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BUNK. The pointed comment scrawled in the margin of a page proof was that of a university professor whom we had asked to review the article on aluminum that appears in this issue. He obviously disagreed with a statement quoted by author Tom Canby, that aluminum is "friendly to food." The insides of aluminum cans, the professor noted, are coated with lacquer. True enough, for technical reasons. But as cans, cookware, or foil wrapping, the metal is—as we note—"so chemically stable it doesn't react with most foods."

The professor was one of no fewer than 80 experts and organizations our Research Division consulted, in addition to 120 printed sources, to verify what Tom had written after six months and some 16,000 miles covering this major international industry.

I know of no other publication that researches what appears in print more thoroughly than does the GEOGRAPHIC. Our writers are among the best in journalism, and they gather the most complete documentation—but there is always the chance that what they have been told, or heard, or read, is not exact. Or is downright wrong, for one reason or another.

Each manuscript is subjected to a long process of checking facts and verifying information. Like the mills of God, this process grinds exceedingly small. When, for example, Tom came across the dramatic fact that a spiderweb-thin aluminum wire stretching around the world would weigh only a pound and a half, researcher Lesley Rogers took the matter up with Alcoa and the U. S. Bureau of Mines, which in turn consulted a spider expert at the Smithsonian Institution.

Alas, spiders are dreadfully untypical in the webs they weave. However, all experts concluded that a wire .002 inch in diameter, which seems a reasonably spidery sort of dimension, would, when belting the planet, weigh 484 pounds—still remarkable!

The process also grinds exceedingly large. One reviewer thought we should take note that "If it weren't for the huge government subsidies in the form of hydropower dams, we would not have such 'necessities' as aluminum beer cans today." Canby added the contention.

Each article kicks up its own dust of strong pros and heated cons. We look ahead to what our researchers will meet in checking forthcoming articles on Syria today, "talking" gorillas, and natural gas.

Silbert Browner

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August 1978

Startling New Look at Dinosaurs 152

They ruled the earth for 140 million years, then disappeared. Were some of them warm-blooded? Did some evolve into birds? Paleontologist John H. Ostrom discusses new ideas about those "terrible lizards," brought back to life by artist Roy Andersen.

The Magic of Aluminum 186

Earth's most plentiful and versatile metal also takes prodigious energy to produce. Thomas Y. Canby and James L. Amos report on a phenomenon of the industrial age.

Georgia, Unlimited 212

Still rich in peaches, pecans, and peanuts, a forward-looking state is shouldering its way to industrial prosperity as well. Alice J. Hall and Bill Weems find little left of its poor-South past.

New Zealand's High Country 246

Yva Momatiuk and John Eastcott tramp the Southern Alps, where ranchers endure the trials and enjoy the rewards of a rugged, lonely way of life.

Spitsbergen, Norway's Arctic Hot Spot 267

Strategic location, a wealth of coal—and possibly oil—focus attention on a top-of-the-world archipelago named Svalbard—Land With Frozen Shores. Gordon Young and Martin Rogers visit islands once too unimportant for any nation to claim.

Mountain Goats— Guardians of the Heights 284

Wildlife biologist Douglas H. Chadwick records the precarious life of regal, surefooted masters of shrinking mountain fastnesses.

COVER: *With a lethal battery of teeth, a six-ton Tyrannosaurus dispatches a duck-billed dinosaur, Anatosaurus. Painting by Roy Andersen.*

STARTLING FINDS PROMPT...

A NEW LOOK AT DINOSAURS

By JOHN H. OSTROM, Ph.D.

CURATOR OF VERTEBRATE PALEONTOLOGY
PEABODY MUSEUM OF NATURAL HISTORY, YALE UNIVERSITY

Paintings by ROY ANDERSEN

WHAT KIND OF ANIMALS were the dinosaurs? What ever happened to them? Up until the last decade, many paleontologists would have answered with confidence: Dinosaurs were huge, slow-moving, cold-blooded reptiles of the past. After some 140 million years as lords of the earth, they died out—from no obvious cause—about 65 million years ago, leaving no descendants.

Today, some paleontologists offer radically different views: Dinosaurs were active, perhaps even warm-blooded animals, comparable to modern mammals and birds. Furthermore, they did not completely die out; some left their lineal descendants in today's birds.

My own involvement with these novel ideas began on a Montana hillside in 1964. Mine were the first human eyes to see those fragments of fossil bone. Their weathered condition told me that they had lain exposed there, unrecognized, for years—perhaps for centuries. But I knew at once that they were unique, and that this was the most important discovery our expedition had made all summer.

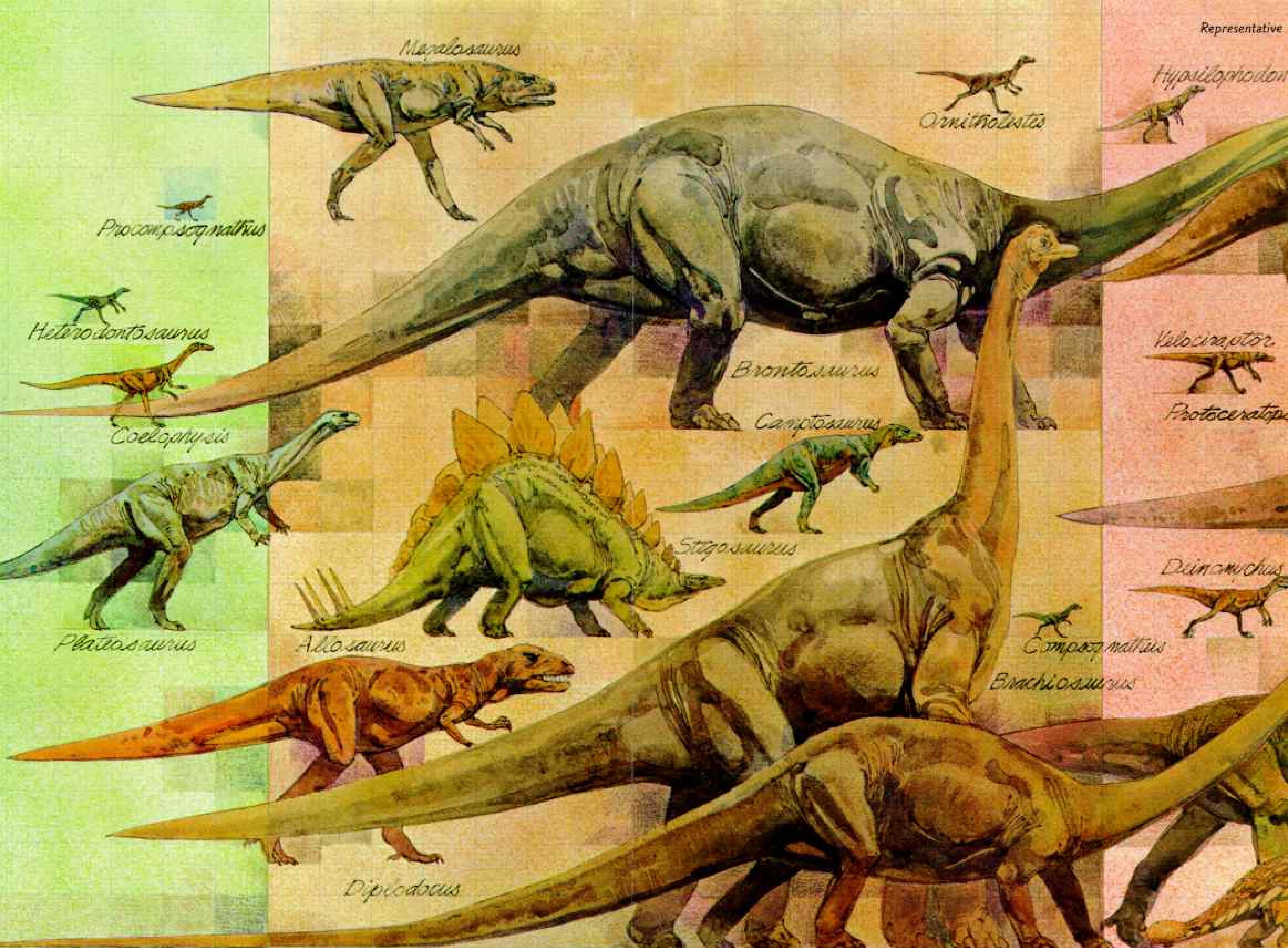
That afternoon my assistant Grant Meyer and I, feeling like the discoverers of lost treasure, gently brushed away the soil and clay from around the fragile fossils. Gradually we uncovered several finger bones, somewhat larger than

Phantoms from a lost world, skeletons at Toronto's Royal Ontario Museum (right) evoke the grace and power of earth's rulers for 140 million years. A parade of dinosaurs (following pages) suggests their immense diversity in size, anatomy, and adaptation. The author's studies conclude that some dinosaurs were likely warm-blooded, and that one group gave rise to their only living descendants—birds.

