark "Massacre"

The Boston we treasure is colonial Boston, the Boston of narrow streets and narrow minds—narrow minds that suddenly burgeoned and helped bring forth some of the broadest thoughts ever conceived about the liberty of man.

Colonial Boston lives on in the Old State House, the narrow brick structure that bears the lion and unicorn of the British Royal



PHOTOGRAPH BY E. J. PHOENIX STEWART © R.S.L.

Arms. Here in 1761 James Otis argued against the Writs of Assistance—special search warrants—and John Adams later declared, “American independence was then and there born. . . .”

And on the night of March 5, 1770, boisterous Bostonians looking for trouble taunted the British garrison—and threw snowballs, sharp ice, and pieces of wood at the sentries. The British fired into the crowd, and five men died. A circle of cobblestones at State and Congress Streets marks the site of the Boston Massacre (page 792).

A few yards away stands Faneuil Hall, a

“Cradle of American liberty,” Daniel Webster called Boston’s Faneuil Hall. In the canvas above the rostrum, the fiery orator argues before the United States Senate in 1830 for “Liberty and Union, now and forever.” Gift of merchant Peter Faneuil in 1742, the hall provided a forum for patriots in the early days of the Revolution. Citizens protested the Stamp Act and railed against the hated tea tax. Today, any organization may meet in the hall. Here the U. S. Internal Revenue Service honors outstanding employees in Boston.

combination public market and meeting place—the gift in 1742 of Peter Faneuil, “the top-most merchant in all the town.” The building still has butcher stalls on the ground floor, and public meetings are still held in the white-columned chamber on the second floor (left).

A custodian showed me the armory on the top floor. With its “Stairway of the Constitution,” bearing on the risers the names of the original 13 states, it houses a remarkable collection of weaponry, flags, and uniforms.

“The Ancient and Honorable Artillery Company of Massachusetts meets here,” he said proudly. “It was chartered in 1638.”

Next day I crossed Boston Common to the old Granary Burying Ground, lying in dappled shade next to the Park Street Church on Tremont Street. John Hancock is buried here, along with Peter Faneuil, James Otis, the parents of Benjamin Franklin, Mary Goose (regarded by many as the original Mother Goose), and, most famous of all, Paul Revere.

*Listen, my children, and you shall hear
Of the midnight ride of Paul Revere. . . .*

It seems appropriate that the oldest house standing in Boston, a somber clapboard, belonged to Paul Revere. He left it on the night of April 18, 1775, to warn the Minutemen of the approach of the British, who sought to seize ammunition and arms stored in Concord. Paul Revere House still preserves some relics of the patriot’s life—his cane, a lantern, a pair of flintlock pistols.

Revere was captured beyond Lexington, but Dr. Samuel Prescott, a compatriot, carried the warning to Concord. Nevertheless, Revere got the poem and the fame.

Not far from the Revere house stands Christ Church, the Old North Church. In the belfry hung the lanterns that signaled the departure of the British from Boston—“one if by land and two if by sea.”

I sat in the Revere pew as the vicar, the Rev. Howard Pearson Kellett, told the story to a group of school children. He explained how



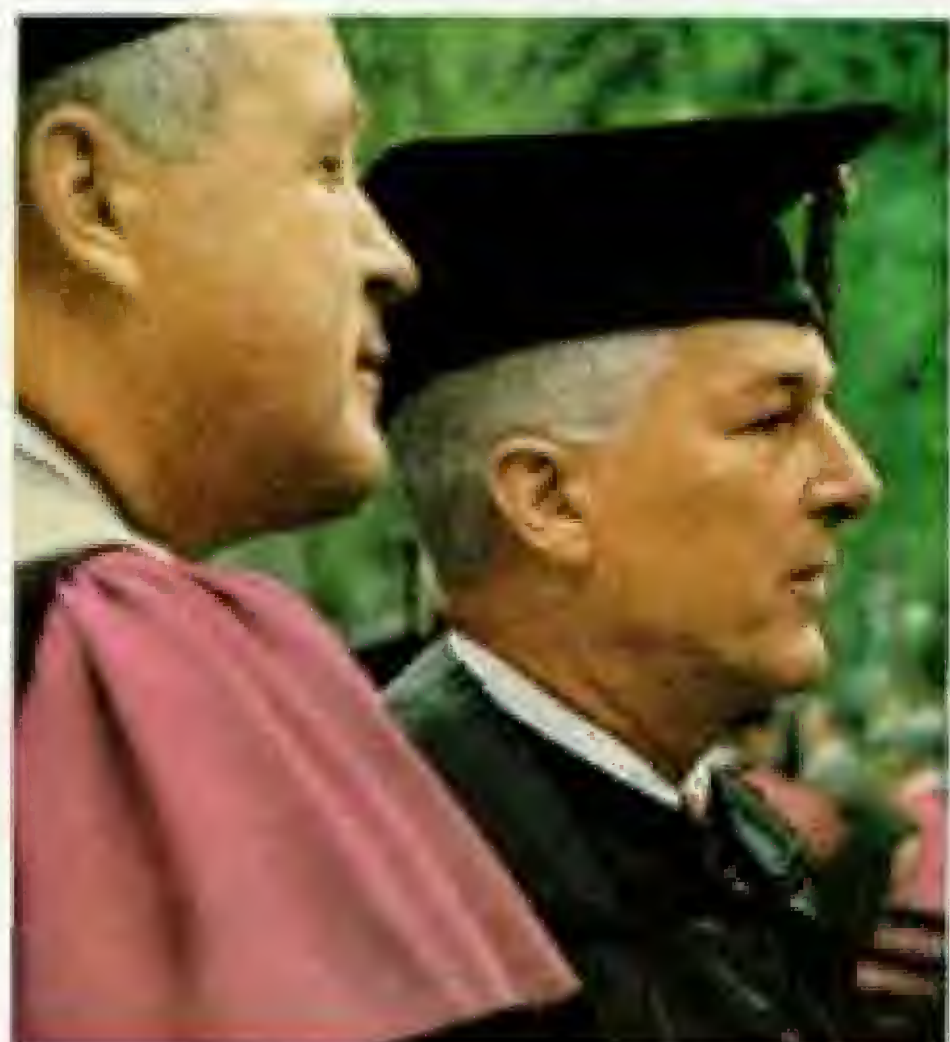
DETROIT: (RIGHT) AND BOSTON: (LEFT) © R. K. P.

Erwin D. Canham plays a dual role as president of the Christian Science Church and editor in chief of its daily *Monitor*. His office faces the Mother Church in Boston.

Perry T. Rathbone, director of Boston's Museum of Fine Arts, oversees treasures that include the finest collection of Old Kingdom Egyptian sculpture outside Cairo.



Edwin H. Land holds his invention, the Polaroid camera, capable of delivering a finished print, even in color, within seconds.



Nathan M. Pusey, president of Harvard, directs the university built around the Nation's oldest college, now in its 330th year.

Dreamers and doers

AN AMERICAN AMALGAM of English, Irish, Italian, and other national strains has produced generations of talented Bay Staters, who seem to heed Ralph Waldo Emerson's advice: "Hitch your wagon to a star." Three rose to the Presidency: John Adams, his son John Quincy Adams, and John F. Kennedy. Countless others have won world recognition, among them Red Cross founder Clara Barton, educator Horace Mann, poets Emily Dickinson and James Russell Lowell, historian George Bancroft, artists John Singleton Copley and Winslow Homer, architect Charles Bulfinch, and the two Oliver Wendell Holmeses, physician-essayist and jurist.



Mary I. Bunting, first woman to serve on the Atomic Energy Commission, heads Radcliffe College.



Charles Francis Adams, descendant of two U. S. Presidents, presides over the board of Raytheon Company. He holds an electronic guidance element for the Apollo mooncraft.



Governor John A. Volpe, son of Italian immigrants, confers with Edward W. Brooke, his attorney general. Brooke's service in that post made him the Nation's highest elected Negro official.



Howard W. Johnson became head of Massachusetts Institute of Technology in 1966.

Revere left instructions with a trusted friend to hang the signal lights in the steeple, and he described the lantern-bearer's long climb:

*Up the trembling ladder, steep and tall,
To the highest window in the wall. . . .*

"I talk to more than 50,000 fifth-graders from all over New England every year," Mr. Kellett said. "I think it is a good thing to tell the story here where it happened."

Old Boston lives on in many historical places: the Bulfinch State House with its golden dome; the frigate U.S.S. *Constitution*, "Old Ironsides," at the Boston Naval Shipyard, Charlestown; Benjamin Franklin's birth-

place; Cotton Mather's grave in Copp's Hill Burying Ground (map, next page).

One legacy of colonial days is Boston's narrow streets, never designed for the automobile.

"The Massachusetts is not a bloodthirsty people," an early governor once remarked. If he could be plunged into Boston's heavy traffic today, he might change his mind.

Family Dynasties Gave Leadership

For generations Boston has looked to men of family to lead her—the Adamases, the Lawrences, the Lowells, the Cabots, the Saltonstalls, the Higginsons, to name a few. Though

(Continued on page 805)





Massachusetts

MOTHER of New England, the old Bay State set the spark to the American Revolution with the fire and finesse of her patriot captains, and great men in varied fields have been her legacy to the world for generations. Leadership in the industrial revolution of the 19th century mushroomed neat white villages into sprawling mill towns and cities. But a migration of manufacturing to the South and West began some three decades ago, threatening stagnation. Now historic Boston, hub of half the state's population, spearheads rejuvenation, leveling slums, nurturing new housing and commercial and industrial growth. Electronics plants thrive around Boston, fed by the area's concentrated brain power and skilled labor.



Lures of a different kind, however, draw visitors by the thousands. Salty old sailor ports beguile travelers along the rocky coasts, and breeze-swept dunes beckon beach lovers to the upraised arm of Cape Cod. Beyond the fertile trench of the Connecticut Valley, which bisects the state, the land rises westward to the forested tranquility of the Berkshires. Throughout Massachusetts, preparatory schools and colleges with hallowed names shape eager young minds for tomorrow's tasks.

AREA: 8,257 square miles, ranks 45th. **POPULATION:** 5,338,000, ranks 10th. **ECONOMY:** Heavily industrial (shoes, textiles, paper, chemicals, electronics, machinery). Commercial fishing. **MAJOR CITIES:** Boston (1965 metropolitan population 3,590,040; city proper 698,080), capital, port, Worcester, textiles, metals; Springfield, machinery. **ADMISSION:** 6th of 13-Original States.



LITERARY CONCORD

Henry David Thoreau lived here from 1845 to 1847 in a solitary communion with nature that produced two of his most significant works, *A Week* on the Concord and Merrimack Rivers, and *Walden*.

Walden Pond

Concord Center

Walden Pond



PHOTOGRAPHY BY E. ANTHONY STEWART, IN THOMPSON



Memorial to a glorious defeat, Bunker Hill Monument soars 221 feet above visitors and vendors on a Charlestown height, where in 1775 rebels decimated British regulars before running out of powder. "Aim low; pick off the officers; don't fire till you see the whites of their eyes," were their orders. The Marquis de Lafayette laid the monument's cornerstone during a visit to the United States 50 years after the battle.

Colonial gravestone in Boston Common's Central Burying Ground gives up its worn letters to a collector's charcoal rubbing.

THIS PAGE FOLDS OUT

The well-kept past



804





LEAF LEFT, LOWER BY JAMES H. WISLARD © W. H. A.

Sons of Harvard relax with a football after classes. Dunster House, a student residence, reposes in Georgian dignity beside the Charles in Cambridge.

"Ready to ride and spread the alarm . . ." in poet Henry Wadsworth Longfellow's phrase, patriot Paul Revere sits on his bronze horse behind the Old North Church. Two lanterns in its tower signaled the coming of troops. Engraver, sometime dentist, and silversmith, Revere fashioned such exquisite works as the teapot at left.

marked for leadership by blood, these families maintained their position by community service and example. And they kept a sharp watch on Boston's manners and morals.

There are those who think they detect a certain parochialism in the outlook of Bostonians, and this has been a joke—everywhere but in Boston—for a hundred years. "Why should I travel when I'm already here?" remains a classic remark by a Beacon Hill matron.

When I was in Massachusetts in 1949, the centennial year of the California gold rush, Bostonians claimed the anniversary. "After all, we were the ones who rushed," they said.

In fact, neither Bostonians nor Bay Staters in general can validly be accused of provincialism. For Massachusetts men have always roved the world; her sailors and whalers knew Trinidad and Hawaii as they did the streets of New Bedford.

It is more typical than surprising that an infirmary for ailing donkeys and camels in Morocco has been run for nearly 40 years, at a current cost of \$50,000 a year, by a Boston committee.

Some of the treasures Massachusetts travelers brought back grace Boston's Museum of Fine Arts, once called "The Old Lady of Huntington Avenue," but today bustling with new life. Its Egyptian and Asiatic collections are the finest in the country, and its collection of Greek vases has few rivals in the world.

"The whole destiny of this museum is to educate," said Director Perry T. Rathbone, "to offer delight to every age" (page 798).

Where the Brahmins Now Speak to the Irish

Over the years the "Proper Bostonians" have unflinchingly supported the good things of mind and spirit. They also kept a tight rein on city and state governments—until the day John F. Fitzgerald, grandfather of John Fitzgerald Kennedy, was elected mayor, the first native-born Irish Catholic to achieve the post.

"When the Irish broke into politics, 'cold-roast' Boston retired to fight a rear-guard action," said Charles A. Coolidge, himself a first-family man and a leading Boston attorney. Proper Bostonians may have "lost" Boston, but over the years the proper names still cropped up as Massachusetts governors and senators—such names as Leverett Saltonstall, Henry Cabot Lodge, and Endicott Peabody.

Years ago Mayor Fitzgerald declared, "What this city needs is a lunch club where the blue bloods will eat with the rest of us."

Boston has those meetings now—not at a luncheon club, but instead at Boston College, at civic conferences called the Citizen Seminars. Erwin D. Canham, editor of the *Christian Science Monitor* and one of the most influential men in Massachusetts (page 798), remarked upon how the seminars had helped change the climate in Boston: "With the seminars, the college began to fulfill its responsibility to the community, and the sessions have become a place for the professional, business, and academic worlds to meet with the politicians."

As industry expanded in 20th-century America, Boston—the entire state, in fact—found competition from manufacturers elsewhere too fierce. Textile mills closed, the shoe industry declined, and metal works moved nearer the sources of ore. But after World War II, the revolution in technology suggested that the Boston area, with its universities and skilled labor, would be an excellent place for light industry, especially electronics.

One man in particular sensed what such a development could

(Continued on page 810)

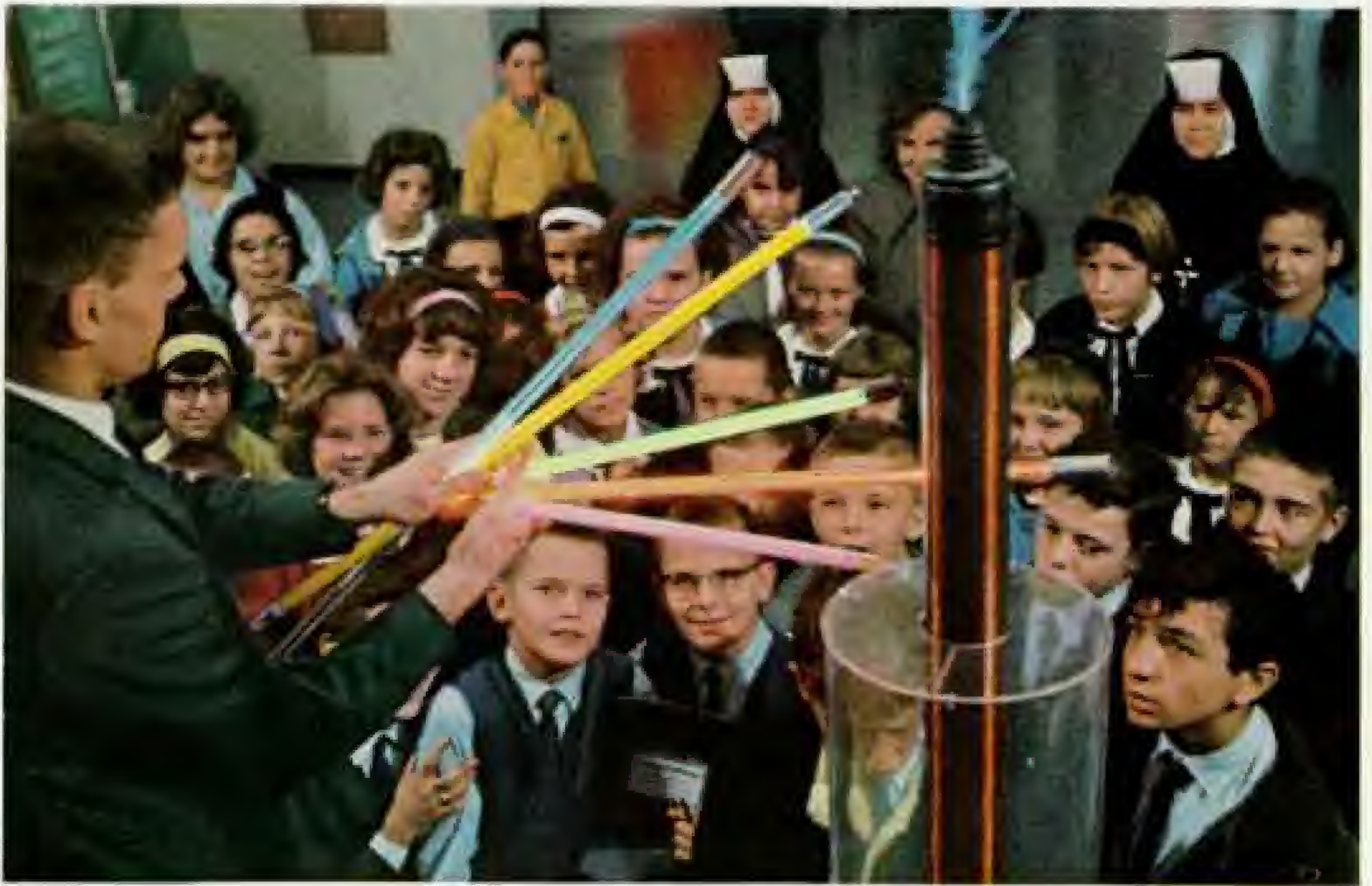


Like resting gulls, sailboats flock together for Race Week in Marblehead's snug harbor; more than 500 compete in the annual August regatta. Red-brick spire of the town hall



RETROPHOTO BY LAWRENCE LOWRY © N.A.S.P.

overlooks colonial homes built by early ship captains. Leathery Marbleheaders ferried Washington's army on its historic crossing of the Delaware on Christmas night of 1776.



Showcase for science, the Bay State throbs to the hum of electronic devices that replace the water wheels and textile looms of yesteryear.

Magician with five wands enralls students at the Museum of Science in Boston (above). Fluorescent rods glow without hookup; power radiates from a Tesla coil crackling with 70,000 volts.