SAM ABELL







Representative

Megalosaurus

Ornithomimus

Hypsilophodon

Procompsognathus

Heterodontosaurus

Brontosaurus

Velociraptor

Coelophysis

Camptosaurus

Protoceratops

Platasaurus

Stegosaurus

Allosaurus

Deinonychus

Compsognathus

Brachiosaurus

Diplodocus

◀ 225 MILLION YEARS AGO
TRIASSIC

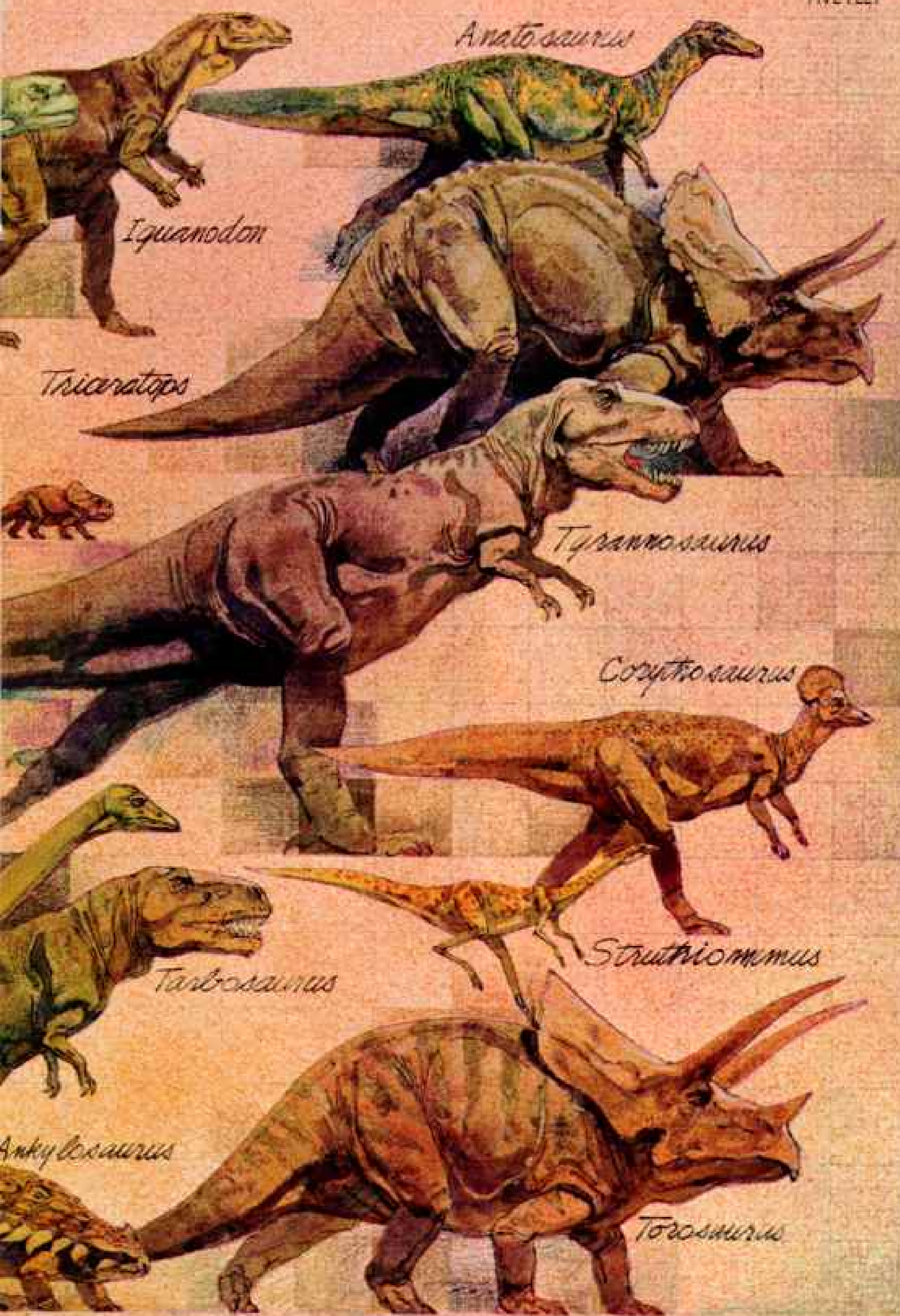
◀ 195 MILLION YEARS AGO

JURASSIC

◀ 136 MILLION YEARS

sample of dinosaur reconstructions based on fossil evidence and drawn to scale. Placements in time are approximate.

FIVE FEET



Anatosaurus

Iguanodon

Triceratops

Tyrannosaurus

Corythosaurus

Struthiomimus

Tarbosaurus

Ankylosaurus

Torosaurus

AGO

65 MILLION YEARS AGO ▶

CRETACEOUS

my own, then a couple of large, sharp claws. Finally the other bones of a powerful, three-fingered, grasping hand came to light. Close by, we unearthed the perfectly preserved bones of a foot.

Here, in a remote pocket of badlands not far from the city of Billings, we had uncovered a small, totally new kind of dinosaur more than a hundred million years old. And the creature's fossilized remains offered astounding clues to its life and habits. One such clue prompted the scientific name I later gave this peculiar beast: *Deinonychus*, which means "terrible claw."

Patient Study Reveals New Genus

Indirectly this claw was important in my later speculations on warm-bloodedness in dinosaurs. But that came after years of work on the more than a thousand bones of at least three *Deinonychus* skeletons recovered from our Montana excavations during the next two summers.

For three years after that, in my laboratories at Yale University's Peabody Museum of Natural History, these fossilized bones were painstakingly removed from the enclosing rock matrix. Only then was I able to compare them with other dinosaurian kinds, and, literally, put the skeletons back together. A most remarkable animal grew out of these reconstructions.

Deinonychus's sharp, serrated teeth revealed that it had been a carnivore, and its skeletal structure indicated it belonged to the suborder of dinosaurs known as the Theropoda (meaning "beast foot"). Included among the theropods is perhaps the best known of all dinosaurs—the giant, fearsome *Tyrannosaurus* ("tyrant lizard"), which also stalked its prey across Montana, but some

O MINOUS MOUND in Montana proved to be a killer's 200-foot-high crypt when the author found the first remains of a swift, carnivorous biped. One lethal claw on each hind foot suggested the name *Deinonychus*—"terrible claw." Here was evidence of a dinosaur (following pages) very unlike the stereotyped picture of the slow-moving, cold-blooded reptiles. If anything, it was more like an oversize roadrunner. JOHN H. OSTRUM







FLESHED OUT at four feet tall and 150 pounds, *Deinonychus* was perfectly equipped to be a warm-blooded predator: powerful hind limbs for running down the quarry, good vision for coordination, hands articulated for grasping, pivoting hind talons for slashing, and a tail with long tendons for dynamic balance during the attack.

Probably hunting in packs, *Deinonychus* could take on large animals, as the foot of one victim demonstrates (below).

JOHN H. OSTRUM

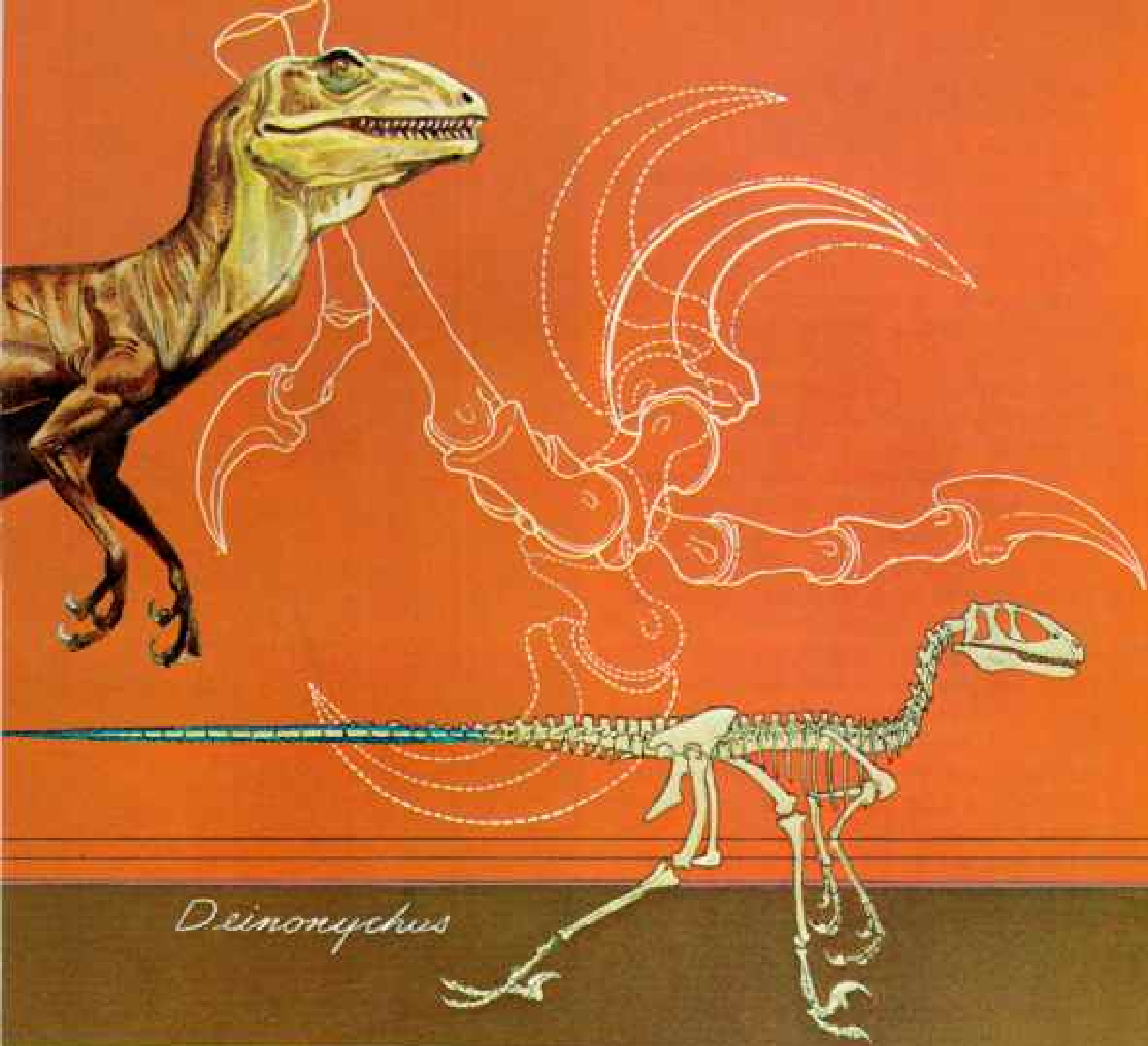


fifty million years after *Deinonychus*.

Compared to *Tyrannosaurus*, *Deinonychus* was a lightweight: 150 to 175 pounds, eight or nine feet from snout to tail tip, and standing only four to five feet high. Like all other theropods, *Deinonychus* stood, walked, and ran on its hind legs like a large bird. The forelimbs and hands were so constructed that they could not possibly have been used for walking. To assist in this two-legged stance, *Deinonychus* had a relatively long tail, with a feature that had never been seen before: The entire length of the tail was reinforced by peculiar rodlike tendons, which we found in an ossified state. These must have made the tail an extremely effective balancing appendage—with control much like that of a cat's or a squirrel's.

But the striking feature of *Deinonychus*

National Geographic, August 1978



—and the reason for its name—was on its feet. All previously known theropods had birdlike feet, but *Deinonychus* also had a huge, sicklelike bone more than three inches long on one toe of each foot. In life, sharp, curved, nail-like sheaths covered these claw bones and must have been four or five inches long. Obviously they served as weapons—most probably to kill prey. When not in use these claws were carried in a retracted position, so as not to be damaged.

Ideally Suited to Catch and Slash

Since *Deinonychus* was bipedal and could not walk, or even stand, on all four legs, it must have been extremely agile to employ its foot talons against an enemy or victim—perhaps jumping from one foot to the other, while kicking out at its prey or

attacker with its free foot. That slashing attack required highly accurate foot-eye coordination and a keen sense of balance. Such agility and speed are not what we usually visualize in cold-blooded reptiles. The image is more that of the large flightless birds like the ostrich, or of predatory runners like the secretary bird of Africa or the roadrunner of the American West.

The arms and hands of *Deinonychus* were another surprise. The long hands bore three powerful fingers with large sharp claws designed for grasping. The wrist joints enabled the hands to turn toward each other, permitting precise grasping of prey by both hands working together—something only man and certain other mammals can do. *Deinonychus* almost certainly was a swift-footed predator that ran down its prey,

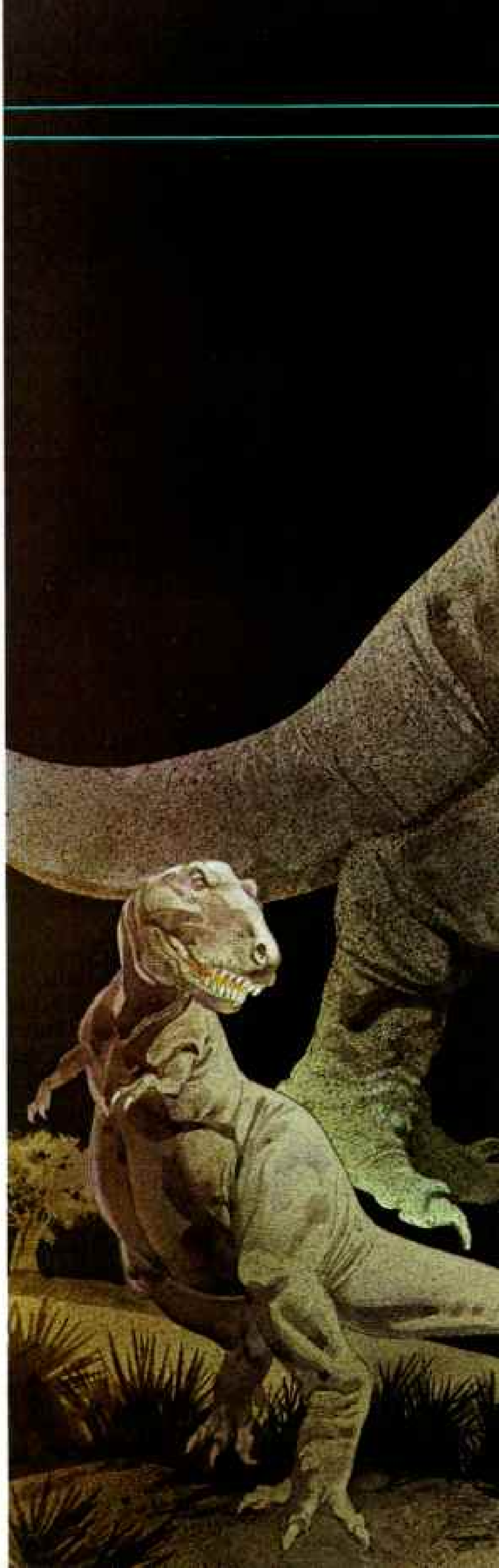
seized it in its powerful hands, and then slashed at the belly and flanks of its victim with those razor-sharp talons.

Together with the several specimens of *Deinonychus*, we found a few parts of a single herbivorous dinosaur, *Tenontosaurus*. Since *Tenontosaurus*, the presumed prey animal, was six times larger than its attackers, weighing 800 to 1,000 pounds, I concluded that *Deinonychus* probably hunted in packs. The much larger size of the prey animal also explains the dead predators at the site—victims of the struggle.

We normally associate pack hunting with warm-blooded animals, but, in addition to *Deinonychus*, some other dinosaurs appear to have moved in packs. At Connecticut's Dinosaur State Park, thousands of dinosaur footprints have been uncovered. Some of them are parallel, suggesting herd movement. Another site, in Holyoke, Massachusetts, preserves the trackways of 28 bipedal dinosaurs, 19 of which led in a near-parallel westerly direction—clear evidence of group behavior. A third site, in Texas, records the passage of a herd of brontosaurlike animals, huge herbivores. First recognized by Roland Bird of the American Museum of Natural History as evidence of herding behavior, those trackways have been interpreted by Dr. Robert Bakker of Johns Hopkins University as resulting from a "structured" herd, with the young in the center surrounded and protected by the adults.

So there is persuasive evidence for the idea of *Deinonychus* as a pack hunter. But I was especially gratified to find my hypothesized killing techniques—those slashing kicks of the foot talons at the belly of its victims—confirmed by colleagues halfway

THE "KING" of carnivorous dinosaurs (and villain of many a monster movie) was fifty feet and six tons of bad news for the ponderous herbivores of its time. No speedster like *Deinonychus* 50 million years earlier, *Tyrannosaurus* may have patiently stalked its prey as fossilized trackways suggest. It might only warily try to employ its sixty teeth, set in a four-foot skull, against the powerful, three-horned *Triceratops*, whose defenses were formidable. Like all predators, *Tyrannosaurus* preferred easy prey.



Tyrannosaurus



round the world. A team of paleontologists led by Dr. Zofia Kielan-Jaworowska of the Institute of Paleobiology in Warsaw, Poland, made an incredible discovery in Mongolia's Gobi Desert in 1971. Her expedition, jointly sponsored by the Polish and Mongolian Academies of Sciences, uncovered the skeletons of two dinosaurs tangled together. One was the fairly well-known *Protoceratops*, a calf-size plant eater with a turtlelike beak. The other was a rare, two-legged, near-man-size carnivore—*Velociraptor* ("swift robber").

These two animals had apparently killed each other, and their skeletons had been buried and preserved exactly as they died. *Velociraptor*, like *Deinonychus*, had a large sicklelike talon on each hind foot, and it died with one of those foot claws embedded in the belly of *Protoceratops*—an amazing life-and-death drama from 80 million years ago!

Birds May Be Direct Descendants

This image of *Deinonychus* and *Velociraptor* as agile, pursuing, leaping predators, running down their prey and slashing it to death, is quite different from the sit-and-wait hunting strategy that we associate with most cold-blooded modern reptiles. It seems more like that of the stalk-chase-and-attack technique used by predatory birds adapted to running and by many mammalian carnivores. It suggests that, like these modern hunters, at least some of the predatory dinosaurs might have been warm-blooded and have had high metabolic rates.