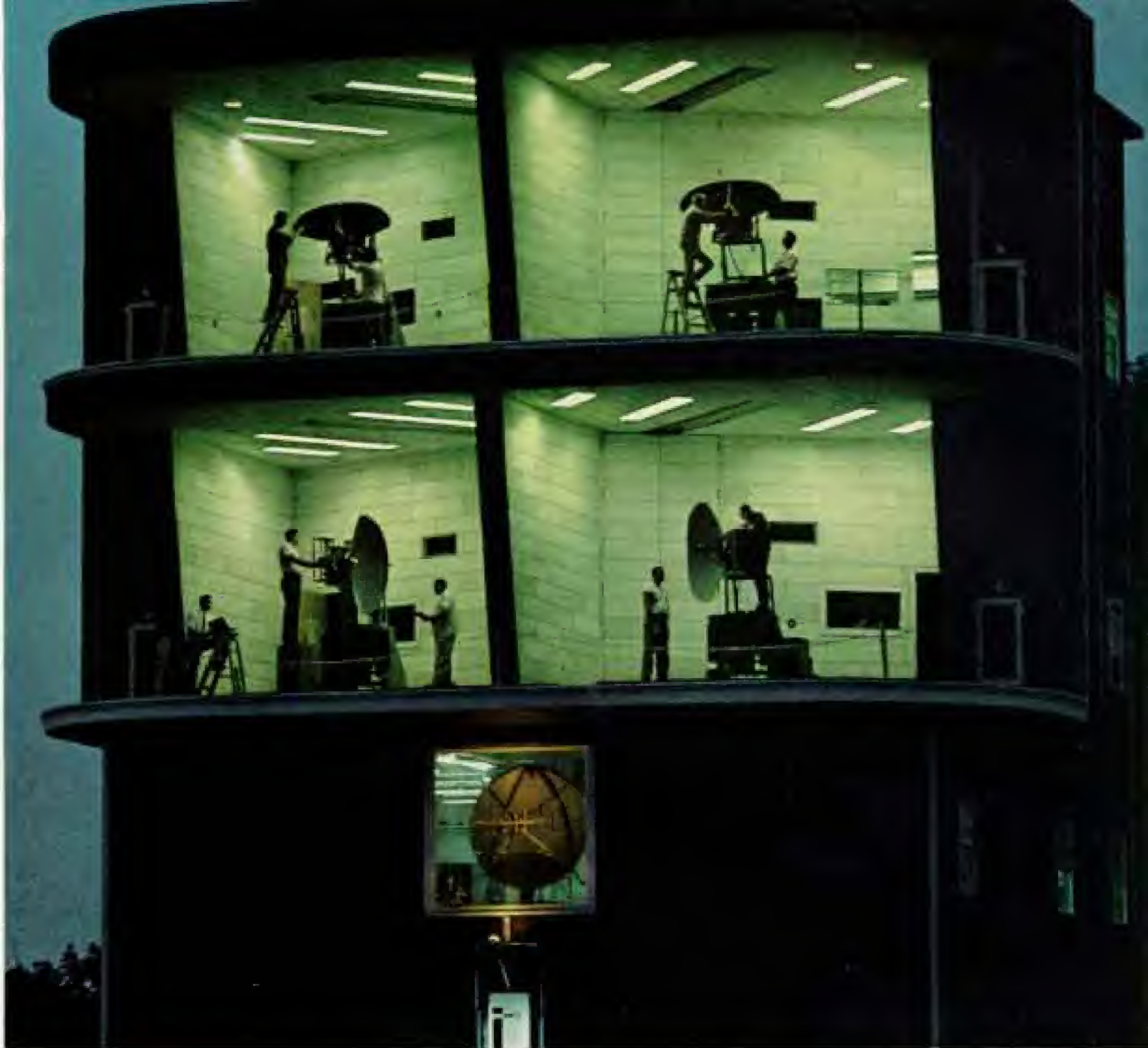
All-seeing eye of a technician scans computer circuitry at Honeywell, Inc., in Brighton.

Simulating the Martian atmosphere in a dome (below center), Avco Corporation scientists in Wilmington test a radio antenna for sending messages from a craft orbiting the red planet.

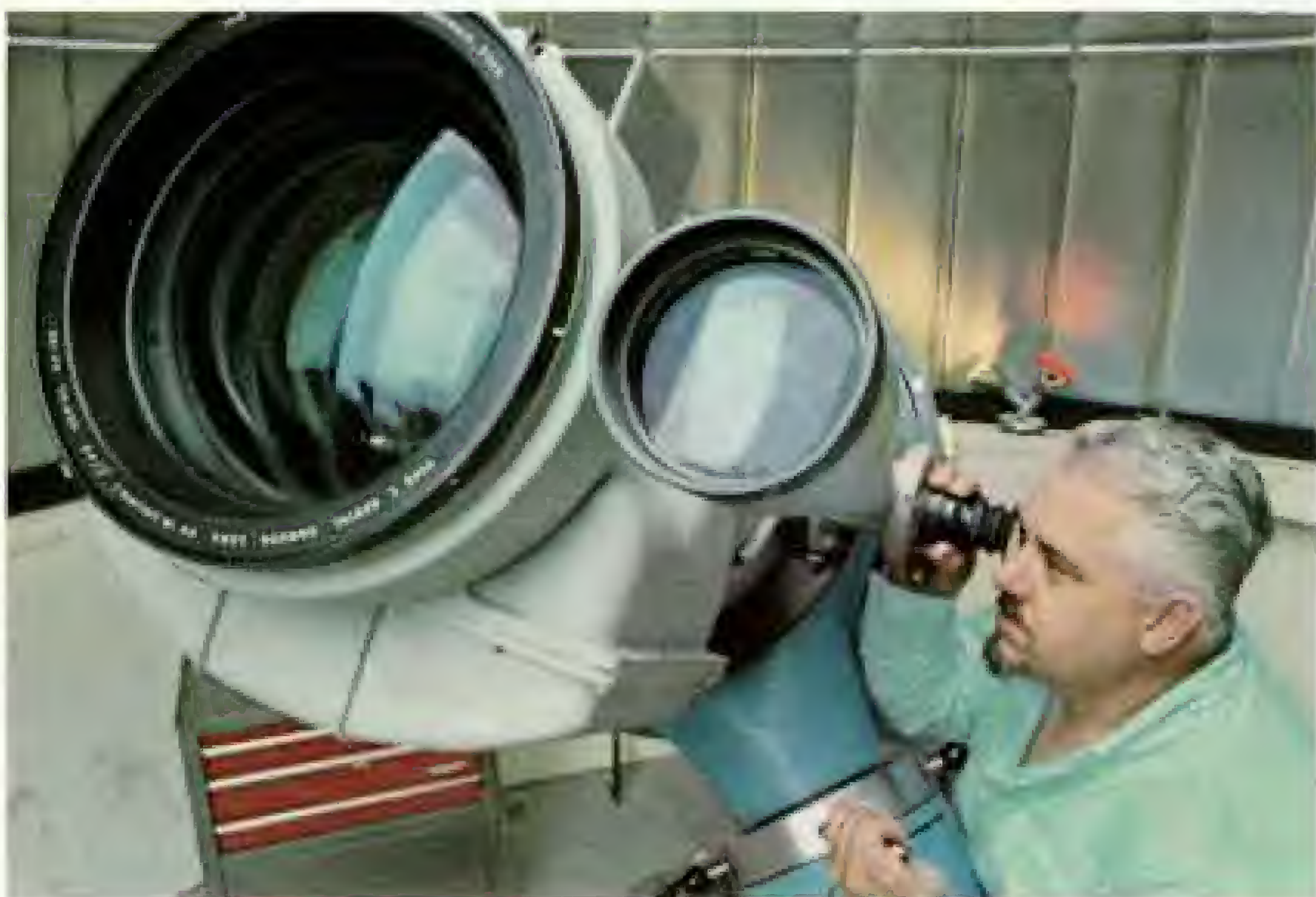
From the open bays of a 65-foot tower (right), engineers "sight in" aircraft radars on nearby targets at Raytheon's Waltham plant. The tower stands near "Research Row," a concentration of hundreds of modern industries along Route 128 in its crescent sweep around Boston.

Satellite-tracking K-50 camera (lower right) finds and photographs man-made and natural space objects for the Smithsonian Institution's Astrophysical Observatory in Cambridge. By taking more than 40,000 fixes on satellites, Smithsonian technicians have measured the distances between the continents to within 50 feet.





ENTRANCES (UPPER AND OPPOSITE SIDES) AND OBSERVATIONS BY W. ANTHONY STEWART © N. S. S.



mean to Boston. John F. Collins, a ruddy-faced, handsome man of 46 (page 795), was in his second term as mayor when we talked.

"I wanted to be mayor because this city had the chance to remake itself and continue as a great city," he told me. "People had fled Boston to raise crab grass and children away from the smog. Industry fled too, leaving Boston populated by the economically disadvantaged.

"The business community had set up a committee to preside over the dissolution of the city. They were contemplating something like the bankruptcy of a private firm—just wring it out and let it go."

Boston Blueprints Its Future

Under Mayor Collins, the entire community began to remake physical Boston. In the process, a new spirit developed.

"The mayor acted as a sparkplug," Charles Coolidge told me. "He got our imaginations

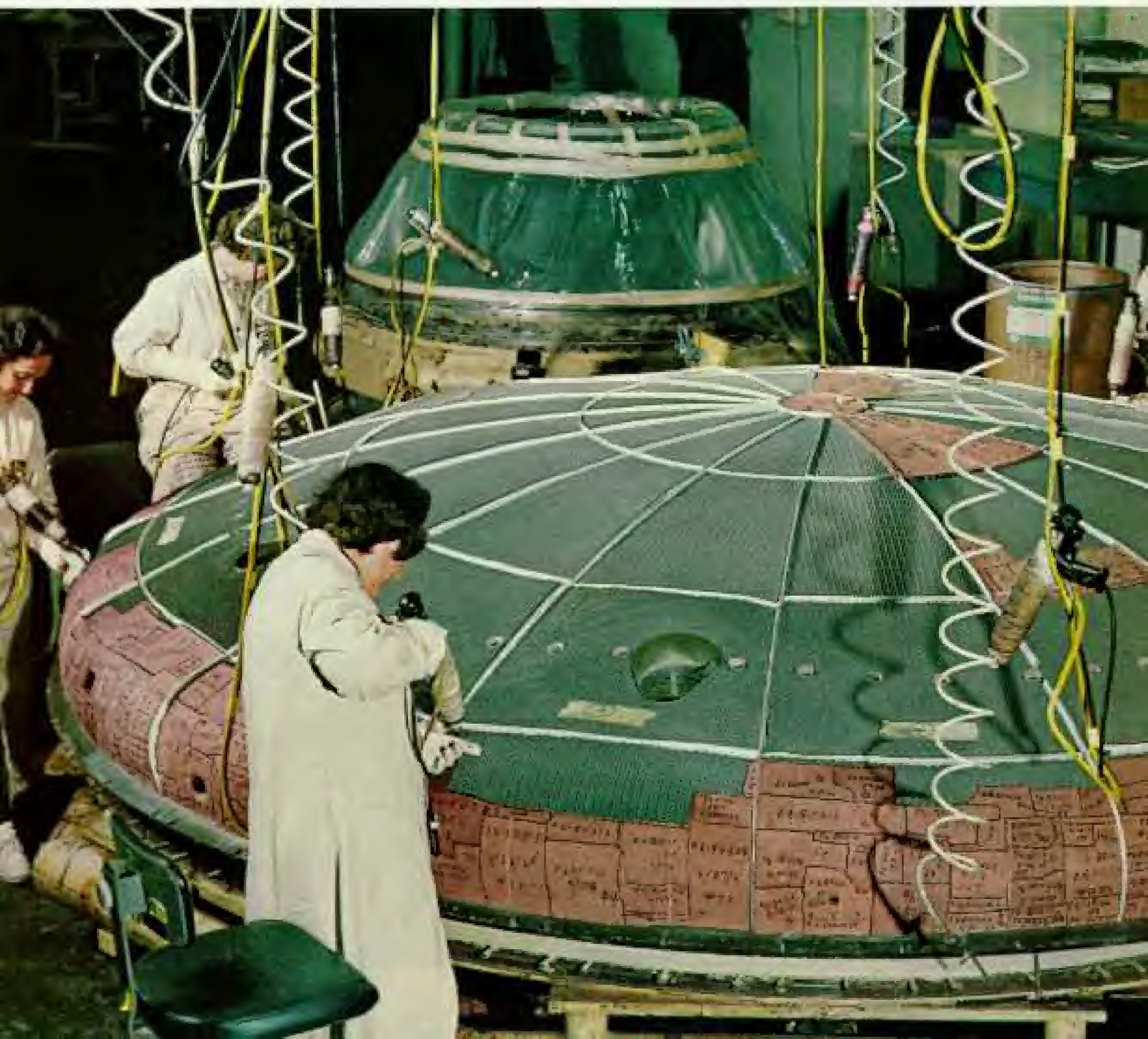
started. There is a new feeling that things can be done in the community."

If the mayor's name is the first you hear in Boston, almost inevitably the second is Edward J. Logue, administrator of the Boston Redevelopment Authority.

"I did a lot of walking," Mr. Logue told me, "and I saw very soon that a comprehensive plan for the whole city was needed."

Such a plan was made and approved by city and Federal officials. "That part was easy," Mr. Logue said. "The rest has been painfully hard."

Some people were skeptical. They did not like the look of what had been done several years before. The entire west end of the city—some 2,500 slum dwellings—had been ripped out and the land left vacant until high-rise, high-cost apartments slowly rose. Every time Ed Logue spoke of redevelopment, opponents brought up the west end.





ENTERTAINMENT WEEKLY AND SUBSCRIBERS © 1973

Dream comes true for youngsters allowed to make their own sundaes at the Putnam Pantry candy and ice cream shop in Danvers. Hot fudge, marshmallow, cherries, and nuts provide the makings for a mighty treat.



Space Age sewing circle in the Avco Corporation's Lowell plant insulates the heat shield of an Apollo spacecraft that will carry astronauts to the moon. Here women, considered not as mistake-prone as men, squirt epoxy resin into honeycomb cells. Markings identify each person's work. Plastic-wrapped forward section awaits coating. Oven-hardened, the shield will dissipate the fiery blast when the craft re-enters earth's atmosphere at 25,000 miles an hour.

Now, however, major portions of the plan are under way. Scollay Square, an area famed for its gin mills and burlesque theaters, is gone. Replacing them on the site is the new Government Center—a Federal office building, a state service center, eight commercial buildings, a parking garage, and a \$25,000,000 City Hall (pages 790-92).

The Federal building seemed to me commonplace—a tall structure with a shell of prefabricated concrete blocks. But the new City Hall, still under construction, is anything but commonplace. A massive building of unconventional shape designed to dominate an enormous plaza, it has been called a "Greco-Roman gas station" and "a paradise for pigeons." Its proponents praise it as an extraordinary example of modern architecture.

A downtown group sponsored by the

Guiding rein on the education of young men marks the career of Headmaster Frank L. Boyden of Deerfield Academy, here pausing in his daily rounds to watch the football squad limber up. Arriving 65 years ago as principal and sole teacher, Mr. Boyden, now 87, stands today as a leader in secondary education, and Deerfield ranks with such renowned Massachusetts preparatory schools as Groton, Milton, Worcester, Middlesex, St. Mark's, and Phillips Academy at Andover.

Greater Boston Chamber of Commerce has helped to plan a new waterfront development, eventually to cost about \$100,000,000. Another plan focuses on the central business district. In some areas, old homes are being rehabilitated and new low-cost housing units are under construction. Ed Logue's plans will affect more than a third of all land in Boston.

The most striking feature of the new Boston skyline is the 52-story regional office of the Prudential Insurance Company. "Pru Tower," tallest building in Massachusetts, opened in the spring of 1965 (pages 794-5).

The view from its observation deck on the fiftieth floor is stunning. A vast panorama of geography sprawled before me—the blue sweep of Massachusetts Bay, the hump of 2,006-foot Wachusett Mountain rising beyond the farmlands to the west, the South Shore curving toward distant Duxbury.

The 31½-acre Prudential Center includes a 1,000-room hotel, two high-rise apartment buildings, several commercial buildings, and a city-owned War Memorial Auditorium. Among other modern touches, the auditorium has the largest freight elevator in New England. I was astounded to see the doors slowly open and a truck-and-trailer rig drive out.

Prudential Center was built on the Back Bay switchyard of the Boston & Albany Railroad. Today the railroad and the Massachusetts Turnpike run under the center.

Around the city sweep the divided lanes of Boston's "circumferential highway," Route 128, its 65 miles flanked by 25 industrial parks, six shopping centers, and 12 hotels. The road rolls through lightly wooded rocky country, and its first appeal was space—cheap land for warehouses. Today new plants and laboratories along it typify the astounding electronics boom in Massachusetts.

The influx of science-oriented companies began in the early 1950's. "In those years people got the idea that this was a good area for technical activity, with the proximity of M.I.T., Harvard, and a number of other important universities," said Charles Francis



Adams, chairman of the board of Raytheon Company and a member of the long-enduring Adams family (page 799). As a recent example, he mentioned the new NASA Electronics Research Center being built in Cambridge. It will have 2,100 scientists, engineers, technicians, and administrative personnel.

In 1955 the Smithsonian Institution, based in Washington, D. C., moved its Astrophysical Observatory to Cambridge. Its staff now exceeds 500. The observatory has measured the fall of dust onto the earth from space, developed an ultraviolet telescope for an orbiting observatory, devised laboratory techniques to simulate planetary environments, and determined the histories of meteorites.

The brains of Cambridge attract scholars and scientists from all over the world. They form a unique community. I talked with Julius A. Stratton, then president of the Mas-



PHOTOGRAPH BY G. ANTHONY STEWART © NATIONAL GEOGRAPHIC SOCIETY

sachusetts Institute of Technology, now chairman of the board of the Ford Foundation.

"The mood here is venturesome," he said. "The people shaping M.I.T. today are optimistic, imaginative, and captivated by new things to do."

Harvard, M.I.T. Pioneered Automation

Some astonishing—and eminently practical—things have sprung from the agile minds of the men of Harvard and M.I.T.

In the 1920's Dr. Vannevar Bush of M.I.T. developed three analytical machines, culminating in the "Bush differential analyzer." It was the first computer capable of handling differential equations, and as a forerunner of all today's analytical machinery, a proper wonder of its time.

The first large-scale, high-capacity digital computers were designed by Howard Aiken

at Harvard, beginning with the famed Mark I during World War II. And M.I.T. mathematician Norbert Wiener worked out theories and mathematical models that formed the basis of today's automation.

Harvard, the country's oldest institution of higher learning, is the foundation stone of the Bay State's eminent position in American education. The Massachusetts General Court founded the college at "Newetowne" (now Cambridge) in 1636—just six years after the Massachusetts Bay Colony was established on a harsh shore. (Indians were accepted at Harvard, but only one, Caleb Cheeshahtemuck, graduated, in 1665.)

Named for Puritan minister John Harvard, who bequeathed it his library and half his estate, the college became the choice of Boston's blue bloods. Today it has become university to the world (page 804).

Harvard has the largest library of any university in the world; it is also the repository of rare collections. The Ware glass flowers in the University Museum are a favorite tourist attraction. The flowers were blown in delicate colored glass by Leopold Blaschka and his son Rudolph, the only men to perfect the art. Mrs. Elizabeth C. Ware and her daughter contracted for the entire Blaschka output over almost 50 years. Then, as proper Bostonians, they gave the collection to Harvard.

The libraries, museums, and art galleries of this great university—as well as the quiet charm of the Yard—are visible assets. The

highly charged intellectual atmosphere is less tangible. But, year after year, Harvard's philosophers, chemists, physicists—experimenters in almost every field—have given their long thoughts to the world.

Boston Dentist Pioneered Use of Ether

An important segment of Massachusetts' educational system is its medical complex. Harvard Medical School alone is affiliated with seven teaching hospitals. About 650 faculty and 1,100 teaching staff members serve a student body of around 500.

Boston early won fame for its medical dis-



"Bonjour . . . Guten Tag . . . Hello!" Medley of tongues hums in earphones at a language laboratory of Smith College, Northampton. Recordings range from Arabic to Chinese. Out-of-state students predominate at such Massachusetts women's colleges as Smith, Wellesley, Mount Holyoke, Radcliffe, and Wheaton.