Other small theropods earlier than *Deinonychus* and *Velociraptor* feature in another fascinating aspect of the dinosaur story. I am convinced that modern birds are their direct living descendants. So, in a sense, not *all* dinosaurs became extinct, as we were taught in school.

Among the most important of all fossil specimens are those of *Archaeopteryx*, the oldest known bird, which lived 140 million years ago. Only five specimens are known, but they constitute excellent examples of a transitional form between two kinds of animals. Concrete evidence of evolutionary change, they are a missing link (no longer missing) between reptiles and birds.

Impressions of feathers, "wings," and a long, feathered tail are seen in the limestone

surrounding the skeletons. But the skeletons are reptilian, not avian, and the jaws are full of teeth, tiny but sharp. The skeleton is extraordinarily similar to that of some small carnivorous dinosaurs, like *Deinonychus*, *Velociraptor*, and *Ornitholestes*. Its feathers establish that it was a bird, but its skeleton shows me it had not evolved very far from its dinosaurian ancestors.

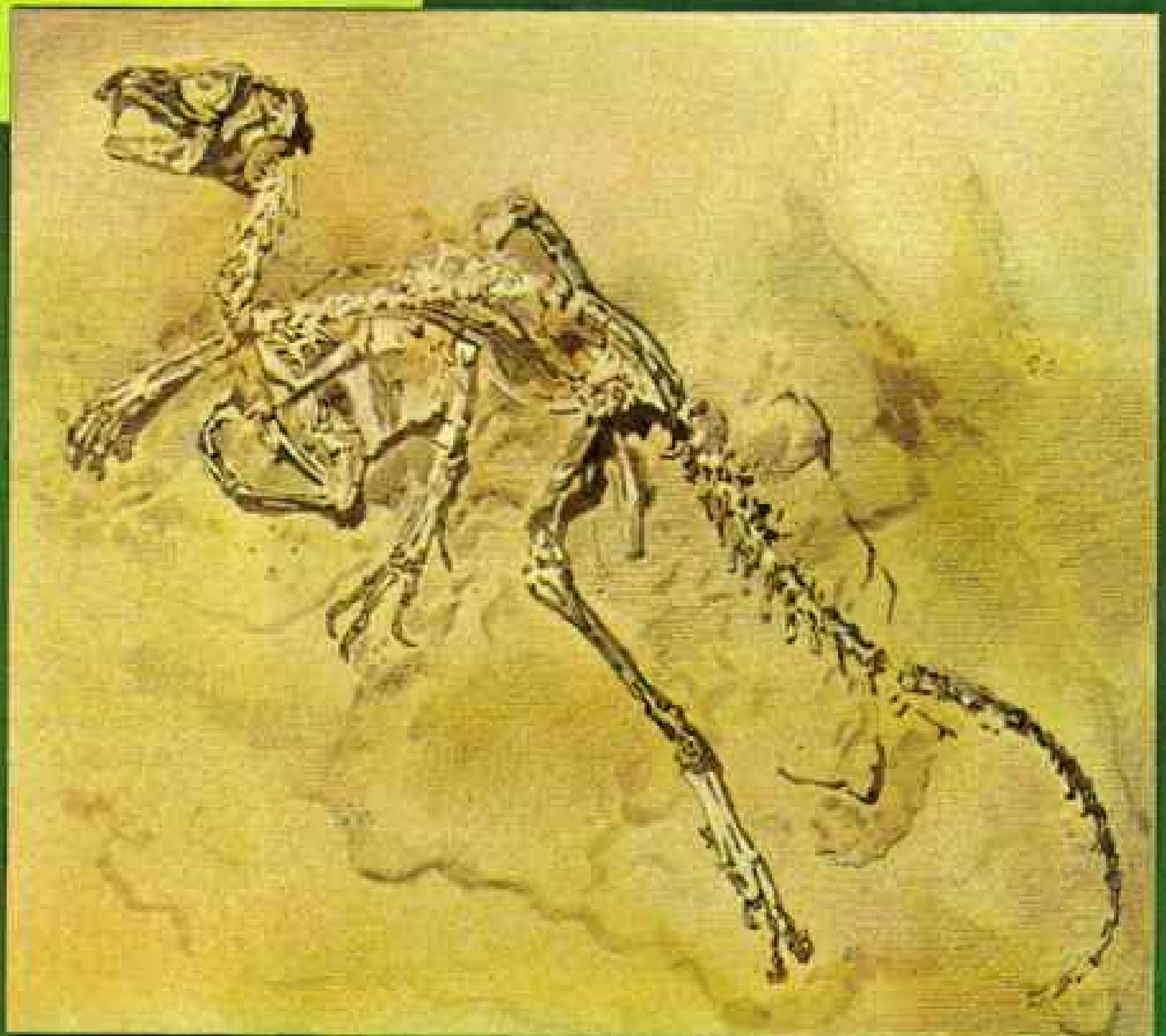
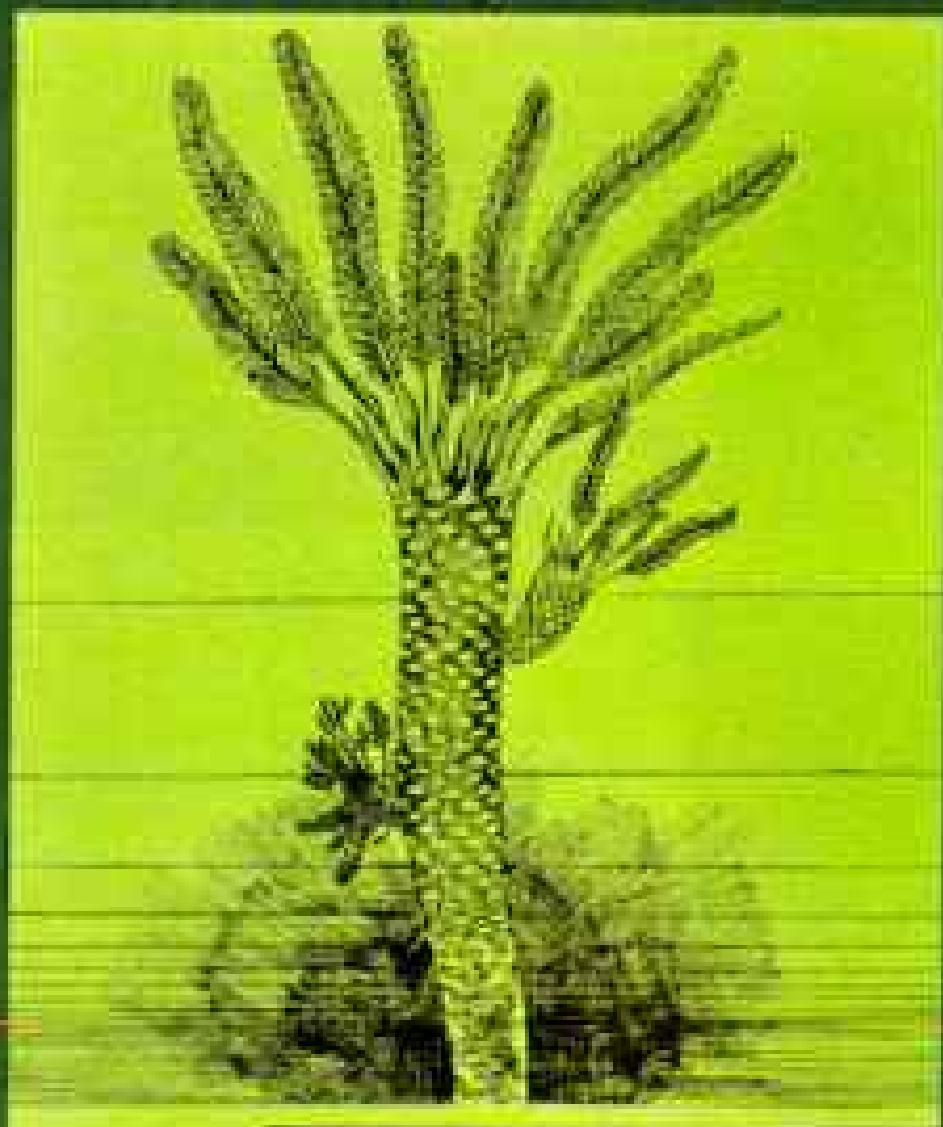
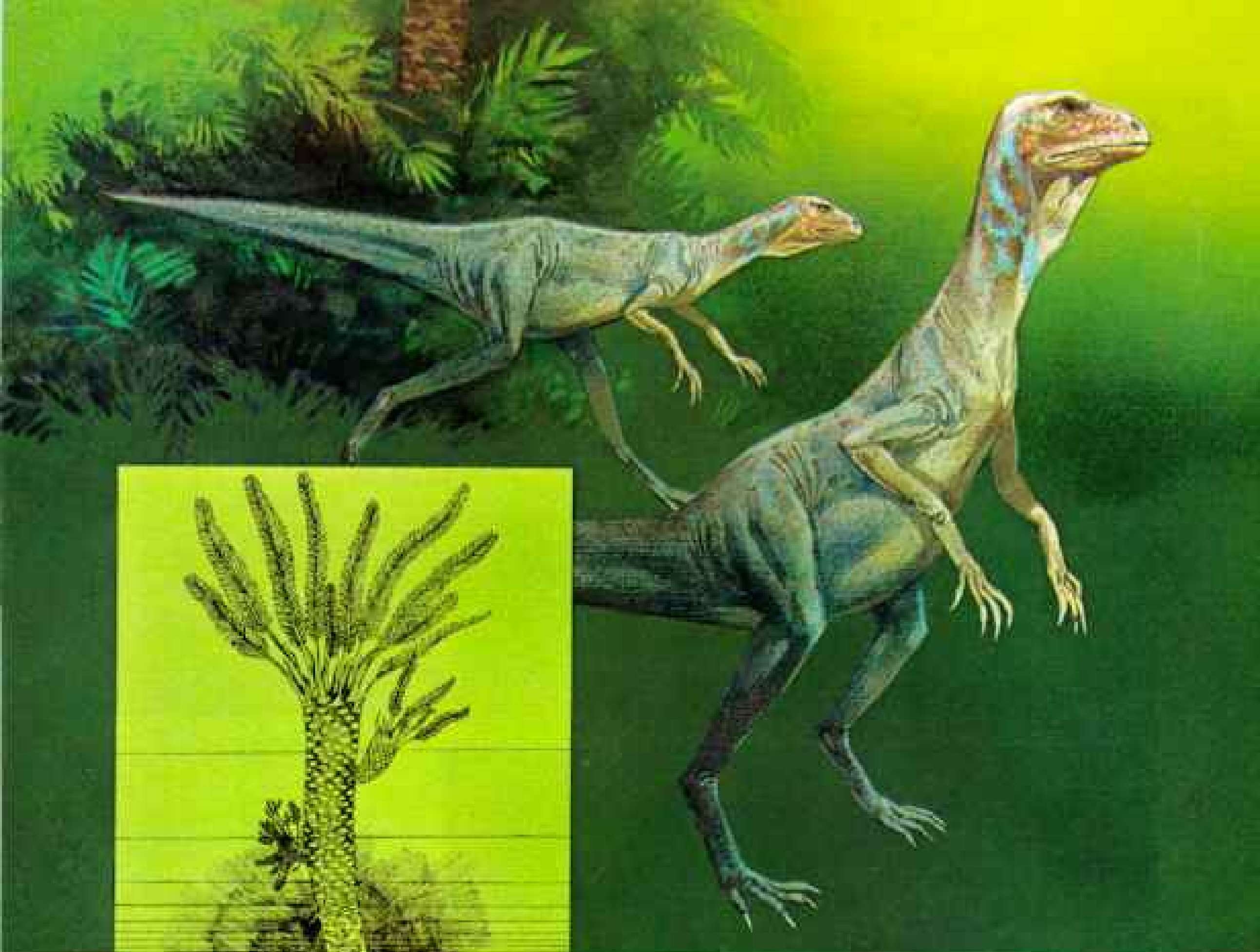
Modern birds, of course, are warm-blooded and very active creatures. I wonder whether *Archaeopteryx* might not have been also. And doesn't this evolutionary linkage between birds and theropods suggest that at least the theropod dinosaurs might have been warm-blooded too?