Joy of speech comes to the deaf at Clarke School in Northampton. Guided by her reflection, five-year-old Laura Goodman learns to say "ah." Her hand touches the face of teacher Marjorie E. Magner, detecting voice vibrations she will try to imitate. Earphones amplify sounds for her and Michael Henry. Gardiner Greene Hubbard, first President of the National Geographic Society, helped found the pioneering school a century ago. Alexander Graham Bell, the Society's second President, served Clarke for 51 years as teacher, consultant, and board president.



coveries. On October 16, 1846, William T. G. Morton first demonstrated in public the use of ether as an anesthetic. The old Ether Dome in the Massachusetts General Hospital no longer serves as an operating room, but Ether Day, observed annually, celebrates one of the greatest medical advances of the 19th century.

Benjamin Waterhouse, a member of the Harvard Medical School's original three-man faculty, gave the first vaccination for smallpox in the United States with a cowpox vaccine. He vaccinated his four children in 1800, and later sent vaccine to President Thomas Jefferson, who vaccinated his family.

Modern Boston researchers have pioneered in techniques for heart surgery, locating brain tumors, the use of an electric shock to restart a human heart, kidney transfers, and many other techniques for prolonging human life.

Massachusetts has educational resources unexcelled by any other state. The Boston area alone counts 47 degree-granting institutions; Massachusetts annually draws more than 50,000 students from out of state.

My pursuit of the state's institutions of higher learning led me through the green-and-red-and-gold Connecticut River Valley to Amherst. There I watched students entering

EXTRAORDINARY © A. S. S.





and leaving the new Robert Frost Library at Amherst College. It honors the famous poet who was an Amherst faculty member when he died in 1963.

Amherst shares in the ancestry of the National Geographic Society. Here Dr. Edwin A. Grosvenor taught as a beloved professor of history, and here his son Gilbert H. Grosvenor, "the architect and master builder of the Society," was educated.*

816 Amherst limits itself to 1,200 students, and

a remarkable group they are. Ninety percent of them go on to graduate study—one of the highest percentages in the country.

Not far away, land has been acquired for a new college, Hampshire, scheduled to open in late 1969. Across town, the University of Massachusetts is in the midst of a tremendous expansion. From its campus rise five

*A tribute to the late Dr. Gilbert H. Grosvenor, by Frederick G. Voshburgh and the Society's staff, appeared in the October, 1966, NATIONAL GEOGRAPHIC.



CONTRIBUTOR: © NATIONAL GEOGRAPHIC SOCIETY

new 22-story dormitories. For years the university was content to be a leisurely land-grant college. Now, with 12,800 students, it has assumed a role of leadership. "We are committed to the concept of high-quality education," Robert J. McCartney, secretary of the university, declared.

The University of Massachusetts, Amherst, Smith College at Northampton, and Mount Holyoke College at South Hadley cooperate under the "four-college" plan, whereby their

Emblem of New England, a church lifts a stern spire above the tree-sheltered town of Sunderland, in the verdant Connecticut River Valley. The traditions of self-government took strong root in such Yankee villages. Today, Bay State citizens still gather at town meetings to decide local issues and continue the vigorous political life that has bred many statesmen.

Land of fairy tales—of knights jousting for her favor—comes alive for a young lady at the John Woodman Higgins Armory in Worcester. She kneels beside life-size models of a hunting dog armored against wild bear and a prince wearing a steel suit of the 16th century. The Worcester Pressed Steel Company maintains the collection in tribute to the metalworker's craft.

students can take courses at any of the colleges.

I came away from Amherst with Massachusetts' reverence for cultural achievement very much in my thoughts. In Concord I was reminded of it again.

In soft sunshine I walked to "the rude bridge that arched the flood" (pages 820-21). Across the Concord River stands the famous Minuteman statue, the first major work of a young Concord sculptor, Daniel Chester French. He later created the colossal Lincoln in the Lincoln Memorial at Washington, D. C.

Thoreau Shrine Draws Foreign Visitors

"The shot heard round the world" was not the only explosion in Concord's history. A literary and intellectual explosion rocked the town in the early part of the 19th century. It was as if everyone in Concord began thinking and writing at the same time.

Ralph Waldo Emerson, Nathaniel Hawthorne, Bronson Alcott and his daughter Louisa May, William Ellery Channing, and Henry David Thoreau poured out the words a large part of the Nation listened to.

In a way it was the gentle Thoreau, the nonconforming naturalist, who left the most lasting mark. He departed Concord society for the nearby solitude of Walden Pond, where he spent the two years described in his famed *Walden, or Life in the Woods*.*

His forest was soft and cool as I walked the path to the pond (page 823). Two dogs, a Labrador and a beagle, raced up and down the shore barking loudly, clearly leading lives of noisy desperation.

Near the site of Thoreau's cabin, marked by a cairn and outlined by chains, a state park policeman told me, "We get many visitors from India. Thoreau is a minor saint there. Mahatma Gandhi got some of his ideas about civil disobedience from Thoreau."

At nearby Lexington I revisited my favorite spot in Massachusetts, the village green. I could almost hear the stirring words that tradition—if not history—attributes to Lexington Capt. John Parker on that April day in 1775: "Stand your ground. Don't fire unless



fired upon. But if they mean to have a war, let it begin here."

As so many times before, I read the history-evoking inscription on the monument erected in 1799 to honor the men "...Who fell on this field, the first Victims to the Sword of British Tyranny & Oppression. On the morning of the ever memorable Nineteenth of April, An. Dom. 1775. The Die was cast!!!"

And so it was. I drove to Breed's Hill in Charlestown, where the Bunker Hill Monument, a 221-foot obelisk, bayonets a blue sky (page 803). It commemorates the battle of

*In the NATIONAL GEOGRAPHIC, see "Literary Landmarks of Massachusetts," by William H. Nicholas, March, 1950; and "New England, a Modern Pilgrim's Pride," by Beverley M. Bowie, June, 1955.



WALLACE HUNTER © NATIONAL GEOGRAPHIC SOCIETY

June 17, 1775, in which patriots killed more than 1,000 British soldiers before powder ran out and they were overwhelmed.

Dogging history's footsteps, I sliced through Boston and headed for Quincy, birthplace of Presidents John and John Quincy Adams.

The farmhouse where our second President was born in 1735 is a simple clapboard. Next door stands the cottage to which he took his bride Abigail, and where their first son, John Quincy, was born in 1767. During the Revolution Abigail managed the farm alone while John served the cause of independence. Home briefly in 1779, her husband worked in his tiny law office with cousin Samuel Adams and James Bowdoin to draft a constitution for Massachusetts, adopted in 1780.

Returning from diplomatic duties in England in 1788, John and Abigail moved to a bigger house, two and a half miles away. Here the Adams family lived for four generations, until Brooks Adams died in 1927. Today the house is a national historic site.

A West Indian planter built the frame dwelling about 1730 and laid out the formal garden, importing boxwood from England; Abigail enlarged the house around 1800. Today it holds many portraits, Oriental rugs, family china, silver, and furniture collected over the years. In 1870 Charles Francis Adams, son of John Quincy, built the fire-proof library to hold his father's books, 14,000 volumes in 11 tongues.

The Adams family has produced at least



one outstanding member in every generation since 1735—two signers of the Declaration of Independence, two Presidents of the United States, diplomats, businessmen, and historians. It has been called the most distinguished family in America.

Standish Name Lives On in Duxbury

The motorist driving Boston's South Shore sometimes whizzes along State 3, sometimes drifts toward the beaches on secondary roads. One such led me to Duxbury. There, on a wooded hill, towers the Myles Standish Monument, topped by a 14-foot statue of the Pilgrim captain. He settled in Duxbury about 1631 and is buried in the town.

Later, at Sudbury, I met Myles Standish, Jr., nine generations removed from his famous forebear. "My son and grandson are also

named Myles," he said. "That extends the name to the twelfth generation."

I arrived late on a Friday afternoon in Plymouth, revered as the birthplace of New England. The town was jam-packed, but the effect was not oppressive. Everyone wore a smile, as if being in Plymouth was a cherished accomplishment.

I had just parked my car when I heard a drum. I followed the sound to Leyden Street, which leads up from the waterfront.

The drumming stopped, and townsfolk, dressed to represent survivors of the first Plymouth winter, marched slowly uphill to a burial ground behind the two main churches. Some carried Bibles, some carried muskets, and many carried psalters. This was "the Pilgrim Progress," a march made every Friday during August to honor the founders of



© EASTMAN STRONG SCHOOL AND JOHN BIRNBAUM, BOSTON, MASS. © N.E.A.

Freedom took a stand at Concord's Old North Bridge. An autumn rain spatters the place where determined colonial militia faced the British regulars who had come to confiscate their arms. Warned of the redcoats' approach, the Minutemen—immortalized in the statue by Daniel Chester French—marched to Concord from surrounding hamlets. The stirring tune of "The White Cockade" shrilled across the fields as the colonials advanced on the bridge. The British fired, American flintlocks answered, and the regulars broke. Their numbers swelling, the revolutionaries harried their adversaries all the way back to Boston. Each April 19 groups such as the Sudbury Ancient Fife and Drum Company retrace the footsteps of their forebears, sometimes through a late spring snow,

Plymouth. The crowd watched the little procession in silence, and then followed it to Burial Hill. There the "Pilgrims" lined out original Pilgrim songs.

The white bulk of the Church of the Pilgrimage stands near the First Church in Plymouth. About 160 years ago a conservative group broke away from this original congregation and built the Church of the Pilgrimage as a haven of orthodox Calvinist belief.

Pilgrim John Howland House, the only house that remains of those actually used by Pilgrims, was built in 1666. There, Priscilla Alden Draffone showed me a courting mirror and told me its legendary story.

"In the early days a girl smiled into her glass if she wished to show acceptance of a suitor," she said. "If she turned the mirror down, he was rejected. Do you suppose that's why we still say, 'she turned him down?'"

"Are you really a Priscilla Alden?" I asked.

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REDACTED BY E. ANTHONY FERNANDEZ © R.S.C.

Four sisters of long ago live forever in Louisa May Alcott's most famous book. Visitor Donna Wilson reads the classic in the parlor of Orchard House, the Alcott home in Concord. A bas-relief of the author rests on the piano.

"It is like molten glass . . . and the few notes in it are pure and beautiful like the imperfections in glass," wrote Henry David Thoreau of Walden Pond, seen here at sunset. Seeking life's meanings, Thoreau lived without luxuries in Walden's woods for two years and advised, "Our life is frittered away by detail. . . . Simplify, simplify."

"Oh, yes," she laughed. "I'm the twelfth generation. My family came over on the Mayflower and has always lived in Plymouth."

Two miles from the center of the present town, Plimoth Plantation takes shape, re-creating Plymouth as it was in its earliest days. Built on a site similar to the original, the Plantation includes a reconstruction of the original Fort-Meetinghouse, plank-sided houses along First Street, and an Indian village, all surrounded by a stockade. When completed, the restoration will contain 22 buildings.

Mayflower II, permanently moored at Plymouth, made me wonder how the Pilgrims could ever have conquered the Atlantic in such a vessel. Somehow I marveled even more at the feat of Alan Villiers, who sailed this tiny vessel safely from England in 1957.*

Sand and Salt Air Bring Summer Money

From peaceful Plymouth I drove to Cape Cod, a wild and beautiful bit of land flexed into the Atlantic like a skinny arm. And of course here also is spectacular water—this ocean that so mildly pats the land in serene moods and lashes the shore when the winter winds blow.† From U.S. 6, extending the length of the Cape, motorists peel off for the shore towns: Hyannis Port, Dennis, Chatham, Orleans, Wellfleet, Provincetown.

Summer Provincetown sees a constant flow of bearded youths, mothers in crisp cottons herding children, girls in bathing suits and straw hats, girls in stretch pants. The town basks in its fame as an art center, and its Chrysler Art Museum fills a white clapboard church building with glass, paintings, and antique furniture.

Old-timers will tell you tourists are spoiling the Cape, but Norman H. Cook of the Cape

Cod Chamber of Commerce does not agree.

"There are more than a million visitors during the summer," he told me. "They bring 120 million dollars to the Cape, and last year stimulated 50 million in construction. Our next largest income is 11 million in Social Security payments. So you can see this 'imported money' is vital to us."

At Harwich Port, on the Cape's south shore, I spent the night at Wychmere Harbor Club. Next day a rising wind blew potato chips and parsley from the luncheon plates. Then it rained hard. Long rows of lawn chairs dripped under a dark sky. The silver-gray Cape Cod cottages took on a darker hue.

Damply, I drove to Eastham to see the oldest windmill (1793) on the Cape. "It will grind 800 pounds of corn in three hours," the caretaker told me. "We don't run it in the summer for fear we might maim a visitor."

Windmills were a familiar sight on the Cape when salting thrived. In the early 1800's wind-driven pumps lifted sea water to be evaporated; 350 gallons of water produced 80 pounds of salt.

Cape Cod men were bred to the sea. I was in Wellfleet when the clock in the steeple of the First Congregational Church struck two—and the hands pointed to five o'clock.

"What's wrong with the clock?" I asked Cliff Hatch in his nearby fish market.

"It rings ship's time," he said. "It's the only town clock in the world that does." Wellfleet's seafaring men, who built the church, wanted no part of landlubbers' time.

*See "How We Sailed the New *Mayflower* to America," by Capt. Alan Villiers, NATIONAL GEOGRAPHIC, November, 1957.

† Nathaniel T. Kenney reported on "Cape Cod, Where Sea Holds Sway Over Man and Land," in the August, 1961, NATIONAL GEOGRAPHIC.





Of Cape Cod, Thoreau said, "It is a wild, rank place, and there is no flattery in it." Although time and tourists have tempered the Cape, his words still describe Cape Cod National Seashore, an expanse of wind and surf, of beaches, dunes, bog, and brush.

The national seashore ultimately will hold 27,000 acres of the Cape from its tip to the long hook of Nauset Beach seaward of Chatham. It also cuts across the Cape to include Great Island and Jeremy Point.

Vernon C. Gilbert, Jr., a National Park Service naturalist, showed me around. He wheeled his jeep off the road, across the hard sand of Nauset Beach, and into the marsh, a flat expanse of grass and sand interlaced by channels of salt water. He stopped on a long

sand flat, littered with clam and mussel shells. Shore birds sprayed into the air at our approach—greater yellowlegs and least sandpipers—and, farther off, herring gulls and black-backed gulls. Terns nested in sand cradles amid clumps of wind-tossed grass.

Sea Claiming Marconi Station

Back on the hard road, we drove past the red-and-white cylinder of the Nauset Beach Light to the remains of the Marconi wireless station. It sent the first wireless message from the United States across the Atlantic in 1901.

"The beach has eroded 170 feet since the station was built," Mr. Gilbert said. "Most of the station has fallen into the sea."

As we walked inland, he pointed to the



LEONARD HUBER © NATIONAL GEOGRAPHIC SOCIETY

Foothold in the New World: Cottages of hewn planks and thatch, later replaced by clapboard and shingles, sheltered the intrepid men and women from England who founded the Pilgrim colony at Plymouth in 1620. Cold and disease that first winter cut the colonists to a handful. The survivors rejoiced at harvest time, 1621—the first Thanksgiving. The non-profit Plimoth Plantation built these replicas on Plymouth's shore near *Mayflower II*, the bulky little vessel coaxed by Capt. Alan Villiers across the Atlantic in 1957. Two miles away, a complete village being constructed by the Plantation includes the Fort-Meetinghouse and Governor William Bradford's house.



Like a picture of Priscilla Alden, Ann Kusmin Souza smiles a welcome for visitors to the Bradford house. In 1630, Governor Bradford wrote: "As one small candle may light a thousand, so the light here kindled hath shone . . . to our whole nation . . ."

changing flora. "This is an example of progressive vegetation. First there is the barren of the beach. Then the dune grasses. On the backs of the dunes, better protected from salt spray, you get bear oak, bayberry, black cherry, and beach-plum shrubs.

"I cut a bear oak the other day," he continued. "It was only two inches in diameter, but it was 70 years old."

Seaside goldenrod grew wildly. Grasshoppers were as white as the sand. As we went on, black oak and white oak began to appear along with broom crowberry. Trailing arbutus grew in ground-hugging clumps. Mr. Gilbert stooped to one. "This is also called the Mayflower," he said. "It is the state flower."

On a boardwalk, we entered a bog. Two

civil-service jays screamed at us, and I heard the chittering of a federalized gray squirrel.

"The bog is short of nitrogen," Mr. Gilbert told me. "Plants must either tolerate a low nitrogen level or be able to eat insects. We have three insectivorous plants here—sundew *Drosera*, bladderwort, and pitcher plant."

From nature's wonders, my journeying took me next to those of science, at the Woods Hole Oceanographic Institution at the southernmost part of the Cape. Invited aboard *Atlantis II*, the institution's largest research vessel, I found a floating laboratory for scientific work at sea. She has an extra propeller in her bow for steering, and five conning stations: two on the wings of the bridge, two aft, and one in the wheelhouse.

The institution's newest research tool, the two-man submarine *Alvin*, designed to probe the oceans' depths, was at sea for tests during my visit. It is the craft that made headlines by finding a hydrogen bomb lost off Spain's Mediterranean coast.

From Woods Hole I caught the ferry to Martha's Vineyard, its cliffs turning rosy in the sunset as I reached shore.* I had dinner—swordfish caught right off shore—then hur-

ried to Menemsha to see how the fishermen had done that day (pages 832-3).

It was dark when I arrived, just as Capt. Walter Manning, a swordfish harpooner, brought his boat *Bozo* to the wharf. Captain Manning is a Gay Head Indian—like Tashtego in *Moby Dick*—and a descendant of the famous Martha's Vineyard harpooners who

*See "Martha's Vineyard," by William P. E. Graves, NATIONAL GEOGRAPHIC, June, 1961.



ranged the seas of the world chasing whales.

"We ironed seven swordfish right off this morning, and I thought it was going to be a big day," he said, "but we got only one more."

Captain Manning's art is a passing thing. The new technique is "long-lining." American fishermen set lines up to 20 miles long, with baited hooks every 60 to 90 feet. The Japanese, with larger boats, lay up to 60 miles of line, with hooks 60 to 600 feet apart.

Sheltering hook of Cape Cod gave weary Pilgrims their first landfall. Anchored in this "good harbor" at what is now Provincetown, they drafted the Mayflower Compact. On shore they found Indian corn and "the greatest store of fowle that ever we saw." Today the town's thriving art colony and the Cape Cod National Seashore attract young vacationers (inset), one of whom brings his own accommodations.

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ENTRANCE BY LEONARD LOWRY, PHOTOGRAPHY RIGHTS BY R. ARTHUR STEWART © 1988





STOCKPHOTOS BY G. ANDREW STREET (TOP), JAMES R.





A 34-mile ferry ride took me to Nantucket Island. Whaling was its lifeblood until the discovery of petroleum doomed the sperm-oil lamp. Indeed, the sluicing, dashing flight of a boat pulled by a harpooned whale was known on all the seas as a "Nantucket sleigh ride."

The town of Nantucket still retains its charm of an earlier day. Law prohibits any unfitting architecture in the historic area. The Pacific National Bank, at the head of the business section of Main Street, and the captains' Pacific Club, at the foot, reflect its past wealth in whale oil and whalebone from faraway seas.

The Nantucket Whaling Museum exhibits the scrimshaw work turned out by sailors on the long voyages—elaborately carved pie crimpers, yarn winders, rings, and cane handles, all of whale ivory.

Happily, the art of scrimshaw still flourishes in Nantucket. I watched a Nantucket girl, Nancy Chase, carve ivory whales and gulls to adorn woven-cane handbags produced by local artist José Formoso Reyes.

A Filipino who came to Nantucket 18 years ago, he copies the sturdy covered baskets once produced by town coopers and crews of offshore lightships. He can make only one a day, but customers gladly wait more than a year for a scrimshaw-decorated handbag.

Gloucester's Fleet Fades Away

What the whale was to Nantucket, the codfish was to Gloucester, on the rock-bound North Shore. But the racks in Gloucester where acres of salted cod once dried in the sun have long since vanished. Instead of cured cod, the town now deals in frozen fish, most of it imported from Canada, Iceland, and Norway.

"We are in Gloucester because we always have been," Paul M. Jacobs, executive vice president of the Gorton Corporation of Gloucester, told me. "But we could just as well have our plants in North Dakota."

He explained that the Gloucester fleet dwindled because cod and haddock, once its mainstays, are now fished by boats based closer to the Grand Banks, mostly Canadian bottoms. More recently the demand for ocean perch, important to Gloucester for the past 30 years, has slackened, and whiting, found near the coast, forms the bulk of the catch.

New Bedford, king of whaling in its day, now leads Gloucester as a fishing port. In fact, the value of its catch—yellowtail flounder and scallops taken close to home—ranks it second only to San Pedro, California, in fishing importance in the country.

Sail, sand, and surf lure thousands of summer visitors to the Massachusetts shore. Red-topped spinnakers bellying, International One Design sloops race off Marblehead. On the Cape Cod National Seashore, late-afternoon shadows etch the tracks of beach buggies riding the dunes. Playwright Robert Anderson strums a guitar for his wife, actress Teresa Wright, while her daughter and poodle frolic at water's edge on Nantucket Island.

"In New Bedford, fathers, they say, give whales for dowers to their daughters," wrote Herman Melville of the booming whaling capital of the 1840's. Perhaps to honor a New Bedford girl, a lonely whaler fashioned the charming piece of scrimshaw at right on a seven-inch whale tooth.

Reliving those seafaring days, visitors at the Whaling Museum (below) prepare to board a half-size model of the square-rigged *Lagoda*. The original bark roamed the globe on years-long voyages, hunting the great sperm whale.



Portugal in America: At the annual Blessing of the Fleet in Provincetown, Bishop James J. Gerrard prays for good catches and the safety of the Portuguese-American fishing fleet. The municipal pier bears the name of hometown boy Donald B. MacMillan, now 92, who led some 30 expeditions to the Arctic, including one in 1925 for the National Geographic Society.

Window on the sea: Woods Hole Oceanographic Institution answers some of man's questions about the marine world. Here a researcher measures the vertebrae of *Thunnus thynnus*, the bluefin tuna sought by sportsmen in coastal waters. Other specialists assemble a submersible vehicle outside. Beyond them, the ferry *Nantucket* docks from Martha's Vineyard.



PHOTOGRAPHS BY JAMES B. HILLMAN (TOP); LARRY B. ANTHONY (BOTTOM)





Paul Jacobs took me on a water tour of Gloucester's harbor (pages 836-7). We skimmed past Italian and Portuguese fishing boats named for saints: *St. Bernadette*, *St. Anna Maria*, *Our Lady of Fatima*. Old hulks lay half submerged. Many piers sagged.

But Paul was enthusiastic. "Eight years ago we started to redevelop the harbor," he said, "and the first project will be completed next year. In ten we'll have the prettiest waterfront in the land. I'll bet on that."

Gloucester has its romance, too. Near the city Paul pointed out to me Normans Woe Rock, an islet offshore that was the scene of Longfellow's famous "Wreck of the *Hesperus*."

A few miles northeast of Gloucester, at the opposite end of Cape Ann, sits Rockport, one of the tidiest tucked-away towns in all New England. White houses stand primly under old elms, and churches send tall white steeples toward the sky. The town is famous for its art colony and its Anadama bread.

Bread Named for Lazy Anna

The bread, sent to customers in far-off states, memorializes Anna, the lazy wife of a Rockport fisherman. The story goes that he tired of the corn-meal mush and molasses she served him day after day. So he mixed it with flour and yeast and baked it, meanwhile



KODACHROME BY B. ARTHUR EDWART © R.C.C.

tongue-lashing Anna. His epithet gave the bread its name.

Thirteen miles southwest of Gloucester, Salem recalls its past with its Custom House, with maritime treasures in the Peabody Museum, and with the handsome three-story homes on Chestnut Street. The weather was gray and blustery, but there was something fitting about the drizzle as I stood on Derby Wharf, where so many Salem men began their voyages in foul weather as well as fair.

Salem's captains and sailors were the first to establish trade, after the Revolution, with Russia, Madagascar, Zanzibar, Arabia, India, Java, and Australia. They brought back many

Atlantic mist veils Menemsha's harbor on Martha's Vineyard, largest island off the Bay State coast, as boys walk a curving wharf past idle fishing boats. Dinghy rides beneath *Aloyria's* bowsprit pulpit—a platform for harpooning swordfish. English explorer Bartholomew Gosnold landed on the Vineyard in 1602, naming the island for its profusion of wild grapes and, one scholar suggests, his mother-in-law.

strange mementos. The first elephant ever seen in the United States arrived at Salem in 1796. That was a day!

Near Derby Wharf stands the Custom House, where Nathaniel Hawthorne served as Surveyor (collector) of the Port, Salem, for all its magnificent Federal architecture and the memory of its infamous witchcraft trials in 1692, is Hawthorne's domain.

Hawthorne's House of the Seven Gables is a happy place today, alive with the wonder of children and adults, though in Hawthorne's somber tale it was the scene of death and madness. The Gables stands amid other colonial homes around an old-fashioned garden beaming with hollyhocks, petunias, and roses. The guides proudly display a secret staircase—which Hawthorne did not mention in his book. It is a fine secret staircase.

Race Week Jams Marblehead Waters

Under sunny skies on another August day, I visited Marblehead during its annual Race Week. Hundreds of sailboats jammed the narrow harbor (pages 806-7). Small boats puttered about, taking sailors to their craft. More than a thousand boats were there that day.

From the deck of Edna and Ray Phillips's luxurious cruiser *Rayna*, I watched the parade of boats nodding toward the starting line. Soon hundreds spanned the horizon, their white sails standing like candles on some bizarre blue cake. Then one after another the "candles" exploded like party favors as spinners billowed out in gaudy colors and crazy designs.

"Isn't that a wonderful sight?" cried Mrs. Phillips. "No wonder they call Marblehead a capital of sailing."

Nearby Saugus is the site of America's first major ironworks, built in the 1640's. In its heyday Governor John Winthrop boasted that "the Furnace runnes 8 tun per weeke. . . ." Creaking water wheels of today's restoration pump giant bellows, and sparks fly from the furnace amid a great clatter. It is a good and authentic bit of history.

North at Lawrence slim smokestacks spear 833



ROCKEFELLER BY G. ANTHONY STEWART (CROOK) AND HARRY SEAWELL. BUCKY TOOK © R. S. I.





"One brief shining moment"—songs of *Camelot* charm a matinee audience under the Cape Cod Melody Tent at Hyannis. The Cape, host to ten summer theaters, traces its footlight traditions to 1915. A year later an unknown playwright, Eugene O'Neill, launched his career with the Provincetown Players, who performed in a converted fishhouse.

Vacation idyll: United States Senator from Massachusetts Edward M. Kennedy, his wife Joan, and children Teddy and Kara lounge on the lawn of their Cape Cod home on Squaw Island. At nearby Hyannis Port other members of the famous family spend summers in neighboring houses.

the sky along the Merrimack River over red-brick factory buildings that once housed textile mills. When the textile industry moved south, to take advantage of cheaper labor and lower taxes, the city stagnated. But in recent years Lawrence bestirred itself and persuaded other industries of its assets—available factory space and a trained labor force. Western Electric, for one, now employs 10,000, and the Lawrence area has such an air of well-being and optimism that it is hard to believe this was one of the most depressed parts of the Nation a few years ago.

"Lawrence's comeback has to be called spectacular," said Justin T. Horan, executive vice president of the Greater Lawrence Chamber of Commerce. "We are now on a threshold of development unlike anything this area has ever known."

Mr. Horan feels that the new roads slashed across Massachusetts are one big factor in increased industrial and business activity. Interstate 93 and Interstate 495 intersect a few miles south of Lawrence and put the city within easy reach of Boston.

"The other day I drove from Boston to Lawrence in about 40 minutes," Mr. Horan said. "And only an hour north of here is the gateway of the White Mountain resort area. The roads already are bringing people in, and motels are going up just about as fast as they can be built."

The story is almost identical in Lowell, another city hard hit when the textile industry moved away. Avco Corporation now has a big plant at Lowell, building among other things heat shields for the Apollo mooncraft (pages 810-11).

American Novel Born in Worcester

I drove over winding country roads south and west to Worcester, which has been an industrial center for 150 years.

Worcester abounds in "firsts"—here in 1789 was published the first American novel (*The Power of Sympathy*, by William Hill Brown), near here Dr. Robert H. Goddard of Clark University first successfully launched a liquid-fueled rocket, and here was born the steam calliope. Norton Company—now one of the country's largest manufacturers of abrasives—was first to produce an emery grinding wheel.

Downtown renewal goes apace; the Worcester Expressway will be completed by 1968; and—biggest news of all—the University of Massachusetts Medical School will open in Worcester in 1970.

Turning west again, I stepped back in time—to the early 1800's—at Old Sturbridge Village, a lively re-creation of a typical New England town. Visitors stream through its 36 buildings to see costumed artisans weave homespun, dip candles, and make pewter.

Going on west to Springfield, I visited G. & C. Merriam Company, publishers of Noah Webster's dictionary for more than a century. Crawford Lincoln, secretary of the venerable company, met me



Salty as a sou'wester, Gloucester remains one of the Nation's leading fishing ports, though its catch declines. For centuries Gloucestermen have braved the Atlantic to harvest coastal banks. Here a fisherman unloads whiting for the scales of the Empire Fish Company, while his mates stack boards used to pen fish in the hold of their boat. Their two-day trip brought in 65,000 pounds. Herring gull finds a scrap on the timbered wharf.

The North Shore Art Association sponsors a Saturday Flea Market at East Gloucester (above), offering an array of bric-a-brac. Tourists browse unnoticed by banjo player and an artist.



PHOTOGRAPHS BY R. ANTHONY STEWART © REGIONAL GEOGRAPHIC SOCIETY

in the Webster Room and showed me pages from the great lexicographer's first dictionary.

From the flowing hand, it is evident that Webster, after years of preparation, simply sat down and wrote a dictionary, without the aid of an amanuensis ("... A person whose employment is to write what another dictates": *An American Dictionary of the English Language*, 1828, by Noah Webster).

"It was an incredible piece of work," Mr. Lincoln said, "but Noah was a born definer. He did his first dictionary all alone, and our Third New International required 757 editor-years to prepare. Of course, the third is considerably larger."

From Springfield, the Turnpike carried me into the far western reaches of Massachusetts.

The Berkshire country is a subtle and restrained part of the state, dotted with unobtrusive lakes and ponds. Its gentle hills, covered with tight stands of hemlock, birch, maple, oak, and hickory trees, rise beyond green meadows patterned yellow and white by goldenrod and Queen Anne's lace. Joe-pye weed adds its pink blush. Gray stone walls line the roads and march up the hills.

Berkshire Mill Makes Money Paper

Little of the rolling land here is used for farming, and the Berkshires are not noted for industry. But General Electric has a big plant in Pittsfield, largest city in Berkshire County, and there are many paper mills. In Dalton, Crane & Co., Inc., makes the tough paper on



which United States currency is printed. It must be capable of being folded both ways at least 4,000 times.

"And after all that," laughed President Bruce Crane, "the average dollar bill has a life of only a year and a half."

Crane & Co. makes only all-rag paper. "Papermaking is the by-product of the textile industry," Mr. Crane said. "We get cotton from garment manufacturers throughout the country. These cotton cuttings are about half the price of raw cotton because they are waste products."

The chief product in the Berkshire area is neither paper nor textiles but culture. There are theaters in the round and theaters on the square, concerts of music, concerts of the dance—most notably at Jacob's Pillow, where Ted Shawn, a pioneer of American dance, presents a summer festival. There are jazz camps, art camps, and more than 50 boys' and girls' camps.

Boston Symphony Summers in Tanglewood

The Berkshire Festival, patriarch of American music festivals, at Tanglewood in Lenox, has become one of the greatest cultural attractions in the world. During July and August of each year, Tanglewood is the summer home of the Boston Symphony Orchestra (pages 840-41).

The Berkshires are dotted with huge mansions, once the summer pleasure domes of Boston and New York society. Most have now become schools or religious establishments. Tanglewood was such an estate, owned by William Aspinwall Tappan, Boston banker and merchant. It was given to conductor Serge Koussevitzky and the Boston Symphony in 1936.

Dr. Koussevitzky dreamed of establishing a place where young musicians could work with professionals. By 1940 his dream was a reality: the Berkshire Music Center was open, and he was its first director. Now each summer 350



Sunlight frosts the pumpkins, and the bounty tempts a nanny goat. The Fred Olsons sell pumpkins—some 20 tons each season—and other freshly picked produce at their roadside stand near Springfield.

Frog in a bog collides with floating cranberries. After fall harvest, the A. D. Makepeace Company near Wareham floods its bogs to remove debris and fallen fruit. The Bay State grows the Nation's largest crop of cranberries.



"Gee! . . . haw!" A farmer mule-talks his draft oxen first to the right, then to the left, in a contest of strength at the Eastern States Exposition in West Springfield. The 5,000-pound team tries to pull a concrete load three times its weight for six feet. Such old-time competitions, as well as auto racing and New England arts, livestock, and industrial exhibitions, draw half a million people to the September fair.

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PHOTOGRAPHS BY NATIONAL GEOGRAPHIC SOCIETY





Soft as a Berkshire breeze, music wafts from the harp of student Frances Cohen as she prepares for a concert at Tanglewood, summer home of the Boston Symphony Orchestra. On the 200-acre estate, the orchestra sponsors the Berkshire Music Center, a school for aspiring young musicians. The golden horns of a brass choir, tutored by trumpet player Roger Voisin, sound against the backdrop of blue hills and the waters of Stockbridge Bowl. Music lovers gather from afar during Tanglewood's eight-week festival.

Nathaniel Hawthorne lived on the estate in 1850 and 1851. In the introduction to his *Tanglewood Tales*, a retelling of Greek myths, he remembered the "rough, broken, rugged, headlong Berkshire."

gifted young musicians come to study and perform here.

Leonard Bernstein, conductor of the New York Philharmonic, is an alumnus, having studied under Dr. Koussevitzky himself. When Dr. Koussevitzky died in 1951, he was succeeded as director by Charles Munch; Erich Leinsdorf is the present director.

Everywhere the Sound of Music

Lake Mahkeenac, more often called Stockbridge Bowl, shines in the sun at the foot of a long, gentle hill, and comfortable old hemlocks, elms, and birches cast great shadows on the lawns. All is music. Bits of Mozart and snatches of Bach tumble from rehearsal halls and studios. Violins compete with the rustle



PHOTOGRAPH BY © N.S.J.

of the trees. A soprano voice cuts through the sunlight like a musical rocket. A sprinkler on the lawn sends out plumes of water and taps a steady beat like a liquid metronome.

"What tempo is that?" I asked.

Linda Sanford Rousseau, a slender singer, listened to the beat and said firmly, "Allegretto." The gardeners' rakes, scraping the gravel paths, were slower: *andante*.

In the Music Shed, Erich Leinsdorf rehearsed the orchestra for a weekend concert. Dressed all in black, he hopped on and off a high stool as he directed the 106 men and women. Frequently he interrupted to explain how he wanted certain passages played. Then, at a graceful wave of his hand, the orchestra again burst into music.

As I left the Shed, I turned for a last look at the musicians. Below the orchestra platform five cello cases stood in a group—like fat, long-necked men in earnest conversation.

The modern Berkshires still stir thoughts of the past. Herman Melville wrote *Moby Dick* at Pittsfield; William Cullen Bryant lived at Great Barrington; Hawthorne began work on his *The House of the Seven Gables* while staying in a cottage in Tanglewood.

Tucked away in the northwest corner of Massachusetts is Williamstown, home of Williams College and the Sterling and Francine Clark Art Institute. My visit to the institute was made in October, when the Berkshires were vibrant with color. I had seen the autumn foliage explosion before, but always in



a "bad year." This time, everyone agreed, I hit a banner season. Like many another lady in her autumn years, Massachusetts had put on a flamboyantly gay dress, and the effect was almost overwhelming.

Assiduous Collector Bought Art Daily

I arrived on a day when the institute was closed. But I know a secret: The best time to find a museum director is on his day off; he will be in his office catching up on work.

Sure enough, Peter Guille was there. He greeted me warmly and showed me the treasures of this extraordinary place. Robert Sterling Clark, one of the heirs to the Singer Sewing Machine fortune, built the institute and left it half his estate and all his art—paintings from the 14th to the 20th centuries, including works by Degas and Renoir, prints, drawings, and sculpture, as well as a superb silver collection.

"Mr. Clark bought art just as you and I go to work," Peter Guille said. "From 9 to 5 he bought art. He was irate when the five-day week came along."

Berkshire County contains thirty towns and two cities, and each has some point of pride—if only to badger its neighbors.

Thus, when North Adams erected a sign proclaiming, "North Adams—Mother of the Mohawk Trail," Adams erected a sign of its own: "Adams—Mother of North Adams and Grandmother of the Mohawk Trail."

The trail, a modern road from Greenfield to North Adams near the New York State border, was originally an Indian trace. It skirts the tallest of the Berkshires, offering changing views of Mount Greylock, at 3,491 feet the highest point in Massachusetts.

One bright summer's day I rode the Mohawk Trail toward the east, stopping at old Deerfield. The town was settled in 1669 on a site John Quincy Adams described as not excelled by anything he had ever seen. A fa-

vorite target for marauding Indians in colonial days, it was almost wiped out several times. But the hardy settlers always rebuilt.

Clapboard houses of the 18th century line "The Street." There also stands Deerfield Academy, brooding under fine old shade trees. Founded in 1797, the Academy had only 14 students when Frank L. Boyden took over as headmaster in 1907. Since then, Deerfield has become one of the most respected preparatory schools in the country—and 65 years after taking over, Mr. Boyden still serves as its headmaster (pages 812-13).

Deerfield is only one of many excellent private schools in the state. Phillips Academy for boys opened in 1778 in Andover,

and is the oldest incorporated preparatory school in the country. In Andover also is Abbott Academy, the oldest incorporated girls' school. Groton School, on a wooded rural campus just outside the town of Groton, remembers that Franklin D. Roosevelt was a student there, graduating in 1900.

Out of my many weeks in Massachusetts, I most often

remember Groton and Andover and Deerfield and dozens of other towns like them—towns where the gleaming white spires of simple churches speak of centuries of concern for things of the spirit, of pride in the land and pride in solid workmanship.

Heritage of Excellence and Beauty

Massachusetts left me with a keen sense of the Commonwealth's drive for excellence and its reverence for cultural achievement. I discovered its beauty, too. I saw it bright under summer sun, in rain and under winter snow, and found it a tranquil and lovely place.

I will remember the sound of a symphony in the night, flaming trees on gentle hills, the solemn notes of a bell buoy, the slash of a lighthouse beam across a misty sky, and the cry of a herring gull in the dusk. THE END



"Earth's the right place for love," wrote Robert Frost in "Birches." His New England poems capture scenes like these at Camp Winadu in Pittsfield. Young campers—whether petting a furry bunny or collecting lakeside insects (opposite)—fall heir to their industrious state's regard for natural beauty.

Crossroads of the Insect World

By J. W. MACSWAIN, Ph.D.

Photographs by EDWARD S. ROSS, Ph.D.

I HAD SPENT a sleepless night, and now a tickling in my throat started me coughing. Dawn's pink light tinted the sagebrush and sand of the Mojave canyon around our camp. Lest I awaken my two entomologist colleagues, I dressed and slipped out of the tent.