The idea that birds might be related to dinosaurs is not entirely new. The celebrated English biologist Thomas Henry Huxley suggested it more than a century ago. He noted the similarities between the tiny dinosaur *Compsognathus* ("elegant jaw") and the first specimen of *Archaeopteryx*, both of which were reported from Bavarian limestone deposits in 1861. Huxley's theory fell into disfavor, but I believe the evidence for a theropod dinosaurian origin of birds, by way of *Archaeopteryx*, is overwhelming.

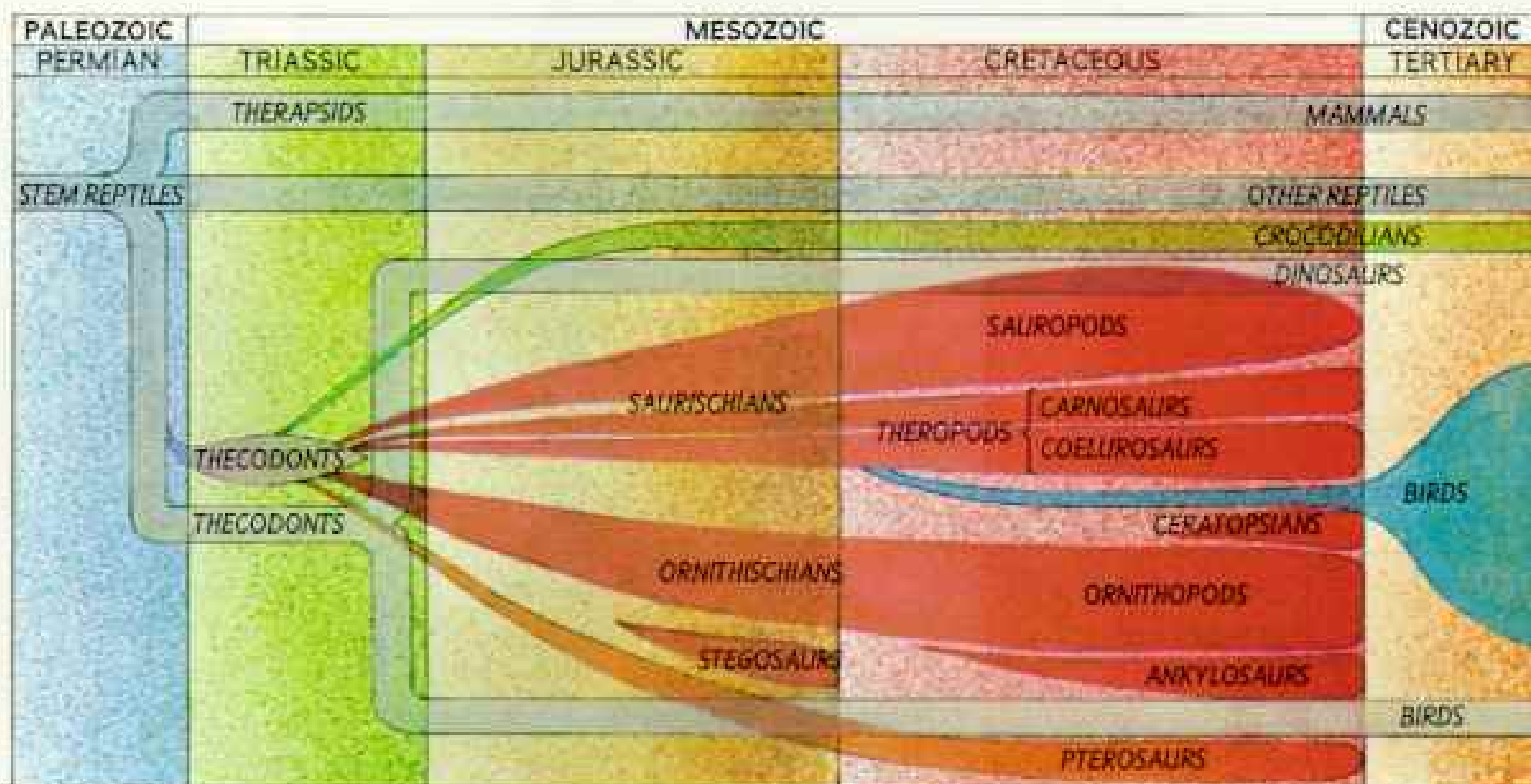
I am, however, intrigued by some new evidence that might modify the role of *Archaeopteryx* as a single missing link. My friend Dr. James Jensen of Brigham Young University in Utah, in part with a grant from the National Geographic Society, has been making important discoveries high up on

A CHAMPION TURKEY would match in size the curious *Heterodontosaurus*, an early dinosaur of about 200 million years ago. Unlike most herbivores that had only one sort of teeth, it had three kinds. Front teeth were adapted to biting or nipping, followed by a pair of canines, used in mammals for tearing, and rear teeth for chewing—a mammal-like system for efficient processing of large amounts of food.

This, plus small size and light build for rapid bipedal locomotion, seems to point toward endothermy—warm-bloodedness based on high metabolism and internal heat regulation—although the evidence is not as compelling as for the larger and later *Deinonychus*.



Heterodontosaurus



BOTH BY DAVID CLIFF

TRADITIONAL WAY of classifying the descent of dinosaurs and birds is shown by gray bars in the diagram (above). Each evolved independently from a group called thecodonts, themselves an offshoot of predecessor reptiles. The author believes new evidence (colored shapes) has fixed birds as descendants of theropods, two-legged carnivorous dinosaurs, one of a number of dinosaurian heirs of thecodonts. Unchanged is the descent of mammals from reptiles through the intermediate forms called therapsids.

Such rethinking is based on the slow accumulation of fossil remains. The author (middle, left) studies a bone found by colleague Dr. James Jensen and compares it (left, below) to a modern bird bone. Firm identification awaits further finds and analysis.

the Uncompahgre Plateau in western Colorado's Dry Mesa quarry. This may be one of the most important fossil sites of the late Jurassic Period to be found in North America in the past half century.