About me I could sense the stirring that greets an approaching day in the California desert. And then, at sunrise, came one of the chance rewards that enrich the lives of those who find lasting fascination in the complexities of the insect realm.

Bees began to buzz around me. I recognized them as belonging to the widespread genus *Andrena*. But these were black andrenas, insects so seldom seen that always before I had interrupted anything to capture a single specimen. Now, no matter which way I looked, I could see dozens of them, darting about the blossoms of an evening primrose.

The flower is a traffic focus of the world of insects, a crossroads where much of the wonder in that world converges. To the insect, the flower offers a banquet table, a hunting ground, a mating site, a place of refuge—and of danger.

My interest in insects draws me frequently to this meeting place of plant and animal, where I seldom fail to learn some new and intriguing fact. This time it was a ridiculously simple but

Harvesting pollen. *Ceratina* bees balance on yellow anthers of a blossom in a Malaysian jungle. Flowers, whether in exotic forest or quiet garden, provide spectacular settings for the intricate life cycles of insects.

PHOTOGRAPHS BY EDWARD S. ROSS © 1984







ANDREW'S BEE (LEFT) AND THREEDOT BEE (RIGHT) © R. G. L.



unsuspected truth: The black andrews are not nearly so rare as entomologists had thought. We just hadn't been getting up early enough to see them!

Excitedly I dashed back to camp and woke my colleagues. And from that moment we revised our holiday outing to study the bees my insomnia had revealed. They proved to be several previously unknown species. These bees, we learned, gear their workday to the hour-and-a-half period around sunrise, when desert temperatures fit their liking. The rest of the time they hide in burrows they dig three to five feet down in the sandy soil.

Later studies of black andrews have turned up a score of species throughout the Great Basin of the western United States and south into Mexico. Some fly only in the sunrise hours, some around sunset, others both times of day. Some prefer the upper slopes of a canyon side, others inhabit the lower inclines, still others the canyon floor. For such is the intricate relationship between the insect and its environment.

Known insect species number close to a million. New ones turn up every day. The eventual count may soar much higher; scientific estimates range from one and a half to five million. By contrast, all the known species of fish, amphibians, reptiles, birds, and other animals with vertebrae add up to only 36,000—fewer than the types of weevils alone.

Insects exist almost everywhere—30 species even in Antarctica, including midges, springtails, and bird lice. Without insects, life on earth as we know it could not exist. Many legume crops depend exclusively on the honeybee for the pollination that produces the seed for next year's plantings. Much wilderness vegetation

Satiny sleeping bag cuddles an awakening *Hesperapis* bee. Most blossoms of the genus *Clarkia* fold at night, enclosing bees made sluggish by evening's chill. Only the male *H. regularis* sleeps in flowers; females usually nest in ground burrows.

By day, clarkia petals flare. Their bright markings—as in many other flowers—advertise nectar and pollen sources to foragers. A female hesperapis, hind legs glittering with white and lavender pollen, probes clarkia's center.

so important to soil formation, erosion prevention, or colorful bloom depends on insects for reproduction.

Insects appeared on earth probably 350 million years ago. In the eons since, they have developed remarkable adaptations to plants—involving interdependence of one on the other. And hard-to-believe oddities: Pupae of common butterflies that may winter on low shrubbery with no covering but ice and snow. Fruit flies that in flight beat their wings 13,000 strokes a minute. Aphids that give birth only to live female offspring—daughters who, even before they are born, already have begun to develop within themselves the embryos of a third generation.

Odd Partnerships Link Two Worlds

Vast, complex, and exciting, the insect realm pulsates about the blooms of forest, hill, and plain. Most of the insect traffic comes there for nectar. The insects gather it as a source of quick energy for themselves, or as a nutritious addition to food for larval young. Nectar averages from 30 to 40 percent pure sugar; in apple blossoms, it may contain as much as 87 percent.

To gather nectar, insects have perfected remarkable adaptations. Mouth parts have developed into strawlike proboscises, often longer than the insects' bodies, that poke

deep into flowers. Alimentary tracts have developed honey stomachs, or crops, that become carrying pouches and storage vats; the tiny honey ant may swell to eight times normal weight and hang like a balloon in underground chambers.*

But adaptation hasn't been all on the side of the insects. Plants have changed too. Species which cannot depend on chance winds to spread their pollen have developed lures that encourage the crawlers and fliers, whose visits help the transfer from one blossom to another. In addition to nectar, flowers attract with color, odor, landing-platform petals, and dottings and markings that serve as guides pointing out the nectar cup.

This mutual adaptation has become so interwoven that some plants cater only to certain insects, whose lives in turn hinge exclusively on that plant. The black bees of my sleepless night, for example, time their short flying existence to the blossoming period of the evening primrose. Other andrenas emerge from their wintering stage when the willow catkins burst into bloom. And in California one year, unseasonable weather caused some spring flowers to blossom in the fall; simultaneously, certain spring bees appeared at the flowers.

*See "Living Honey Jars of the Ant World," by Ross E. Hutchins, NATIONAL GEOGRAPHIC, March, 1962.

Author and photographer: Dr. J. W. MacSwain (right). Professor of Entomology at the University of California at Berkeley, has gained unusual distinction both for his broad knowledge of insects and as a specialist on certain bees and beetles. A veteran of insect-collecting expeditions, he recently flew to Iran to study alfalfa pollination.

Dr. Edward S. Ross, whose remarkable photographs accompany Dr. MacSwain's article, is Curator of Entomology at the California Academy of Sciences in San Francisco. He works only inches from his subjects, hand-holding both camera and flash lamp, since he often has but moments to focus the lens and snap the shutter after encountering an insect.

As youngsters, both scientists were enthusiastic insect collectors. Later they went to college together in California.



EDWARD S. ROSS

Bumblebees and honeybees are not the only ones that take nectar from flowers. So do the 14,000-odd species of solitary bees—so called because the females live alone in crevices and holes to lay eggs and provision their nests. In the community hives only the queen bee lays eggs, the sterile female workers maintaining the colony.

Like bees, butterflies have nectar-sucking mouth parts. Yet many butterflies can't taste with their mouths.

That's true of one of the commonest species, the painted lady, which sometimes migrates by the swarming millions. Taste organs of the painted lady and related butterflies lie on the outermost tips of their legs. They liter-

ally taste with their toes. So sensitive are such tasters that the red admiral butterfly can detect sweetness from as little as one teaspoon of sugar in a bathtub full of water. That sensitivity is about 150 times man's—and 1,000 times the honeybee's.

The Fly That Eats the Spider

Flies also may be nectar gatherers, but most of these have relatively short mouth parts. One exception: Some spider flies (*Acroceridae*) take fluid from deep-tubed blossoms.

Everybody knows that spiders eat flies, but in this case it's the other way round. Spider fly females lay their eggs on grass, weeds, or flowering plants. The tiny larva that hatches



Death waits amid petaled beauty

FLOWERS THAT ATTRACT insects also lure rapacious hunters seeking prey. Cream-colored body blending with the petal tips of a daisylike flower in Mexico (lower left), a crab spider seizes a *Phyciodes* butterfly.

Death ambush bug (genus *Phymata*), clinging to a Utah wildflower (right), captures a halictine bee with grappling forelegs; a stab of its beak subdues the victim.

Green-eyed monster, a Malaysian mantis of the genus *Theopompula*, lurks behind a jungle blossom, poised to snatch a visitor.

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clings to the vegetation until a spider chances by. Then it transfers to the spider's body and burrows inside, eating away at the host's vitals. When the spider dies, the larva winters inside the carcass, emerging in the spring as a fly ready to start the cycle anew.

Though beetles normally have chewing mouth parts, one kind comes equipped with a delicate tube for sucking nectar. This is *Nemognatha*, a blister beetle (page 854, bottom). The genus richly deserves the name; body fluids of some species contain large amounts of an irritating substance called cantharidin. When disturbed, the beetle exudes some of its body juices through joints in its legs; on human skin the chemical raises itching blisters.

I once collected a cupful of blister beetles, killed them in a jar of alcohol, and foolishly stuck my hand into the fluid to strain out the insects. The alcohol had dissolved the cantharidin the beetles released before dying. For a week afterward my hand was covered with blisters, some as much as three-fourths of an inch long, itching like fury.

For sipping nectar, the blister beetle carries a grooved proboscis half again as long as the insect itself. But this proboscis cannot be coiled, so the beetle flies with it tucked beneath its body.

Larvae of the species lie in wait on a flower bud. When a bee comes along, the larva clamps its jaws onto a single hair of the bee's body and hitchhikes to the bee's nest. There it crawls off into a cell, waits until the bee has provisioned and sealed the cell, then eats the bee's egg and stored pollen.



Building a nursery, an industrious *Megachile* bee begins by scissoring the petals of a *Clarkia* blossom in California (from top left). The half-inch insect's heavy body, whirring wings, and sturdy jaws make it an animated cutting tool. Legs rapidly roll the piece of petal into a tube which the bee

Rich in protein, pollen forms an extremely nutritive food. Many types of adult insects eat it for sustenance; some, like the bees, collect it to nourish their young. But to the flower, pollen plays a key role in reproduction, through that process we call pollination.

"Nature," as Charles Darwin once observed, "...abhors perpetual self-fertilisation." Some flower structures make it extremely difficult for pollen from anthers of the male stamen to reach the stigma of the female pistil in the same blossom. But the structures take wondrous ways of making sure that the flower's six-legged visitors assist in pollen transfer to other plants of the same species.

Flower Structure Ensures Pollination

The monkey flower (*Mimulus*), for example, has a double-lipped projecting stigma that scrapes pollen off a bee's proboscis as it thrusts into the nectar tube. The lips close, and if the pollen has come from the same species, they stay closed, forming a moist chamber in which the pollen can germinate. But if the pollen is not from the same *mimulus* species—or if you trigger the closing with, for example, a hare needle—the lips will open again to await a proper load.

Another pollination curiosity occurs in the common alfalfa plant. Its unusual blossom has interlocking petals that must be forced apart for an insect to reach directly into the heart of the flower. This broaching, however, trips a sort of spring trap, and pollen-carrying parts snap forward to strike the underside of the intruder's head.

Honeybees, common visitors to alfalfa, apparently dislike being struck; experienced bees learn to get at the nectar from the side of the flower, without triggering the mechanism. Hence seed production cannot depend on the honeybee.

But the wild alkali bee—so named because it commonly digs its burrow in alkaline soil—seems made of sterner stuff. It flies undaunted from flower to flower, tripping blossoms and gathering pollen and nectar—and setting bumper crops of alfalfa seed.

Farmers in the western United States encourage these bees. They protect colonies from such enemies as skunks, which dig up the larval young. Farmers even provide artificial nest sites for the bees.

Perhaps the most startling relationship of all between pollinator and plant exists between yuccas and the little white moths that infest them. The familiar yucca of the southwestern United States and Mexico sends up its towering spire of bloom in the spring. At the same time a three-eighths-inch moth emerges from the ground, where it spent the winter as a larva, and heads for the flower stalk. With front legs and mouth parts, it scoops up a small mass of pollen. Then it flies off to another blossom. It enters and carries the pollen unerringly to a receptacle in the stigma of the bloom, developed especially to receive it. Without this instinctive act by the moth, the yucca could not reproduce.

The yucca moth lays its eggs, and the caterpillars that hatch dine on matured seeds. Usually, not more than six caterpillars develop



PHOTOGRAPHS BY FRED LYLE-BUST BY EDWARD S. ROSE © 1962

carries into its burrow. The round trip, including cutting, may take only 10 seconds!

By overlapping many cut petals, the bee fashions a tight nest cell, measured against fingertip and tweezers. It packs one end of the cell with beebread made of pollen and nectar and on this deposits a

single egg. Finishing the job, megachile plugs the other end with petal cuttings.

The larva consumes the beebread, then spins a cocoon within the cell to protect itself through the winter. It develops into a pupa and in late spring breaks out of the cell as an adult.



ED ROSS LIFE-SIZE

Squeezing into a stream orchid, a syrphid fly gets an unwanted pollen load for its back. Rosy color and convenient landing-platform petal led the nectar seeker beneath the flower's male anthers. Unable to rid itself of the sticky packets—called pollinia—the syrphid darts to another blossom (below). As the fly moves into the opening, the pollen dislodges inside twin sockets of the female stigma. Dr. Ross, drawn by yellow spots in flight, captured this rare documentation of wildflower pollination.

within a blossom, and each needs only about twelve seeds for sustenance. Since each flower can produce about two hundred seeds, there is, in nature's exquisite ordering of things, an excess of seeds to assure new yucca plants.

Perils Lurk Amid the Petals

Pitfalls await the unwary insect at such flowering crossroads. Where eaters of pollen and nectar seek food, there also insect predators find a hunting ground.

Many times I have watched assassin bugs and ambush bugs on plants, carrying out the rapacious predation that has won them their names. I have often seen a female sand wasp course a clump of wild anise, seeking syrphid flies and paralyzing them with her sting to provision the nest cells of her young. And I have often observed a crab spider, a yellow splotch on a yellow flower, awaiting a bee or other insect for dinner (page 848).

For fearsomeness as insect predators, however, few creatures can equal the praying mantises, which lie in wait to grab their victims (page 849). Some take on the colors and shapes of the growths where they lurk. In the jungles of Malaysia my colleague Ed Ross photographed one so delicately beautiful and so perfectly matched to the flower it frequents that natives have a legend about it. They say



ED ROSS LIFE-SIZE

the mantis isn't really an insect, but a flower come to life (page 853A).*

Not all predators at the insect crossroads travel there to eat. Some have a more bizarre purpose: to find a host for their young.

The conopid fly, for example, waits on a flower until a sand wasp comes along. Then it chases the wasp, catches it, and with a specially adapted egg-laying organ forces apart the segments of the wasp's abdomen to deposit an egg inside. The egg hatches, and the larva begins to eat its host. Eventually the wasp flies to its burrow in the sand and dies. The larva winters in the wasp's dry abdomen, then transforms into a pupa.

Fly Digs With Inflatable Head

Spring comes, and with it, a final wonder of the conopid's life. The adult punches its way out of its shroud and up through the sand to the surface, using a strange inflatable organ. Like a balloon, the organ swells out from a slit in the conopid's head and presses back the sand. As the bubble alternately in-

TEAR OUT THE ATTACHED PAGE and plan your voyage, via television, to the hidden world of insects.

flates and deflates, the fly wriggles upward.

Perhaps the most intriguing example of insect parasitism unfolds in the story of a species of *Stylops*, one of the twisted-wing beetles. That tale took 20 years of study to piece together, for the male has a lifetime of only a few hours as a mature insect, and the female spends most of her existence hidden within the body of her host.

Both *stylops* sexes parasitize bees of the genus *Andrena*. Each begins life as a grub no bigger than a minute speck of dust. Each develops in an *andrena* larva, and continues within the body after the larva matures into an adult bee.

Andrenas that harbor male *stylops* die in early spring, shortly after the quarter-inch

*See in NATIONAL GEOGRAPHIC, "Asian Insects in Disguise," by Edward S. Ross, September, 1965; and "Praying Mantis," by John G. Pitkin, May, 1956.

Hazardous cavern of a Dutchman's pipe claims unwitting victims. The plant lures gnats with a scent similar to that of the fungus on which they breed. Once inside, Dr. Ross theorizes, a gnat mistakes the bright stem end for an exit and makes its way there. If the insect carries pollen, fertilization triggers a process that lowers the vase-like throat, admitting light and allowing easy escape. Dead gnats probably carried no pollen or perished in a plant too immature for pollination.



ARISTOLochia reticulata © W. G. B. & C.

Exploring *The Hidden World*—the fascinating insect realm—on television



ILLUSTRATION BY THE NATIONAL GEOGRAPHIC SOCIETY

Wonder lights the faces of youngsters watching *Cecropia* moths on a screen. The lure of insects beckons in the commonplace as well as in the exotic—be it a checker-spot butterfly (overleaf) sipping nectar from a flower, or (opposite, clockwise) a leopard-spotted grasshopper, a nest of wasps on a plant stalk, an inch-long ant from Brazil, or a blossom-mimicking mantis whose saw-tooth forelegs lash out with amazing speed to capture its prey.

MARAUDING WASPS and live-defending bees battle to the death with thrashing stings. Before your eyes, a bizarre caterpillar evolves into that airborne beauty, a monarch butterfly. Ants tend mushroom farms, and termites nurse a monstrous queen that can lay 15,000 eggs a day and live a score of years. This is the incredible world of insects, teeming beneath leaf and log, in flower and field, in exotic jungle and your own backyard. Now its wonders unfold for you in *The Hidden World*, latest in the National Geographic Society's widely hailed series of programs produced in association with David L. Wolper. You can see it in color on the Columbia Broadcasting System television network on Tuesday, December 13. (Keep this tear-out page beside your set for the station listings on the back.)

Through the ages insects have fascinated more—and plagued him. Their array includes creatures that have given him such useful products as silk, honey, wax, lacquer, dyes, medicines—and a dreadful toll of disease. *The Hidden World*, jointly sponsored by Encyclopaedia Britannica, Inc., and the Actna Life and Casualty Insurance Companies, reveals with rare photography this dramatic realm of the insects.



PHOTOGRAPHS BY EDWARD S. ROSS, GEORGE W. BROWN, JR., AND JOHN G. PITKIN





PHOTOGRAPHS BY EDWARD S. WOOD © NATIONAL GEOGRAPHIC SOCIETY



© TIMOTHY L. LANE/ALAMY

Heels over head in a South African strawflower, a $\frac{1}{4}$ -inch scarab beetle (family Scarabaeidae) dives deep to feed on the blossom's heart. Beetle-browed "face" of insect at left is actually its hind quarter.

Strawlike proboscis of a tropical skipper (genus *Pyrrhopyge*) probes for moisture from the Peruvian forest floor. Pollen clots its wings and body, and clings in packets to the uncoiled tongue.



Beauty and the bee—Apis mellifera gorges on nectar from daisylike western wildflowers. Each floret offers sugar-rich liquid; pollen dusts the anthers that crown the protruding stamens. Fastidious honeybee (left) combs pollen from its collecting hairs into a ball carried in a hind-leg cavity. Untidy worker (right) is powdered with grains that may pollinate another bloom.



PHOTOGRAPHS BY TIMOTHY LAFAYETTE JEFFERSON AND F. THOMAS LEITCH III © H.A.S.

I put some of them into a sugar-water solution to find out. Under my microscope I found a little gas bubble forming around each larva. As much as 39 hours later a few of the creatures were still alive! Here, then, was proof of the final link in stylop's life cycle, and the thrilling climax—for one entomologist, at least—of twenty years of work.

Orchid Mimics Female Wasp

Most pollen-and-nectar-gathering insects are females. Where they congregate in the search for food, there also flock the males.

The male *Megachile* bee (page 850) stakes out a courting ground around a group of blossoms, often driving off other males in a display of territorial behavior similar to that of birds. The male *Hesperapis* bee takes overnight refuge within enveloping petals of clarkia—and thus becomes Johnny-on-the-spot next day for any female that arrives to collect morning-fresh nectar as petals open (page 846).

Even flowers capitalize on the mating instinct of insects. One Mediterranean orchid grows a blossom that looks like a female wasp at rest on a small, green bloom. So perfect is the imitation that petal colors mimic the metallic glint of insect wings, and bumblebees shy away from the seemingly occupied plants. The male wasp, however, alights and attempts to mate with the female-simulating flower. In the process he receives the pollen-bearing structures he will carry to another flower for its pollination.

Such is the drama of life that draws so many varied creatures to the crossroads of the insect world—including fascinated humans like me.

The Laser's Bright Magic

By THOMAS MELOY

Photographs by
HOWARD SOCHUREK

IN *The War of the Worlds*, written before the turn of the century, H. G. Wells told a fanciful story of how Martians invaded, and almost conquered, earth. Their weapon was a mysterious "sword of heat," from which flickered "a ghost of a beam of light."

Radiation from this Martian ray gun, focused by a curved mirror, dropped men and horses in their tracks, made lead run like water, and flashed anything combustible into masses of flame.

In Wells's day, such ideas were pure imagination. Today his "sword of heat" comes close to reality in the laser, the marvelous new device that shoots out narrow, highly concentrated beams of light—the sharpest, purest, most intense light ever known.

The blinding radiation from the more powerful lasers can indeed melt lead so that it runs like water. When focused to a sharp point at very close range, it can vaporize any substance on earth. Within extremely small

LASER ILLUSION turns the Washington Monument into a flaming Christmas candle. A beam of highly concentrated laser light, flashed across the Potomac from the Monument, creates a star and halo in the camera lens two miles away. The laser—brightest, most powerful light known to man—holds enormous promise for medicine, industry, and research.







REPRODUCED BY ARLAN R. WILKINSON AND BEN FINESTONE © N.A.S.

How the monument picture was made

RED CLOUD suffuses photographers and cameras atop an apartment house in Arlington, Virginia, as they take aim at the scene on the preceding page. Brilliant laser radiation coming from the Washington Monument lights up camera view finders like railway- semaphore signals, and flares

on the photographic film to create a synthetic moon and trio of rings.

High up in the monument, Benjamin L. Toler of the U. S. Army Night Vision Laboratory lines up a helium-neon gas laser (left) before the shooting begins. He aims the laser through a window by focusing a telescope sight on a Sun Gun, a bright lamp set up at the camera location two miles away. By walkie-talkie he signals that all is ready.

Comparatively weak as lasers go, this one produces only about twelve-thousandths of a watt. However, because of the brightness of its distilled energy, its power was shut off at the approach of planes to avoid distracting pilots.



areas—incredibly—it burns *billions* of times brighter than the light at the sun's surface.

The laser is far from being a practical death ray, although scientists are at work developing it as a weapon. In my opinion it may become the answer to the missile problem—the swift, powerful ray capable of knocking enemy missiles from the sky.

Multiple Laser Uses Foreseen

Meanwhile, the peaceful purposes to which the laser may be put are so many and so varied as to suggest magic. For example, laser light can bore holes through steel in the wink of an eye, detect art frauds, make three-dimensional photographs, subdue some cancers. In the future it may lead the blind, detect earthquakes, prevent tooth decay. Potentially it can illuminate the ocean depths, avert plane crashes, carry millions of simultaneous telephone messages, and perhaps revolutionize surgery. And this is but the beginning of a lengthy catalogue.

Small wonder that the laser's potential has created a tremendous stir in the industrial and scientific world. I am particularly aware of its significance since one of the companies with which I am associated, Isomet Corporation, produces laser devices and grows a variety of crystals for them. So rapidly is the field developing that some experts foresee the laser industry topping a billion dollars a year by 1970 in the United States alone.

Though only six years old, the laser has already figured in movies (*Goldfinger* used one against James Bond) and in comic strips (Moon Maid in "Dick Tracy" has a built-in natural laser).

All this excitement really began in 1958 when Dr. Charles H. Townes and Dr. Arthur L. Schawlow published the first paper describing how a laser might be made. They called it an "optical maser," since it was an optical adaptation of a microwave-amplifying device known as the maser, which Dr. Townes had invented in 1951 (and which led to his receiving the Nobel Prize in 1964).

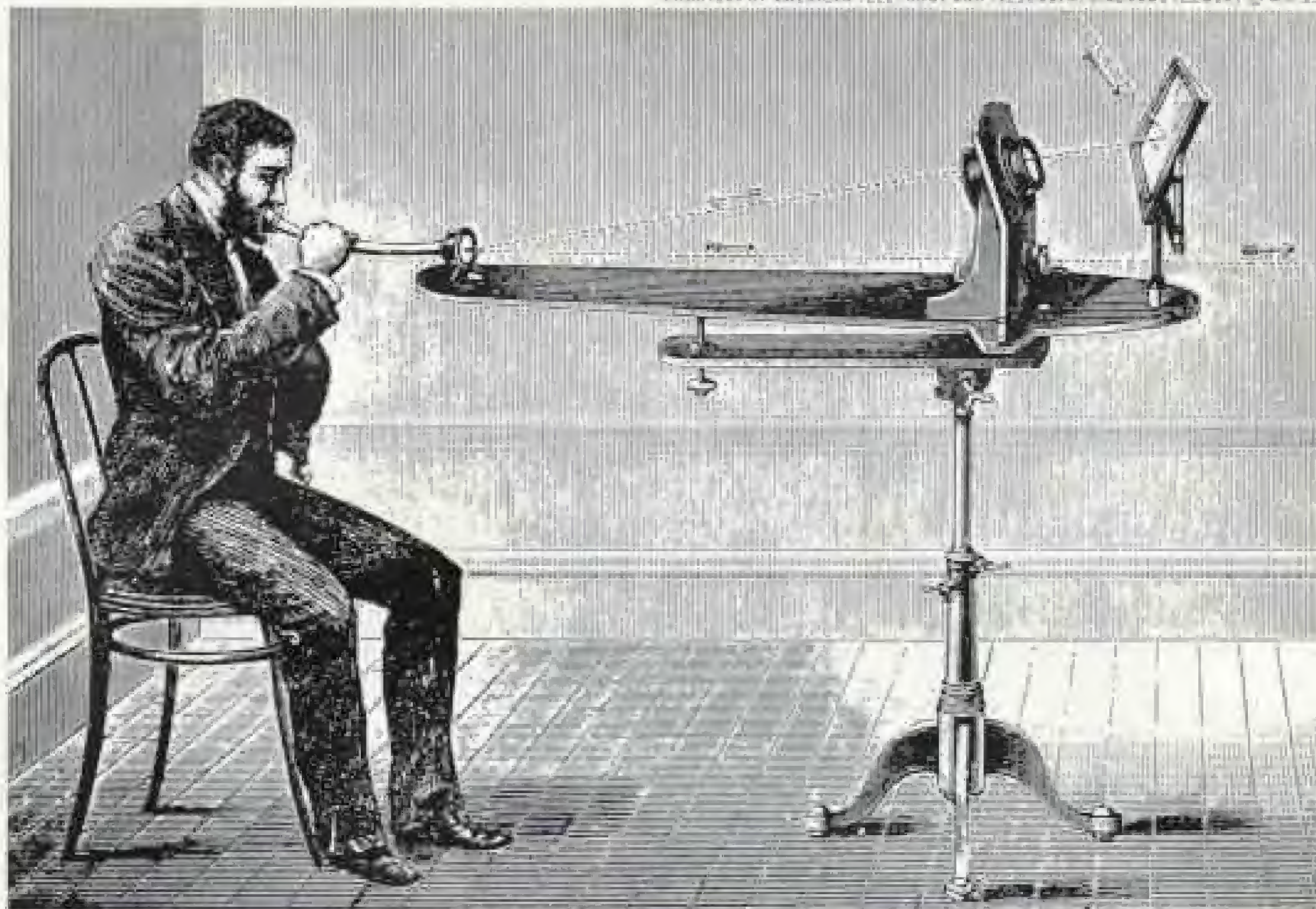
Their theoretical work was followed by the success of Dr. Theodore H. Maiman, then at the Hughes Aircraft Company in Malibu, California, who in 1960 coaxed from a man-made ruby the world's first laser beam—a shaft of brilliant red radiation. The light fantastic had been born.

My own involvement with lasers began in the spring of that same year. IBM called us at Isomet and asked us to make a most unusual kind of crystal—a rod of calcium fluoride

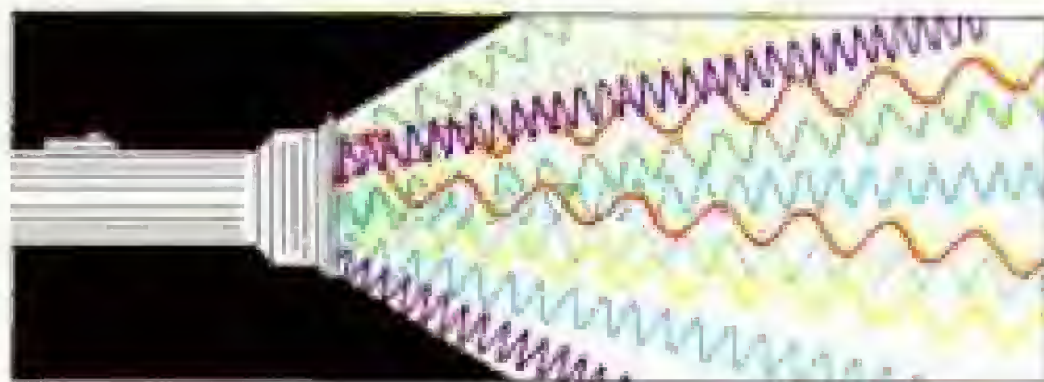


RIBBONS OF BLUE AND GREEN, split by a prism, flow from a laser beam. Lasers usually emit light of a single color, but this one, containing argon gas, produces several closely related colors simultaneously. Dr. Peter S. Zory, Jr., physicist at the Sperry Gyroscope Company, Great Neck, New York, wears protective goggles against the hazardous brilliance.

KODACHROME BY JONATHAN S. BLAIR © N.G.S.



"I have heard a ray of the sun laugh and cough and sing!" wrote Alexander Graham Bell in 1880, speaking of his new photophone, first device to transmit sound by light. The photophone modulated a beam of sunlight with a vibrating mirror, then converted the vibrations to sound. It foreshadowed a similar use of laser light, which could carry millions of messages simultaneously.



Medley of colors blends in ordinary incandescent light. Scientists call such light *incoherent*. It mixes colors, or wavelengths. Out of step with one another, waves fly off in widely diverging directions. Even with lenses, incoherent light beams spread out over long distances.



Like water from a fire hose, *coherent* laser light travels in a direct stream that remains remarkably compact for long distances. Coherence is the secret of the laser's power: Its light is essentially of one color, or wavelength, and the waves always stay exactly in step.

Nobel Prize winner Dr. Charles H. Townes received the award for developments in quantum electronics, including the maser, forerunner of the laser. In 1958, with Dr. A. L. Schawlow, he published the first theoretical description of a laser. Here Dr. Townes, Institute Professor at Massachusetts Institute of Technology, observes an argon laser.

"doped," or impregnated, with samarium, a rare earth. Its ends were to be ground parallel and flat to an unbelievable accuracy of about 1/200,000th of an inch.

We had a lot of trouble making that crystal. Optical polishing by hand is almost a lost art, and this one couldn't be done by machine. Naturally we wondered what it was for.

One day Mirek J. Stevenson, who made important early contributions to laser technology, called us from IBM.

"You might be interested to know," he told us, "that we used your crystal to make a laser. We're sending you an article about it."

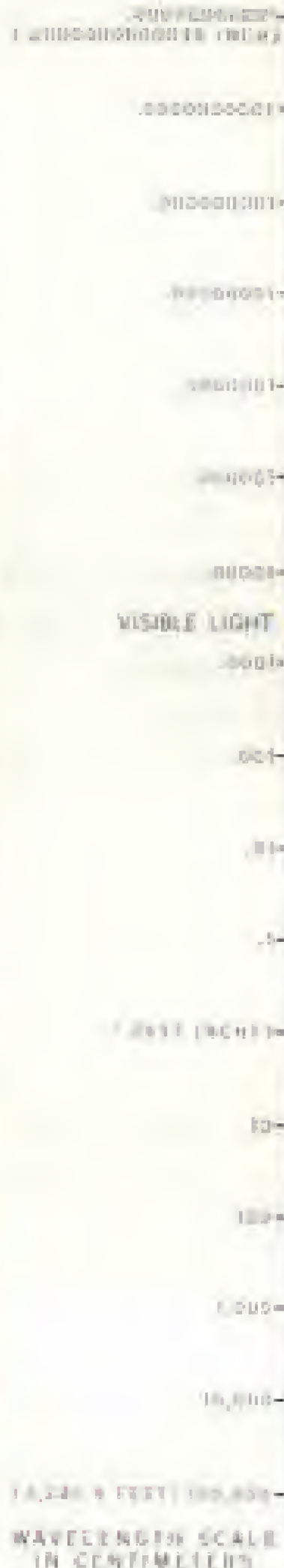
That turned out to be one of the first successful lasers.

Of course we became deeply interested then and tried building our own lasers. No one knew much about them—it was trial and error at first. Some of the crystals were very hard to make and broke easily.

As a matter of fact, the first laser we made blew up with a loud noise. But we persisted,

A narrow rainbow marks the small portion of the electromagnetic spectrum occupied by visible light. Many lasers radiate in this optical region; others produce invisible infrared or ultraviolet "light." Laser radiation differs from other electromagnetic waves, such as X-ray and radio, only in length and frequency.

EXTENSIVE BY HARVEY SHAPIRO © N.S.S.



THE ELECTROMAGNETIC SPECTRUM

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successfully, and in time began to specialize in new materials for crystals and in electro-optical devices to control and modulate lasers.

Dr. Maiman's original laser is so small that you can hold it in the palm of your hand. Most of today's ruby lasers bulk substantially larger, but they work much the same way.

"Caution - Eye Hazard"

If you were to come into my laboratory to watch a ruby laser operate, you might be surprised at the apparent simplicity of a device capable of such power. Essentially you see only two enameled steel boxes: a relatively small one holding the laser itself, and a larger one, with a control panel, holding capacitors, or condensers, to store a heavy charge of electric current.

As you watch, a technician throws a switch, and a whine fills the room while the capacitors charge up. Then the technician points to a sign on the door saying "Caution—Eye Hazard," and hands you a pair of dark gog-

gles to filter out the greater part of the light. A direct hit in the eye by a strong laser beam can cause instant blindness, and even reflected laser rays can burn holes in the retina of the eye. For this reason laser laboratories sometimes have walls painted a dull black, to cut down on reflection.

Now the laser is ready. When we press the firing button, you hear a vicious crack, like a rifle shot. At the same time, a small but incredibly dazzling red spot flashes momentarily on the wall at which the laser is aimed.

To demonstrate the power of the laser, the technician aims it at a piece of steel the thickness of a quarter, using a lens to focus the beam to a fine point. Again you hear a whine, a sharp report. This time a shower of incandescent sparks flies from the piece of steel. It has been pierced all the way through by that awful blast of light.

At the heart of the typical ruby laser is a synthetic ruby crystal in the form of a slender rod, its ends polished and silvered as mirrors,

one totally reflective and one partially transparent. Around this rod spirals a powerful flashtube of the type used for high-speed photography. When the tremendous bolt of electrical energy is suddenly discharged into the tube, it goes off in one swift flash.

Within the ruby rod are chromium atoms that become highly energized by the flood of light energy from the flashtube. Electrons in these atoms become so agitated, in fact, that they jump into patterns, or energy levels, higher than those they normally occupy.

But the excited electrons are not really stable in their new levels, and almost immediately they begin to come back home, stopping only fleetingly at an intermediate level. As they return, each one gives off a photon, the basic unit of light.

At this point the "lasing" process begins, if the rod has been properly constructed. Although some of the photons escape, many travel the length of the rod, bouncing back and forth between the mirrors at its ends. They trigger other excited electrons to give off light in the same way, until a cascade of light hurtles between the mirrors, making the round trip several million times.

Eventually the flood of red light, leaking slowly at first through the partially transparent mirror, becomes so intense that it erupts as one mighty pulse of laser radiation. And all this—from beginning to end—has taken place within the span of a few thousandths of a second (pages 866-7).

In effect, the light of the flashtube has been converted into a new kind of light, a million times purer, more concentrated, and more powerful. Thus does the laser get its name: "Light Amplification by Stimulated Emission of Radiation."

Myriad Light Waves Move as One

To understand why laser light is so concentrated, you must recall that light travels in waves, like ripples on a pond. The number of waves that pass a given point in a second determines the frequency of the light. The distance from the crest of one wave to the crest of the next is the wavelength.

Ordinary white light, such as that from an incandescent light bulb, is made up of many wavelengths (which is the same as saying many colors) all jumbled together and traveling in every direction. That is known as *incoherent* light.

Laser light, on the other hand, is *coherent*.

It is essentially of one wavelength (that is, one color), with all the waves moving in one direction. Moreover, all the waves are in phase, or in step, reinforcing each other like soldiers marching in lock step, or like voices singing in unison. They can remain in an unbelievably straight, narrow beam for long distances, instead of fanning out like a flashlight beam (diagrams, page 862).

As we shall see, it is precisely because laser light is coherent that it is capable of performing such a bagful of tricks.

Some Lasers Emit Invisible Light

What I have explained for the ruby laser holds true in principle for most other kinds of lasers, although they may differ as greatly as a Greyhound bus and a Volkswagen.

We have found that almost any substance—Scotch whisky, for example, vaporized in a glass tube—can be forced to "lase" if you work hard enough with it. Gas lasers, which look just like the tubes in neon advertising signs, typically give off continuous beams of laser light—in contrast to the sharp pulses of the ruby laser. Tiny semiconductor lasers, made of bits of such material as gallium arsenide, will work at supercold temperatures. Smaller than a pinhead, they may be especially useful in computers for transmitting signals where densely packed electrical devices leave little room for wire connections.

Many lasers, as I have described, are excited (or "pumped," as we say in the laboratory) by light. Others may be made to lase by radio waves, or by an electric current, or by chemical reactions.

Not all lasers produce visible light; many give off invisible radiation, either infrared or ultraviolet (diagram, page 865). These include the carbon-dioxide laser, one of the most powerful yet invented. It shoots a continuous beam of intensely hot but invisible infrared "light," like the Martian ray gun in H. G. Wells's fantasy. It just might be used in time against unfriendly missiles, if not against Martians. Already, on a small scale, it can equal Goldfinger's devilish ray gun.

When I think of the "death ray" and the missile threat, I recall my friend Sir Robert Watson-Watt, the first man to put radar to practical use. He was one of the saviors of Britain during World War II.

Early in 1935, when he was a research physicist, the Air Ministry called him in and asked him if he could develop a death ray to destroy



RESEARCH BY HOWARD SCHUBER © R.E.T.

approaching enemy planes. After considering the problem, he told the ministry that electromagnetic limitations made a death ray impracticable. At the same time he offered to develop a device that would locate airplanes at night, in clouds, or in fog.

By spring, he had a research staff, a year's funds, a laboratory. That summer Winston Churchill won a campaign to create a special committee to speed air-defense research. Because of the foresight and persistence of the

Mouse under anesthetic suffers neither pain nor harm from the swift laser pulse that vaporizes a bit of ear tissue. Analysis of the vapor by spectroscope tells the chemical make-up of the tissue and may reveal disease. Heavy concentration of calciums, for example, could in some cases indicate cancer. This laser microprobe, developed by the Jarrell-Ash Company, of Waltham, Massachusetts, also may be used for quick analysis of many industrial materials.



ENTRANCE (ABOVE) BY HOWARD BEHNBERG, EDUCATION BY EDWIN G. BRIDGEMAN © R.O.S.

First to develop a laser—in 1960—Dr. Theodore H. Maiman inspects a crystal rising from a crucible at the Korad Corporation in Santa Monica, California, which he heads. Scores of crystal materials, as well as gases and liquids, have been made to give off laser light.



Crimson energy, compacted into a pencil-thin beam, shoots from a laser of man-made ruby shown with part of its reflecting shield lifted away. A flashing xenon tube, spiraling around the ruby crystal rod, pumps energy into the laser. After each burst of coherent light, a pulse laser must be recharged.