Discovered in 1971, the site not only revealed the gigantic bones of what may be the largest dinosaur known, but also very tiny, matchstick-size bones, which Jim thought might relate to my theory of bird origin. He showed me one of these tiny fragments, and I was surprised to recognize it as part of the wing of a flying reptile, a pterosaur, rare in this part of the world.

Last summer the Dry Mesa quarry produced more than a dozen bones of pterosaurs, plus a fragment from a primitive mammal, and one that might be from a bird. I visited Jim at the quarry to have a look at his find and was impressed with its birdlike form: a hollow bone about two inches long that appeared to be part of a thighbone. Although almost as ancient as *Archaeopteryx*, this fragment seemed in some ways to be more birdlike than the same part in *Archaeopteryx*.

Jim and I debated the creature's identity: bird? pterosaur? mammal? dinosaur? If it could be shown to be a bird, it would be extremely important, because *Archaeopteryx* is the only known Jurassic bird. If this proved to be a bird as old, or nearly as old, as *Archaeopteryx* and more evolved, it could be a challenge to *Archaeopteryx*'s unique role in bird origin.

But all we had was a fragment. Birdlike as it appeared, it could not be certified. Jim and his crew are determined to excavate "grain by grain" to uncover conclusive evidence of a Jurassic bird in North America. So far we have been disappointed, but treasure hunters don't stop hoping for a lucky find. Recently another small birdlike bone has come to light, but its identity has not yet been established.

Answers Still Elude Scientists

Many intriguing questions about dinosaurs remain. Why were the dinosaurs so unlike any other animals living now or in the past? How did they live? Why were so many of them so large—some unbelievably huge? Did they simply never stop growing? How long did it take for them to grow so large?

How could such creatures move about? How could they have eaten enough to keep them going? We don't know.

And finally, the greatest mystery of all: The vast array of dinosaurian kinds all became extinct apparently quite suddenly, about 65 million years ago. After dominating the earth for 140 million years, they disappeared. Why? What could have killed off so many different kinds of well-adapted and highly successful creatures?

"Terrible Lizards" Found in England

The earliest recorded dinosaur find, some large fossilized teeth and a few bones, was made in 1822 by an English doctor, Gideon Mantell, and his wife in Sussex, England. They named the creature *Iguanodon* ("iguana tooth"). In 1824, another Englishman, the Reverend William Buckland, published a description of a fossil jawbone with blade-like teeth found near Oxford. He named the beast *Megalosaurus* ("great lizard").

These fossils were recognized as the remains of large reptiles—far larger than any living reptile—but not until 1842 were such creatures called dinosaurs. The anatomist Sir Richard Owen coined the term Dinosauria ("terrible lizards") for these and other large fossil reptiles that were unearthed in southern England.

Occasional dinosaur remains were found elsewhere in Europe and in North America too, but the big push to discover dinosaurs did not begin until the late 1870's. Then a series of finds of gigantic fossil bones occurred at several places in Wyoming Territory and Colorado, precipitating a great rush among rival paleontologists.

The sedimentary rocks in which most dinosaurs have been found are chiefly lowland deposits. Few upland deposits are known, and thus little evidence exists that would shed light on what kinds of dinosaurs may have roamed across the high plateaus and mountain foothills. (My own finds in Montana, as well as those in Colorado, were in shales and other deposits that once formed lowland areas but subsequently were elevated by geologic forces.)

The lowland dinosaur environs appear to have been similar to America's low coastal plain that borders the Gulf of Mexico—heavily forested and inundated by wide

From dinosaur to bird: the missing link

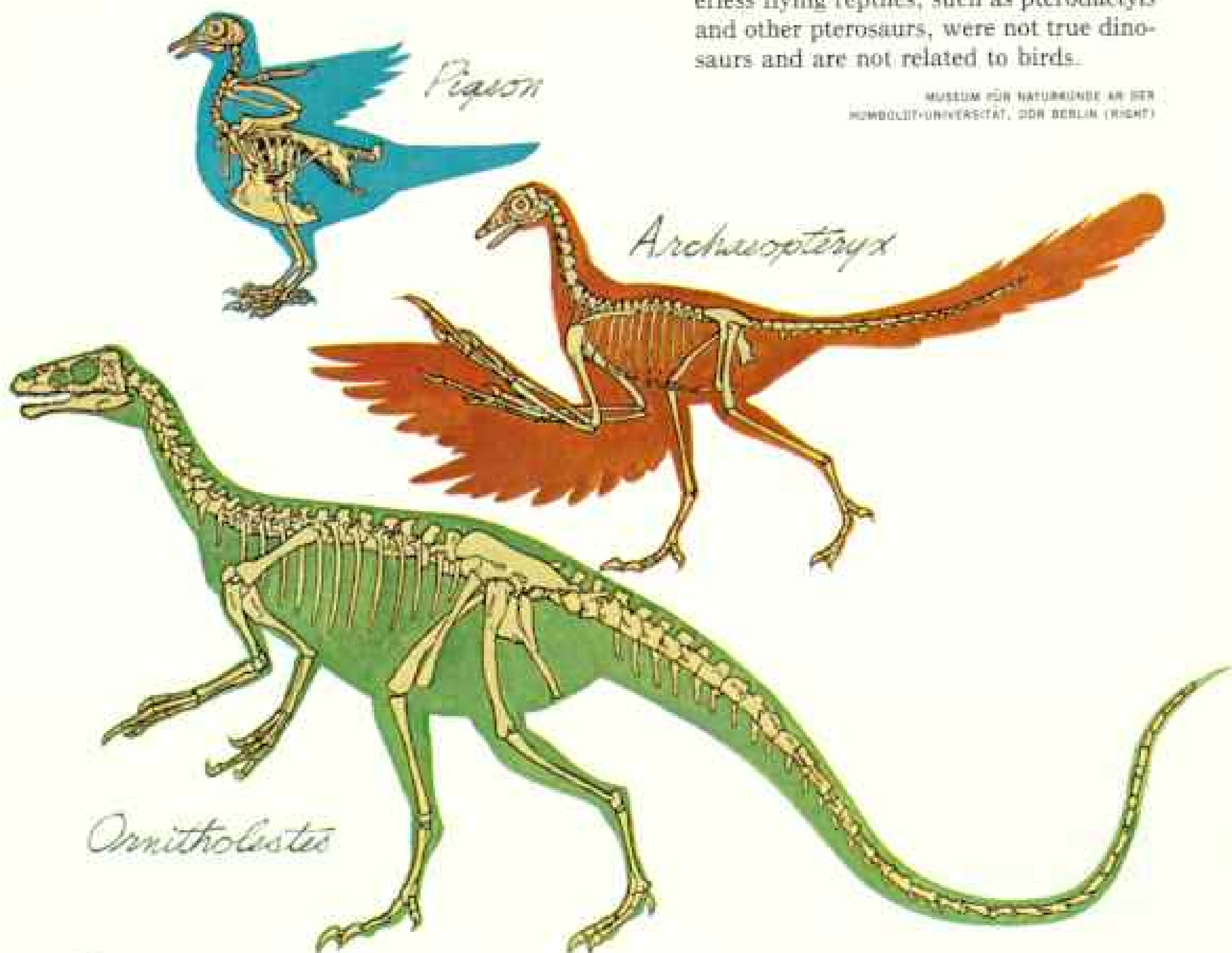
EVER SINCE ITS DISCOVERY in the 19th century, the fossil that looked like a small dinosaur with wings (facing page) has provoked debate. Was *Archaeopteryx* the first bird or a feathered dinosaur? Did it evolve parallel to dinosaurs from some earlier stock, or from dinosaurs themselves? The author's extensive anatomical studies demonstrate its skeleton to be dinosaurian—almost.