How a ruby laser works

A POWERFUL FLOOD of light from the spiral flashtube hits the synthetic ruby rod of this pulse laser, exciting chromium atoms in the ruby. Electrons in these agitated atoms jump temporarily into higher energy levels. When the energized electrons drop back to their original levels, each gives off a photon, or tiny burst of light. Some photons fly in random directions. Others bounce back and forth between parallel mirrors at the ends of the rod. As they oscillate, they trigger other excited electrons to give off photons, all lining up in the same direction. In thousandths of a second, a cascade of photons erupts through the partially reflecting mirror in one swift pulse of coherent laser light.

FLASHTUBE PUMPS ENERGY INTO RUBY ROD



METAL CASE CUT AWAY

two men, a radar network was in operation in Britain by the time the war began.

In answer to inquiries as to its remarkable success in shooting down airplanes hidden in clouds and at night, the Royal Air Force said its pilots were eating carrots to sharpen their eyesight!

Perhaps someday the laser—far faster than a 10,000-mile-an-hour missile—will provide the means of defending the free world, just as radar did in its way in World War II.

Laser Light Can Drill and Weld

When I speak of the laser's tricks and magic, I do not mean to imply that it is at this time a toy. Far from it; I have seen the laser used as a tool for industry and an instrument for science and medicine. Increasingly, this versatile invention will affect your life as we raise its efficiency and find tasks it can do more cheaply or better than other devices.

The most dramatic among the laser's potential applications hinge on its enormous intensity, its brightness. Even without focusing, the most powerful pulse laser—made by Westinghouse—can concentrate 750 trillion watts on a square centimeter (a little smaller than the face of a square sugar cube). It is like squirting Niagara Falls through a water pistol in one brief moment.

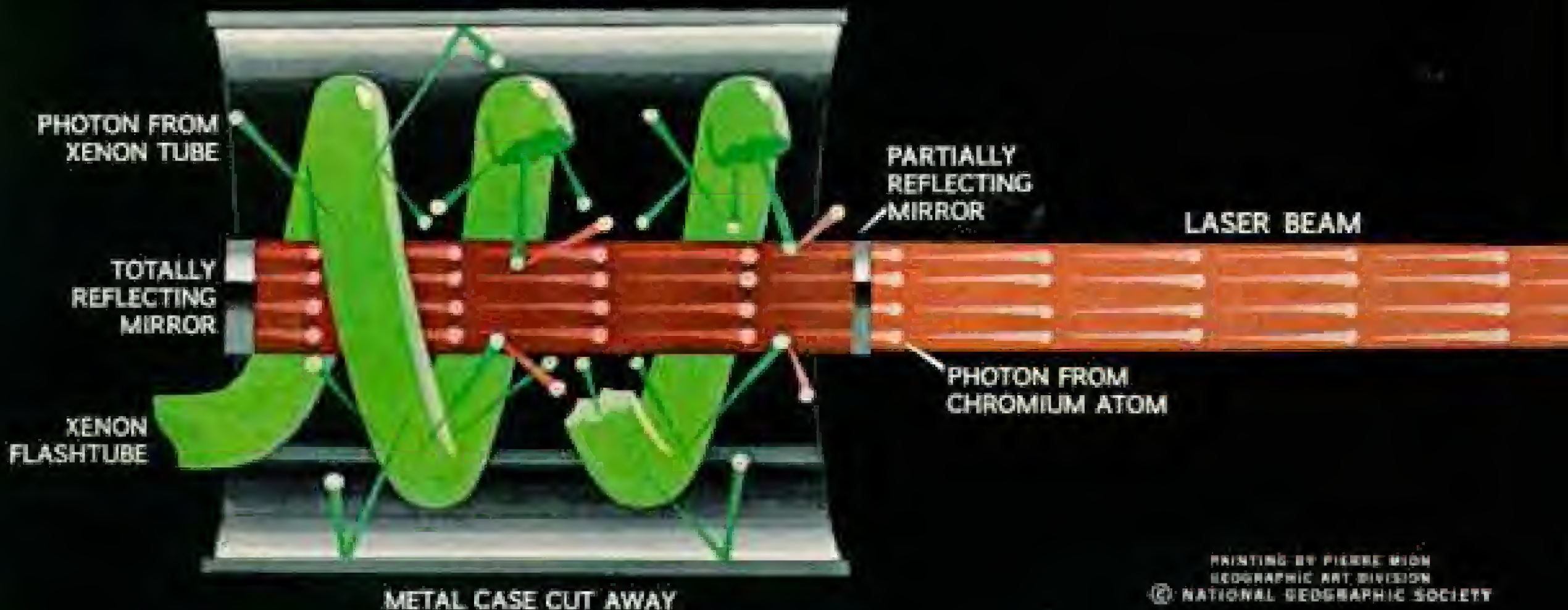
Obviously, pulses of such powerful light produce intense heat and thus can do many jobs for industry—cutting, drilling, shaping, welding. Ultrahard, brittle materials, such as tungsten, yield easily to the laser's insistent thrust. Exotic heat-resistant metals, such as titanium alloys for supersonic aircraft, readily



COURTESY OF HOBAS ENGINEERS © R.C.B.

The Author: An engineer with wide interests in optics, electronics, and information-processing, Thomas Meloy has worked with lasers since their infancy. In earlier years he helped operate railroads and design bridges in China; developed the rear-projection cinema and the brokerage-house projection ticker; and, during World War II, developed radar and antisubmarine devices. Here, at Isomet Corporation in Palisades Park, New Jersey, he watches the growing of a calcium-tungstate laser crystal.

PHOTONS ALIGN IN A PULSE OF LASER LIGHT





PERFORATING (LEFT) BY HERBERT DUCHNER,
 ASSISTANCE BY JONATHAN D. BLAIR © W.E.C.

Cross hairs centered on target, a pulse laser (left, center, with cover here removed for picture) has just blasted a hole through a very small diamond. For safety, the operator watches by TV, which magnifies 80 times. Western Electric Company, in Buffalo, New York, laser-pierces diamonds for dies to draw fine telephone wire to human-hair thinness (above, magnified five times).

join together under the feverish touch of a laser welder.

And—paradoxically—fine wires and foils for today's highly miniaturized electronics equipment can easily be laser-welded. Pinpoint areas heated by a carefully directed laser beam for the merest fraction of an instant form a spot weld so precisely controlled that the delicate materials are not damaged (opposite, upper).

For manufacture of jet-engine turbine blades, General Electric is developing a technique of laser-punching clean-cut air holes undistorted by the heat of drilling.

The Western Electric Company uses the laser to pierce holes in tiny diamonds; these become dies through which copper wire can be drawn as thin as a human hair. In the course of a year, Western Electric produces 30,000,000 miles of such gossamer wire for telephone use, wearing out thousands of diamond dies in the process.

Since diamond is the world's hardest substance, perforating the dies has always been a tedious two-day process, using steel pins coated with olive oil and diamond dust.

Today a ruby pulse laser can pierce a hole of the required size in a diamond in a few minutes. Watching the magnified results on

a TV screen, the operator hits the diamond with focused laser bursts, precisely regulated to avoid shattering it (above).

In the laboratory, I have seen a laser instrument called a microprobe that permits quick and easy analysis of any object without damaging it. The test object goes under a microscope through which is focused a laser beam of controlled power. The laser beam vaporizes an infinitesimal amount of material—as little as a millionth of an ounce—leaving an inconspicuous crater.

The vaporized material, heated further by an electric spark, rises in a plume whose light is "read" by a spectrograph. This instrument breaks down the light into a rainbow, or spectrum of its component colors, and photographs it. Lines on this spectrum, like fingerprints, identify the chemical elements in the object being tested.

Microprobe Uncovers a Fake

At the Jarrell-Ash Company in Waltham, Massachusetts, Frederick Brech has developed the microprobe for industrial purposes, including the manufacture of steel, and for medical diagnosis (page 865). In addition he has put it to use as an art detective. Working with William J. Young, scientific curator at

the Museum of Fine Arts in Boston, he has been able to confirm the age, source, and authenticity of rare objects.

While I was visiting Mr. Brech's laboratory, Mr. Young brought in a small portrait of a Flemish woman in a white cap. Supposedly it had been painted by a 16th-century artist known as the Maitre de Bruges. The curator suspected its authenticity, however, because X-rays passed too easily through it; they should have been blocked by lead carbonate used in 16th-century pigments.

We put the painting under the microprobe, "zapped" it with a carefully calculated laser burst (next page), and then looked at the resulting spectrogram.

"There's the answer," said Mr. Young, pointing to a series of dark lines. "Those show the presence of zinc, and painters did not use zinc-based pigment until 1820!"

The "16th-century" portrait was a fake. Another of curator Young's treasures aroused my interest—a beautiful bronze bull cast more than 4,000 years ago in Anatolia (Turkey) by a people who preceded the great Hittite empire. Scholars believe it to be a ritual object, possibly a symbol of the weather god, from a chieftain's grave.

Strips of inlaid copper decorated the sculpture. But under the microprobe and the spectrograph, something besides copper showed up. The bull, unmistakably, had been coated with arsenic.

Why? At first no one knew, although someone suggested murderous intrigue in an Anatolian court about 2100 B.C. Then Mr. Young discovered that the poisonous coating on the bull was actually an arsenic-silver alloy.



Sun-rivalling intensity of a laser pulse can pierce, slice, or join metals, depending on how it is controlled. This laser microwelder at Hughes Aircraft Company, Malibu, California, repairs an expensive but defective electronic tube. It focuses its heat inside the tube to weld two small wires together.

Classroom midgets: Lasers made by Electro-Optical Systems, Inc., a Pasadena, California, subsidiary of Xerox Corporation, weigh 25 pounds and sell for \$560 each.

ILLUSTRATIONS BY ROBERT BOLTONS © R.S.A.





LEONARDOS © NATIONAL GEOGRAPHIC SOCIETY

Biddles of the art world come to light under the laser microprobe. Bronze bull (left), a 4,000-year-old Anatolian ritual object from the Boston Museum of Fine Arts, reveals an unsuspected coating of arsenic. Painting (right), supposedly 16th century Flemish, shows chemical pigments not used until much later. White spots on the painting locate laser blasts; care can keep the tiny craters nearly invisible.

evidence of a very advanced metallurgy for that ancient day.

A variety of medical boons will likely come to mankind from the laser. One of the most promising applications is the laser photocoagulator, now being used by a growing number of eye surgeons to repair torn retinas and prevent blindness (page 873).

Thousands of persons a year in the United States develop holes or torn places in the retina—the membrane of nerve cells lining the back of the eye that detects light and sends visual messages to the brain. If these rents go unattended, the retinal membrane separates from the wall of the eye. Blindness results unless the patient submits to difficult and painful surgery and a weeks-long convalescence flat on his back.

Before the laser photocoagulator, the only means of forestalling a detachment involved much more cumbersome, painful techniques that were in varying degrees severe and that sometimes made things worse.

In Palo Alto, California, Dr. H. Christian Zweng of the Stanford University School of Medicine and the Palo Alto Medical Research Foundation showed me how easily the laser photocoagulator works. His patient, a Stanford physics professor, sat in a chair with his head tilted while Dr. Zweng aimed a small hand-held instrument at the dilated pupil.

With light from a tiny laser in the handle of his instrument, Dr. Zweng flashed a series of very weak pulses directly around the torn edge in the retina. The lens of the patient's eye focused the beams on pinpoint areas, and

they coagulated the tissues at those points, creating miniature scars that "welded" the torn retina back into place. The whole affair was over in 20 minutes.

The patient had not been anesthetized, yet he never flinched. "In fact, I felt practically no pain, just a very slight sting," he told me afterward as he put on dark glasses and climbed into his car to drive himself home.

Dr. Zweng, a pioneer in use of the laser photocoagulator, reports similar operations on more than 130 patients, only two of them unsuccessful.

Dentists, too, have been experimenting with the laser toward future prevention of cavities. When tooth enamel begins to break down and become susceptible to decay, it develops a characteristic dull, chalky look. If such spots are irradiated with the laser, they show a hard, shiny surface again. Dentists have tested extracted laser-treated teeth in corrosive solutions and have discovered that the new surfaces tend to resist decay.

Some Cancers May Yield to Laser Light

For the biologist, an instrument known as the Biolaser can focus a ruby laser beam to a point forty-millionths of an inch in diameter (right). With this delicate tool an experimenter can study the physiology of a single cell by cutting away part of its nucleus. Using primitive living organisms, he can even split off parts of the chromosome that govern heredity, see what differences develop in succeeding generations, and thus advance our understanding of genetics.

In Cincinnati, at the laser laboratories of Children's Hospital and the University of Cincinnati, Dr. Leon Goldman experiments with the laser to burn away tumors and blemishes from the skin, and to do basic research in the reaction of tissue to laser radiation.

One day I watched him perform six operations—four of them on patients with skin cancers of varying severity, one on a girl whose extraordinary beauty was marred by a birthmark, and one on a former sailor whose wife, Susie, did not care for the tattooed name Betty and a nude figure on his left arm.

No one—least of all Dr. Goldman—claims that the laser is the cure-all for cancer. Nevertheless, small growths have disappeared within a few weeks after exposure to laser light. Dr. Goldman checks for months to catch any recurrences. And larger skin cancers, ugly black splotches known as melanomas, have turned to healthy white skin in areas struck by laser beams (following pages).

Piecemeal destruction: Successive blasts by a precisely aimed laser beam shave away the dandelionlike head of a bread-mold spore. Such delicate operations, valuable in genetic and other biological studies, are possible with the Biolaser, made by TRG, a subsidiary of the Control Data Corporation, Melville, New York. The Biolaser can focus on forty-millionths of an inch, chipping away just a small part of a living cell. This spore has been magnified 100 times.



STACKPOLES BY HOWARD STOVVEN © R. L. S.





It may be that, after much more experimentation, the laser will join X-ray and surgery as part of the arsenal against cancer. In the meantime, Dr. Goldman emphasizes, laser treatment is strictly experimental—for cases in which other methods cannot be used.

How does it feel when a laser pulse strikes human flesh?

"It's just like having hot candle wax fall on your skin," one of Dr. Goldman's patients told me. Another likens it to being touched by a hot iron. The discomfort lasts only a

moment or so, and there is no pain afterward.

At Children's Hospital last winter, other laser experimenters, Dr. Thomas E. Brown and Dr. Bruce Henderson, removed a tumor the size of a golf ball from a man's thigh, using the laser as a "light-knife." Their instrument was an especially powerful gas laser containing argon, which fires a continuous beam of brilliant blue-green light (page 861).

The surgeons focused their light-knife on the proper spot with a curved mirror, watching through protective goggles. The hot beam



Lasers in medicine

CANCER VICTIMS may find new relief in versatile laser light. In powerful doses it vaporizes metals, but in limited strengths it can kill malignant tissue, burn away warts or tattoos, and remove birthmarks—with little pain and a minimum of scarring. As a "light-knife," it makes bloodless surgery possible.

Dr. Leon Goldman, far left, director of the pioneering laser laboratories of the Cincinnati Children's Hospital and the University of Cincinnati, irradiates a huge skin cancer known as a melanoma. Such experimental treatment in some cases has caused the disease to recede, although sometimes it will return.

Testing the effects of laser radiation (below), Dr. Goldman removes a warty spot from his arm with one jolt of a pulse laser; he feels only a momentary sting.



EXPERIMENTED BY H. CHRISTIAN ZHENG, M.D., COURTESY OF AMERICAN JOURNAL OF OPTICAL PHYSICS (BELOW); AND HOWARD COOPER (R) N.S.S.



Even the sensitive human eye can take properly controlled laser treatment. Here a split in the layers of the retina at the back of the eye threatens severe loss of vision. A weak laser light, focused through the eye's own lens, coagulates the tissues in a series of tiny scars, fencing off the split to keep it from extending. In this photomicrograph (left), white dots locate the laser's "spot welds," each actually no bigger than a period on this page. Patients feel no discomfort.



Feeling the face of beauty, fast-moving beam from the laser, right, scans its subject sixty times a second, producing a remarkably clear picture on the screen. This TV, developed by Perkin-Elmer Corporation, Norwalk, Connecticut, needs no additional illumination. It may guard warehouses in the dark or photograph night news events.

cut away the malignant growth in 15 minutes. Although many blood vessels were severed, not one bled, because the laser heat cauterized as it cut.

A doctor who heard me speak about laser surgery came up to me afterward and said:

"What you have told us is the dream of my life. Always I have wanted a knife that would seal off bleeding. If I were younger, I would devote my life to the perfection of the laser knife. What wonders the laser may do with the liver, the lungs, the heart, or the brain, where hemorrhage is so dangerous!"

In their early experiments doctors used primitive laser equipment. More recently, greatly improved lasers have been developed and are being delivered to laboratories and hospitals for further experimental work.

Ruby Eye Scans the Heavens

In the Sacramento Mountains near Cloudcroft, New Mexico, a laser keeps a ruby eye peeled for missiles and satellites. Operated by the Air Force Systems Command, this instrument fires a searching laser beam hundreds of times finer (or narrower) than radar, picks up the reflected signals with an optical telescope, and measures the distance to the target.

As with microwave radar, the time each pulsed signal takes to go to the target and return reveals the distance automatically.

At 500 miles, radar can determine the distance within an error of about 100 feet; the laser narrows the error to about 25 feet. Moreover, the laser range finder, which requires a

MOLECULAR BEAM LASER WAS DEVELOPED BY PROF. GEORGE W. STRAUSS, UNIVERSITY OF MICHIGAN, WITH NATIONAL SCIENCE FOUNDATION SUPPORT



Holograms: picture-window photographs

A MAGIC LANTERN, the laser can project remarkable pictures into the air, seemingly out of nowhere. As true to life as scenes through a window, laser pictures—called holograms—show full three-dimensional depth and perspective.

The laboratory view (opposite, lower) shows the making of a hologram of a model of the famous Lincoln statue in Washington, D. C., left. Diffused light from a helium-neon laser bathes the object, scattering to a photographic plate at lower center.



Meanwhile, a beam splitter in front of the laser angles part of its beam to a mirror, upper left, which reflects it, too, to the plate.

The two streams of light, hitting the plate at different angles, capture no ordinary photograph. Instead, they record a virtually invisible pattern of interference fringes where overlapping light waves augment or cancel one another. A girl (above) holds a hologram. Its *visible* pattern represents other interference fringes caused by diffraction by dust particles.

To see the original scene, one looks through the hologram with laser light shining toward it (right). Blurred red lines show upper and lower edges. The three-dimensional picture, in full scale, seems to float in space beyond the plate.

RESEARCHER (LEFT), BY HOWARD SACHS/REX;
RESEARCHING BY BRUCE DALL © N.S.P.



much smaller antenna, is more difficult for an enemy to detect or jam.

The laser's enormous advantage lies in its almost perfectly parallel, or collimated, radiation. When passed through a telescope-in-reverse, the beam diverges as little as a third of an inch in a mile of travel, and thus dissipates its power very slowly.

Four years ago, a ruby laser considerably smaller than those now available shot a series of pulses at the moon, 240,000 miles away. The beams illuminated a spot less than two miles in diameter and were reflected back to earth with enough strength to be measured by ultrasensitive electronic equipment. The beam of a high-quality searchlight, if it reached that far, would spread out to several times the moon's 2,160-mile diameter.

Such fantastic directivity, combined with brightness, gives the laser incalculable value

for a host of jobs in war and peace. For example, here are some of the most important potential uses:

- Finding the range for precision bombing, and—in portable form—battlefield pinpointing of such targets as tanks.
- Illuminating targets for reconnaissance and for artillery fire.
- Guiding the blind with laser-flashlights whose distance-echoes are translated into audible signals of varying pitch.
- Probing the atmosphere to determine its composition.
- Warning pilots of obstacles ahead by picturing them on cockpit TV screens.
- And, if current experiments succeed, clearing up one of aviation's greatest mysteries: Why have jet planes in rare instances crashed in perfect weather?

Aeronautical experts believe the cause may

ILLUSTRATION BY JACK FILLARD © N.G.S.



New standard of straightness: Bee-lines and arrows, once regarded as symbols of directness, curve sharply as compared to this focused laser beam (left), used to align a new electron accelerator at Stanford University, Palo Alto, California.

The sharply defined red beam striking the center of the screen has traveled two miles along the underground tube of the accelerator. When the beam hits squarely on the pattern, electronic instruments tell the physicist, Dr. W. B. Hertmannsfeldt, that the alignment is correct within one- or two-thousandths of an inch.

The accelerator, built with Atomic Energy Commission funds, will be used in basic research on the structure of atomic nuclei.

Highlighting dust motes in a 21-foot-diameter irrigation tunnel near Aztec, New Mexico, a helium-neon laser beam keeps the 280-ton tunneling machine at right boring straight through solid rock.

Groups of photocells (not visible) serve as a target for the laser. Should the tunneler stray, lights on the operator's console tell him what correction to make.

The laser-guided machine drifted less than an inch off course in a mile and a half.

be clear-air turbulence, invisible but raging, that can throw high-speed planes into steep plunges before the pilots know what is happening. If probing laser beams can detect unusual concentrations of ultramicroscopic particles that possibly characterize these turbulent zones, pilots may have warning in time to take evasive action.

Plotting the Straight and Narrow Way

Another group of applications derives from the unequalled straightness of the laser beam ("straight as an arrow" is now obsolete). Increasingly, the laser finds wide use for alignment of bridges, dams, tunnels.

Near Aztec, New Mexico, for example, a 280-ton boring machine recently chewed its way through two miles of sandstone, guided much of the way by a laser beam (below). This beam, shining down the tunnel to photo-

cells on the machine, marked the true course. Any wandering affected the photocells, causing them to signal the necessary corrections to the operator by means of lights on his console.

The resulting 21-foot-wide tunnel, for the Navajo Indian Irrigation Project, deviated only 5/8ths of an inch so long as the laser guided the machinery—a mile and a half. Ordinarily, tunneling machines drift as much as two or three inches in five feet.

For ultraprecision measurement, too, the laser holds rare promise. Complex instruments, known as laser interferometers, detect length changes of as little as one hundred-billionth of an inch. Such instruments have obvious usefulness for extremely accurate surveying or for guiding machine tools.

A new closed-circuit laser, that sends counter-rotating beams of light around a ring, may provide the most sensitive gyroscope yet

ATTACHMENTS BY HUGHES TOOL COMPANY © N.A.S.





Ring laser, two beams traveling in opposite directions around a closed path, acts like a gyroscope, sensing changes in direction.

invented. Although it has no moving parts, it can detect very slight shifts in the movement of a ship, plane, or missile. Stabilizing equipment, guided by information from the laser, brings the vehicle back on course.

Another device, using a gas laser, acts as a sensitive seismometer to measure earth movements. One of the laser mirrors is attached to a large suspended mass. Any earth tremor moves the mass and therefore the mirror, and in so doing slightly changes the wavelength of the laser beam. The amount of wavelength change tells the strength of the tremor.

A series of strain meters—still another device to which the laser has been adapted—is being installed in California's San Andreas Fault to see if it can detect strains in the earth's crust that may presage earthquakes.

Laser Takes Pictures in the Dark

It would be surprising if so marvelous a light as the laser were not useful in photography. A new laser TV camera, for example, takes pictures without visible light; the camera uses a laser scanner, which moves so fast it is invisible (page 874).

But the most exciting photographic development is the hologram, a three-dimensional picture made with two laser beams. One beam illuminates the subject and scatters from it to the photographic plate. A second beam, split off from the first, bounces to the plate from a mirror. When the two beams meet on the plate, they do not take an ordinary picture. Instead, they produce alternating black and white lines known as interference fringes. Their pattern shows up on the developed plate only as a faint gray smudge.

But when a laser beam is passed through

Whirling dervishes of light, two ring lasers—one large, one small—rotate during tests of accuracy at Sperry Gyroscope. Warren Macek, far right,



developer of the device, foresees numerous applications, for navigating not only ships and planes, but also spacecraft. Ring lasers, fantastically sensitive,

need neither bearings nor moving parts. Photographer Blair lifts a hand to trip the shutter of his overhanging camera.

ATTACHED BY JONATHAN H. BLAIR © 1971





Shaft of blue-green light from an argon laser makes a fast but expensive cigarette lighter. Its price: \$50,000. Raytheon Company in Lexington, Massachusetts, produced this 5-watt instrument for experiments at the George C. Marshall Space Flight Center in Huntsville, Alabama. A similar laser, built by Electro-Optical Systems, Inc., lofted a signal to the Gemini 7 astronauts.



ENTOURAGES BY HOWARD SCHNEPP (LEFT) AND JERRELL ASH CO. © A.S.A.

"Zap!"—as every boy knows—is how a ray gun sounds. "Zap" applies as accurately to the sharp crack of a pulse laser. The author found the word, humorously enough, on the control panel of the microprobe (page 865). The laser fires and "Zap" lights up when the knob is turned to lower right.

this developed plate, the original scene, in startling realism, seems to hover some distance from the plate, like Banquo's ghost. It has all its original depth and scale (although in the color of the laser light), just as though it were being viewed through a tinted window (pages 874-5).

Light waves recorded on a hologram are like scrambled eggs, and, as everybody knows, you can't unscramble eggs. Yet that's what we do with a hologram.

Will holograms revolutionize TV and the movies? I would say that this development, if it does come, is many years away. Long before that, the hologram will have found more practical use in photomicrography, with which one may more easily see and analyze extremely small objects.

As long ago as 1880, Alexander Graham Bell experimented with light as a medium of communication. He proved that it would work—that speech could be transmitted by

modulating, or modifying, a light beam (page 862). But radio waves and electric wires turned out to be more efficient carriers.

Eventually the laser may change all this with the development of electro-optical crystals that act as modulators, or shutters. A beam of red light vibrates nearly 500 trillion times every second, a billion times as fast as ordinary radio waves. Thus it has enormous potential for modulation to carry messages. One laser beam, in theory, could carry all the radio, TV, and telephone messages of the world simultaneously. In just a fraction of a second, one laser beam could transmit all the text of the Encyclopaedia Britannica.

Weather Hinders Beam Transmission

The imagination boggles at all this—but the Bell Telephone System does not. Dozens of researchers at Bell Labs seek to improve lasers and develop their communications possibilities. One major hurdle: rain, snow, smog, and

dust all interfere with the output of most lasers. The answer—perhaps decades away—may be light-carrying pipes to replace today's coaxial cables and microwave relays.

In space and underwater communications, lasers promise earlier use. Light can move unhampered in space, carrying messages from one spacecraft to another, or to earth. Mariner 4, using radio telemetry, sent pictures of Mars to earth on July 14, 1965, at the rate of $8\frac{1}{2}$ "bits" of information a second. So weak was this radio transmission, because of the vast distance, that each picture took more than eight hours to form. Laser light could do the job a million times faster.

Argon Laser Lights Ocean Depths

Submarines are already testing the potent blue-green light of argon lasers, which may pierce as much as 2,000 feet of stygian ocean water to illuminate sea bottoms or to send messages up to satellites for rebroadcast to land or to other submarines.

The lost submarine *Thresher* and the lost

hydrogen bomb off Palomares, Spain, might have come to light much sooner under the glare of the argon laser, had it been available.

At this point, to speak of a laser eraser may sound faintly ridiculous. Yet Dr. Schawlow (below) is patenting such a device. Its very weak beam literally burns away the black, heat-absorbing pigment of a typed character without even scorching the white heat-reflecting paper beneath.

Will it sell? Dr. Schawlow just laughs, but he adds: "Don't forget—there must be five million typewriters manned by five million secretaries who can't spell!"

All of which prompted the *Electronics Weekly* of London to say:

"With all the talk about death rays, it's nice to know that the Americans have decided the laser can be used to erase typing errors. It gives a less frightening meaning to the verb, 'to rub out.'"

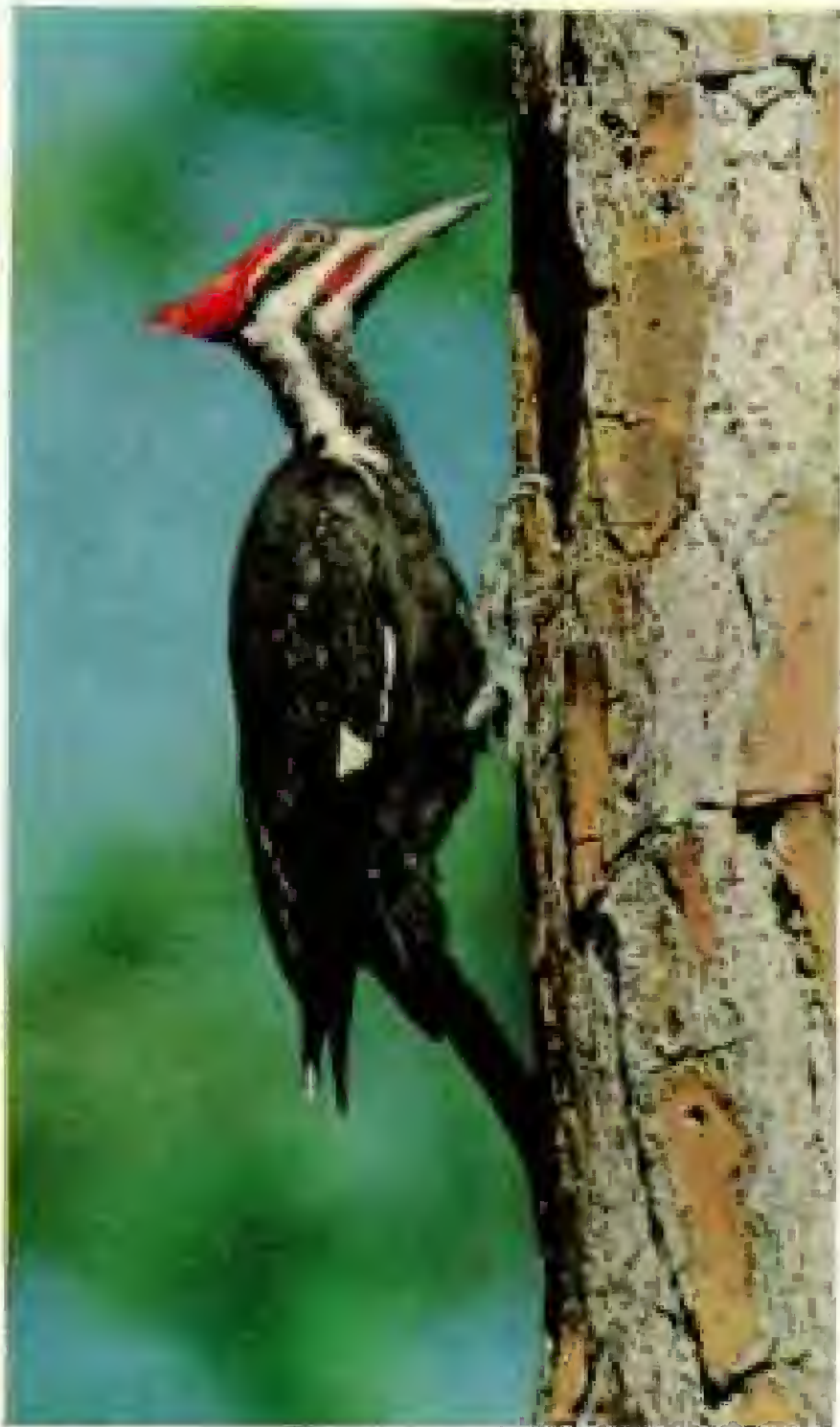
From death ray to eraser—that's a long jump. But if anything can make it, the laser, with its infinite magic, will. THE END

Martian ray guns in the comic strips look and act much like this "toy" laser built by Dr. Arthur L. Schawlow, a pioneer in laser research. For a classroom demonstration, Dr. Schawlow fires the beam through two balloons, a blue one inside a clear one. Transparent rubber allows the beam to pass through, but the darker balloon, absorbing the light and heat, explodes. Dr. Schawlow heads the physics department at Stanford University.



When Disaster

A NATURE DRAMA



WOODPECKERS AND TREES BY G. A. S.

Before the tree broke: Male pileated woodpecker comes to the nesting hole to relieve his mate on the eggs.

ONE SLEEPY Florida afternoon last April, I was sitting in a hot canvas blind on top of a 12-foot tower in Everglades National Park photographing a pair of pileated woodpeckers, when suddenly I found myself in a front-row seat at a true-life drama of nature. I saw a bird react to disaster in a way ornithologists would not have predicted—and indeed might not have believed without the proof of these pictures.

For ten days I had been recording the comings and goings of these big, spectacular woodpeckers—each about a foot and a half long and topped with the red cap, or pileus, that gives them their odd name. The pileated measures only two or three inches less than its fabulous cousin the ivory-billed woodpecker, now so close to extinction that none has been publicly reported in recent

years. To see a pileated woodpecker is enough to make anyone rub his eyes—a long-necked bird as big as a crow suddenly materializing, perpendicular, on the side of a tree.

For a nest, this pair had chosen a dead slash pine about thirty feet high. Eighteen feet from the ground they had pecked out a nice oval entrance and hollowed a pocket inside—not wisely but too well, it proved. Now the two were taking turns on the eggs.

Papa pileated (left), with his larger red cap and red “mustache,” had given way to Mamma at 2:40 p.m., and all was well in their woodpecker world—or so it seemed.

Then all of a sudden, 16 minutes later, that world came crashing down around Mamma's ears. I had turned from the camera for a moment when a splintering of wood, rending of bark, and shuddering crash of a heavy trunk shattered the silence of the piny woods. Peering out, I saw that the whole top of the tree had broken off at the nesting hole, despite a complete absence of wind. Later I found that the woodpeckers had so hollowed out the 8½-inch trunk that the walls at the nest measured only



After: Female peers as if unable to believe that the top of her nest tree has vanished.



Then she backs down to her eggs...

Struck a Woodpecker's Home

PHOTOGRAPHED AND TOLD BY FREDERICK KENT TRUSLOW

a fourth to three-fourths of an inch thick.

Now I saw Mamma—and what a sight! On the trunk of a pine a few feet from me she was alternately fluttering in extreme agitation and slowly pecking and preening as if trying to calm herself.

After six minutes of this, she flew to what was left of the nesting hole, then down to the trunk on the ground, hopping its length and pecking slowly.

Back at her roofless nest (lower left), Mamma descended tailfirst into the cavity (center) and amazed me by emerging with an egg in her bill. She held it first crosswise (below). Then, supporting the egg against her breast, she turned it so that the small end pointed forward (right).



And out she pops with an egg in her bill, to my utter astonishment. In half a century of observing birds, I had never seen one carry its eggs in its beak and could hardly believe my eyes.

Now she has turned the egg from crosswise to lengthwise.



PHOTOGRAPHS BY FREDERICK KENT FROELICH © N.S.A.

Vaulting over the edge of her topleless nest, the mother takes off with her egg. In turn she carried all three to an unknown destination. I have since learned that in Oklahoma Dr. and Mrs. Frederick M. Baumgartner, professional ornithologists, once saw a yellow-shafted flicker fly off with eggs after the breaking of a branch in a windstorm uncovered the nest. John James Audubon 130 years ago reported that if the eggs of the chuck-will's-widow were disturbed the birds would carry them off in their mouths, but repeated attempts to confirm the story have failed and ornithologists today consider it discredited. So far as we can ascertain, these photographs present the first visual proof of such behavior by any bird.

Then she flew off with the egg in her beak. Within two minutes she returned, backed down into the nest, immediately reappeared with a second egg in her bill—small end out—and flew off in the same direction, west. In another minute and a half she was back and did exactly the same with the third egg.

Each time I could see her plainly for 75 yards before the pines hid her, and I am sure she did not drop the eggs in that distance. All had been carried away by 3:12 p.m.—just 16 minutes from the time the tree broke.

It was 4:25 when Papa came home. As you might expect, he seemed highly agitated, not

to say incredulous—pecking the stub, backing down to the nest, drumming loudly on the trunk, and at last uttering the pileated's rapid, high-pitched alarm call. His mate did not answer, but after 10 minutes he flew off south and I saw them together on a high branch.

Had she taken the eggs to one of their roosting holes? I hoped so, for such devotion should have been rewarded. But my friends and I searched for the eggs in vain, and four days after the accident we saw proof they had been abandoned: The pair was hammering out a new nesting hole, this time in a newly installed utility pole of unquestionable soundness.

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Oh. About your wife. You'll square it with her when you start taking all these pictures of the kids.

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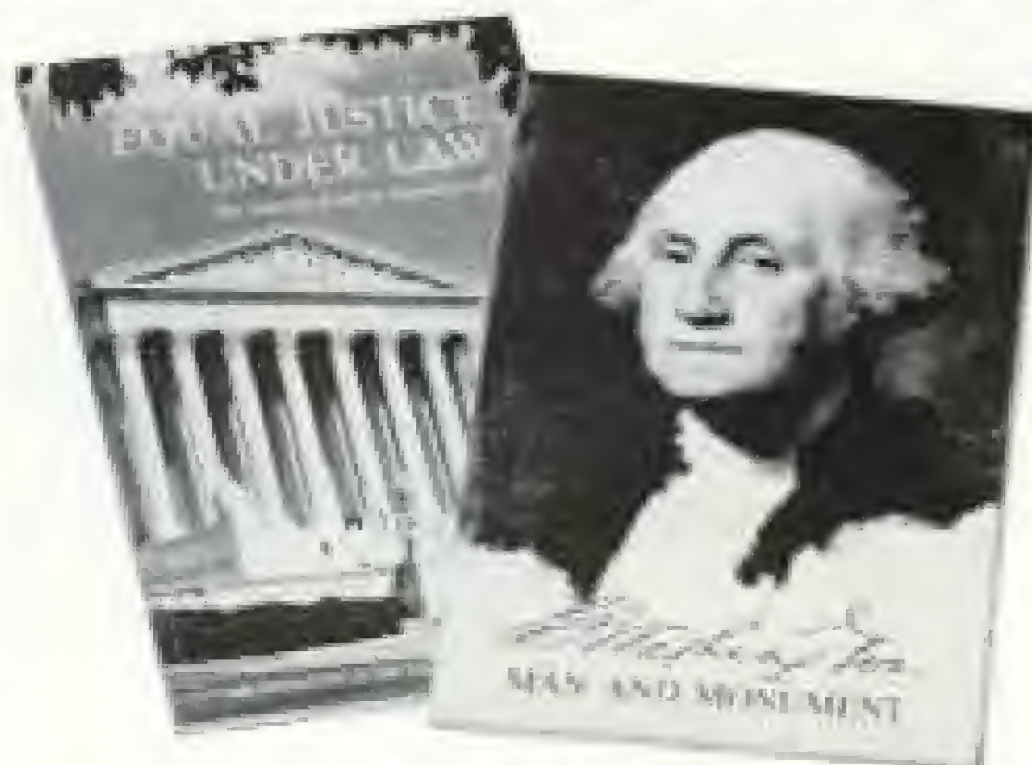
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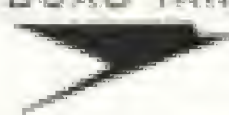
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OWNER AND PUBLISHER: National Geographic Society
EDITOR AND MANAGING EDITOR: MORTON DILLI
HEADQUARTERS IN PUBLISHER AND PUBLICATION:
1145 Seventeenth Street, N.W., Washington, D. C. 20036
STOCKHOLDERS: NONE; BONDHOLDERS: NONE; OTHER
SECURITY HOLDERS: None

Average no. copies each issue during preceding 12 mos. Single issue nearest to filing date

A. TOTAL COPIES PRINTED (Net Press Run)	July '85-June '86	May 1986
	4,021,220	3,983,500
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