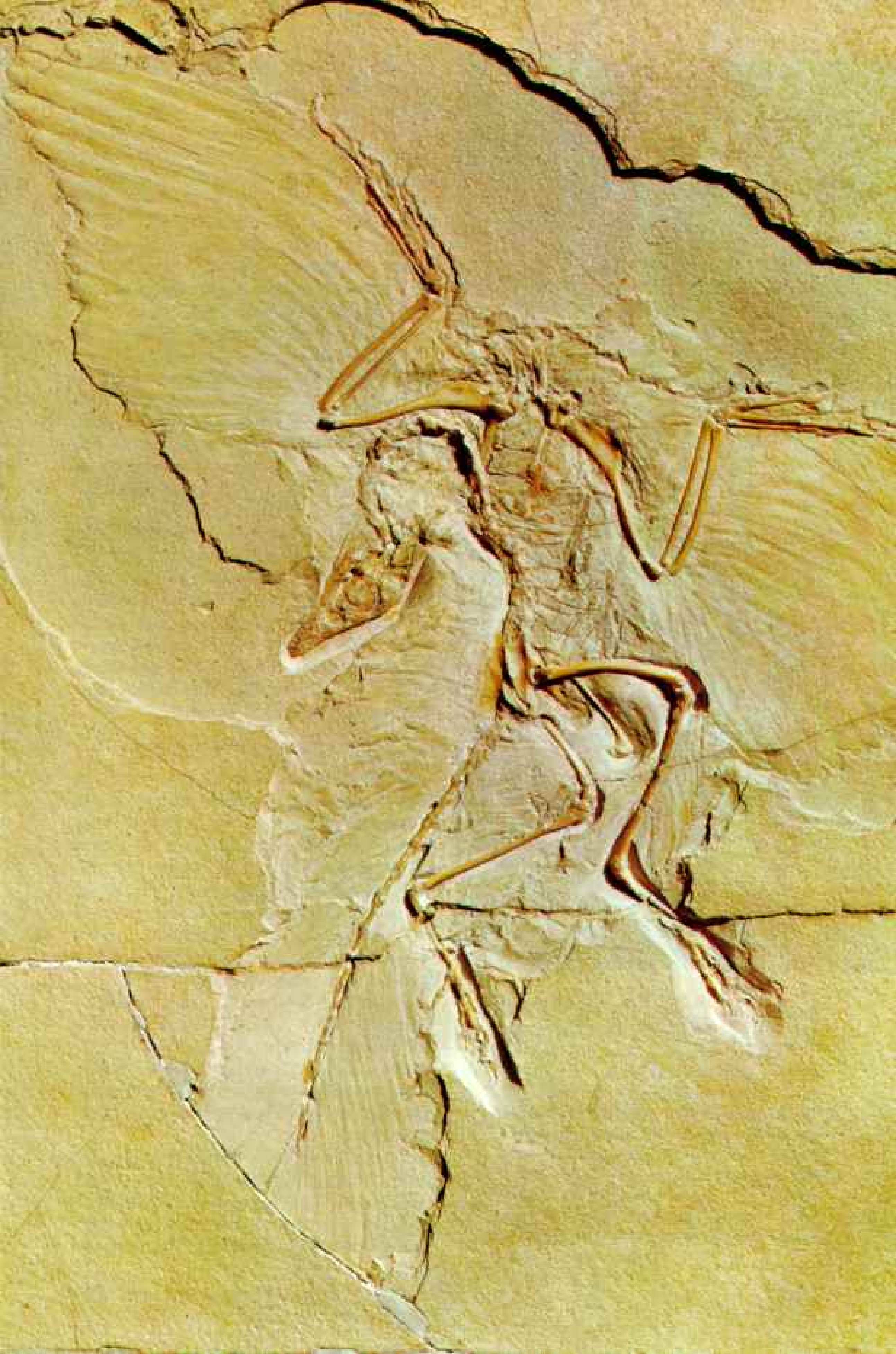
When compared to the skeleton of *Ornitholestes* (bottom), a small theropod dinosaur, that of *Archaeopteryx* (below, middle) was essentially similar. But besides having longer forelimbs, it had two features critical to classification as a bird: a

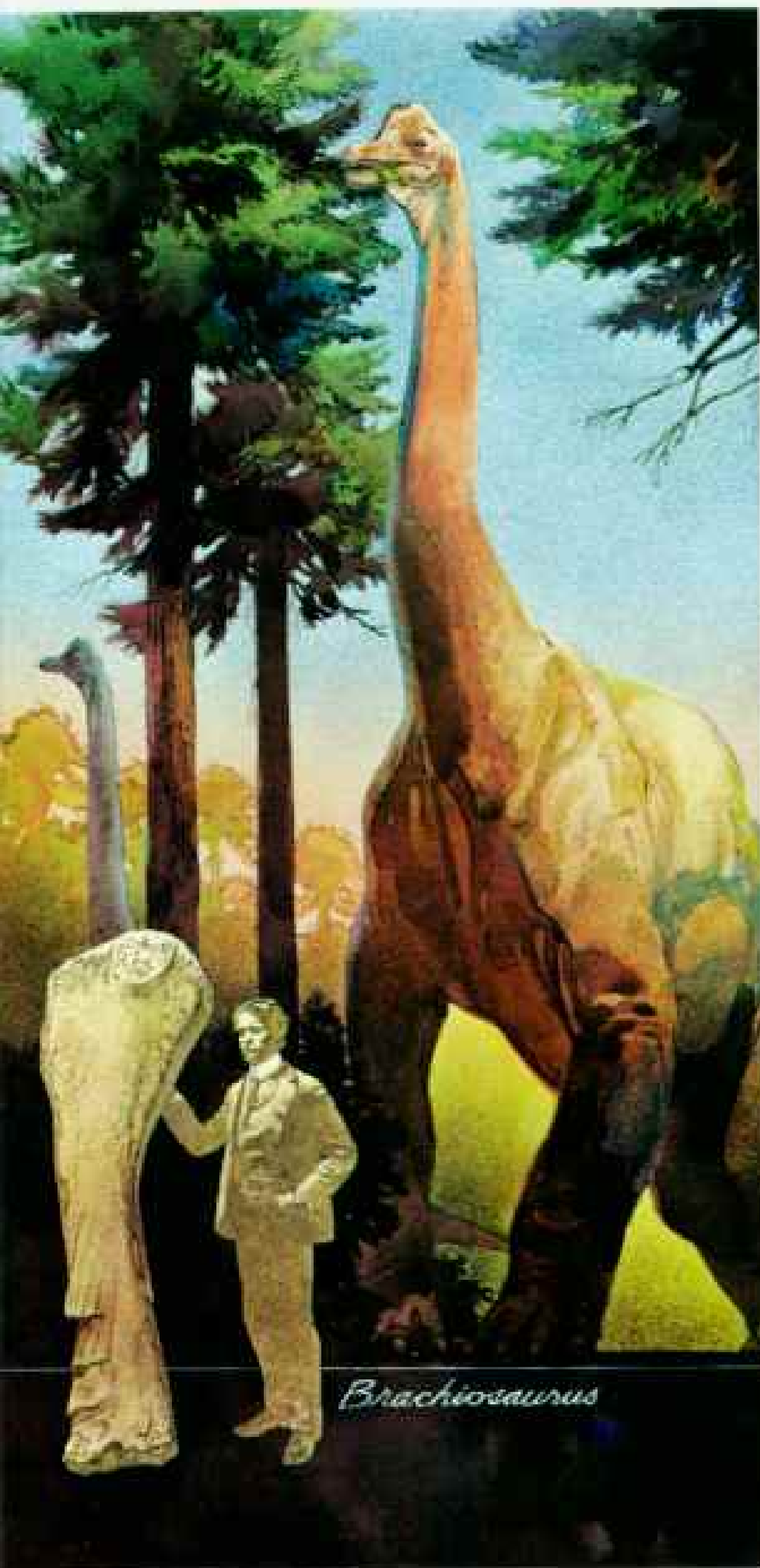
wishbone and, of course, feathers. The skeletal differences were subtle, and in one case, an *Archaeopteryx* was mistakenly identified as a dinosaur for twenty years before the error was realized.

Because the differences are so small, parallel evolution seems unlikely. The feathered form, just barely a bird, must have evolved from a dinosaurian ancestor, the author feels. Feathers were not for powered flight, since the skeleton lacks the large breastbone and other flight-muscle anchors of the modern pigeon (below, left). They were in part for insulation. Only warm-blooded animals have insulation. Thus *Archaeopteryx* supports two theories: warm-bloodedness in dinosaurs and dinosaurian ancestry of birds. Featherless flying reptiles, such as pterodactyls and other pterosaurs, were not true dinosaurs and are not related to birds.

MUSEUM FÜR NATURKUNDE AN DER
HUMBOLDT-UNIVERSITÄT, DDR BERLIN (RIGHT)







EIGHTY TONS OF APPETITE browsing at forty feet, *Brachiosaurus* munched through forests. Nostrils atop its head suggest a snorkel, but its lungs could not have functioned under the pressure of 20 feet of water. Painted beside the upper bone of a forelimb, H. W. Menke of Chicago's Field Museum of Natural History helped uncover the first specimen in 1900, an era when paleontologists were scouring the American West in a great competitive bone rush.

marshes, bayous, and rivers. The forests were made up largely of conifers, cycads, and ferns during the dinosaur reign in Jurassic and early Cretaceous times (200 to 100 million years ago). Gradually the flora changed to include subtropical hardwoods, such as magnolia, dogwood, and oak, toward the end of the Cretaceous Period. All things considered, the climate of regions where dinosaur remains have been discovered appears to have been tropical to subtropical, and only mildly seasonal.

Viewed in terms of today's geography, the dinosaurs seem to have ranged almost from Pole to Pole. They have been found in abundance in regions of all continents except Antarctica. Dinosaur remains have been found as far south as southern Argentina (latitude 48°S.), and their footprints occur on the island of Spitsbergen, well inside the Arctic Circle at close to latitude 80°N.

Do not presume, however, that dinosaurs ranged into high Arctic regions. The continents occupy very different positions now. Because of a phenomenon known as seafloor spreading, earth's landmasses have moved about over the surface of the globe throughout geologic time. In the age of dinosaurs, what is now Spitsbergen was farther from the North Pole than it is today.

Different Sizes, Different Shapes

When I found *Deinonychus* in 1964, many people expressed their surprise to me: "Haven't all prehistoric animals been found?" Far from it. Since then, dozens of other new kinds of dinosaurs have been discovered in widely separated parts of the world—Mongolia, Brazil, China, Argentina, South Africa, India, Rhodesia, Australia, France, Canada, and several western states of the United States.

The variety of dinosaurs discovered in little more than a century is staggering. Big and little, carnivores and herbivores, lumbering quadrupeds and fleet-footed bipeds, they obviously were diverse in their habits and habitats, some perhaps warm-blooded, others not.

There is no end to spectacular finds. Another Polish-Mongolian expedition to the Gobi Desert, in 1965, uncovered the shoulders, arms, hands, and rib fragments of a gigantic carnivorous dinosaur. The arms and

hands measured almost eight feet long! The hands alone were more than two feet long, which is why the creature was named *Deinocheirus* ("terrible hand"). The huge hands appear to have been designed for grasping and tearing apart what must have been very large victims.

The bones of *Deinocheirus* are very similar to those of a North American dinosaur, *Struthiomimus* ("ostrich mimic"), except that they are more than three times larger. The arms and hands of *Struthiomimus* are only two and a half feet long (pages 174-5). If *Deinocheirus* was of the same general design as *Struthiomimus*, the missing parts of its skeleton must have been gigantic. It must have stood 25 feet tall and was perhaps 45 feet long. That is about the size of *Tyrannosaurus*, which, until *Deinocheirus* came along, was the biggest land carnivore of all time: 18 feet tall, 50 feet long, six tons. But we cannot know *Deinocheirus's* size for certain until other parts of its skeleton are discovered. In the meantime, we do have an entire skeleton for *Tyrannosaurus*, and a six-ton biped seems astonishing enough.

When Supersaurus Ruled the Earth

An even more astonishing find than *Tyrannosaurus* or *Deinocheirus* has come out of Jim Jensen's excavations at Dry Mesa quarry. Jim has uncovered bones of what may be the largest dinosaur ever found. As with *Deinocheirus*, only a few bones of this creature have been dug out so far—but these include a pair of shoulder blades eight feet long as well as neck vertebrae nearly five feet long. These measurements are 20 percent larger than in any previous find. The bones are from a huge, herbivorous animal that may have towered to 50 feet and weighed perhaps a hundred tons—if its anatomical design resembled that of *Brachiosaurus* or other more completely known relatives (pages 176-7).

The team in Jim's Dry Mesa quarry was quick to call this animal by the unofficial name of "Supersaurus." It may have been as much as one-fifth larger than anything else known among the dinosaurs.

Imagine, if you can, an animal larger than the famed *Brachiosaurus* from East Africa. Its skeleton, at Humboldt University in East Berlin, stands about 40 feet high. A live

Brachiosaurus may have weighed 70 or 80 tons. How could Supersaurus, weighing perhaps a hundred tons, have sustained itself? One hundred tons is approximately fifteen times the weight of an adult African bull elephant—an animal that consumes 300 to 600 pounds of fodder every 24 hours and spends up to 18 hours a day feeding. Are we to believe that Supersaurus consumed as much as 15 elephants? It seems totally out of the question.

Warm-bloodedness Theory Hits Snag

This Supersaurus-elephant comparison draws us to the very center of the controversy over whether dinosaurs were warm-blooded like today's mammals and birds. The traditional view is that they were cold-blooded, like all living reptiles. If Supersaurus was warm-blooded like the elephant, and comparably active, it would have required a preposterous daily food consumption. This is a critical stumbling block to the warm-blooded-dinosaur theory, at least for the largest kinds.

Warm-blooded birds and mammals can maintain a high and uniform body temperature even when environmental temperatures are lower (or higher). They do this by generating heat internally or shedding excess heat through such means as perspiration or panting. Such internal temperature regulation is termed endothermy. Endothermic animals, like the elephant, have high metabolic rates and are usually capable of long periods of sustained activity as compared with modern reptiles. But these qualities require much fuel: An elephant consumes approximately its own weight in food each month.

Reptiles, such as crocodiles, lizards, and snakes, are cold-blooded—that is, their body temperatures are not internally generated but approximate the environmental temperatures. They are called ectotherms because they are dependent on external heat—the sun. They control their temperature by moving in and out of the shade.

Compared with mammals and birds, most living reptiles have low metabolic rates and are capable of only short bursts of high activity. But they can go for long periods without food. A large snake may eat only two or three times its own weight over an



EVERYBODY'S EXCAVATION on the Utah-Colorado border is the heart of Dinosaur National Monument. From an elevated gallery, visitors can watch as technicians chip away at rock to reveal a veritable zoo of fossilized bones dating from the Jurassic Period. One of the rare finds: the skeleton of an infant *Stegosaurus* without back fins.

What is now stone was once a bend in an ancient river where the flotsam of dinosaur bones piled up to be covered by sand. Those layers preserved the shapes of the bones while minerals exactly replaced the dissolving matter.

The monument lies along extensive exposures known as the Morrison formation, a mother lode for paleontological studies for more than a century.

entire year. The moral: More work (either in generating higher body temperatures or in greater exercise) requires more fuel.

Supersaurus appears a more plausible creature viewed as a typical ectothermic reptile rather than as an endotherm like the elephant. As an ectotherm, Supersaurus would have consumed perhaps 500 to 1,000 pounds a day, rather than the 5,000 pounds it would have required as an endotherm. But this is still much more than an African elephant consumes. It just does not seem possible that these huge brontosaurlike animals, with their small mouths and tiny teeth, could have eaten enough to operate as endotherms.

Nevertheless, the idea that at least some dinosaurs, though classified as reptiles, may have been warm-blooded and capable of



DAVID HISEN

a high and sustained activity level will not go away. More than a century ago Huxley and Owen—the eminent British scientists—hinted at this when they compared the first dinosaur finds with mammals and birds, rather than just with reptiles. Today the warm-blooded-dinosaur theory is the centerpiece of one school of thought, which sees it as *the* explanation of the 140-million-year success story of the dinosaurs.

Erect Posture Points to Endothermy

Several lines of evidence suggest that some dinosaurs might have been more like mammals or birds than like today's reptiles. Most dinosaurs walked with the legs held in near-vertical positions. This same erect posture is found today in mammals and birds—all of which are endothermic and capable of

prolonged activity. I have a strong suspicion that this erect posture may be related to high metabolic rates and therefore to endothermy.

By contrast, most living ectothermic land vertebrates are sprawlers; they stand and move about with the legs held out to the side in a push-up posture. Their walk is a side-to-side waddling. Although crocodiles and alligators can assume a somewhat higher, semierect pose and gait, modern reptiles and amphibians, with only a few exceptions, are not capable of fully erect posture. It hardly seems a chance correlation that ectotherms are sprawlers, while erect animals are endotherms.

Critics of this reasoning claim that the erect posture of dinosaurs is a requisite of their large size, the most effective means of

supporting great weight. But small dinosaurs like *Deinonychus*, *Compsognathus*, and many others had erect posture, while certain other large non-dinosaurian reptiles, such as the dicynodonts, exhibited the primitive sprawling stance.

Some dinosaurs, again like *Deinonychus* and also the ostrichlike struthiomimids, were clearly designed for speed. The bipedal posture of all theropods and some other dinosaurs, by analogy with birds, suggests high activity and perhaps endothermy.

Bob Bakker of Johns Hopkins finds support for his theory that all dinosaurs were warm-blooded in the relative abundance of dinosaurian prey to dinosaurian predators. A given population of prey animals can support far fewer warm-blooded predators than cold-blooded ones. He determined that lions and cheetahs consume their weight in food every seven to ten days, while a large lizard like the Komodo dragon consumes its weight in food only every 60 days.

Bakker tallied the flesh-eating dinosaurs against the herbivorous dinosaurs in late Cretaceous rock strata and found the ratio of predators to prey very low, comparable to modern mammalian predator-prey ratios. He concluded this was strong evidence of dinosaurian endothermy.

Of course, his conclusion rests on the critical assumption that the specimens collected from these strata accurately reflect the abundance of the many different kinds of dinosaurs that coexisted then. That is a very large and completely untestable assumption. But an even more serious flaw in this

WHAT RAN like an ostrich, looked like an ostrich, and maybe even lived like an ostrich? *Struthiomimus*, the "ostrich mimic" of about 80 million years ago. Although probably carnivorous, this dinosaur had no teeth, leading to speculation that it may have eaten, among other things, the eggs of fellow dinosaurs.

As with some obvious features, its pelvis is not birdlike. Paradoxically, dinosaurs without birdlike hips gave rise to birds, while those with such hips did not. However, when *Struthiomimus* roamed, birds had already become established as a divergent group.



Struthiomimus



line of evidence for dinosaurian endothermy is that it applies only to the predators; the herbivorous dinosaurs could all have been cold-blooded.

Dr. Armand de Ricqlès of the University of Paris has explored the warm-blooded theory from another tack. He has found that the bone tissue of various dinosaurs is similar to that of many living mammals but quite unlike the bone tissue of most modern reptiles. The correlation is not absolute, though, and may not be related to warm-bloodedness or endothermy.

Body Heat Linked to Climate?

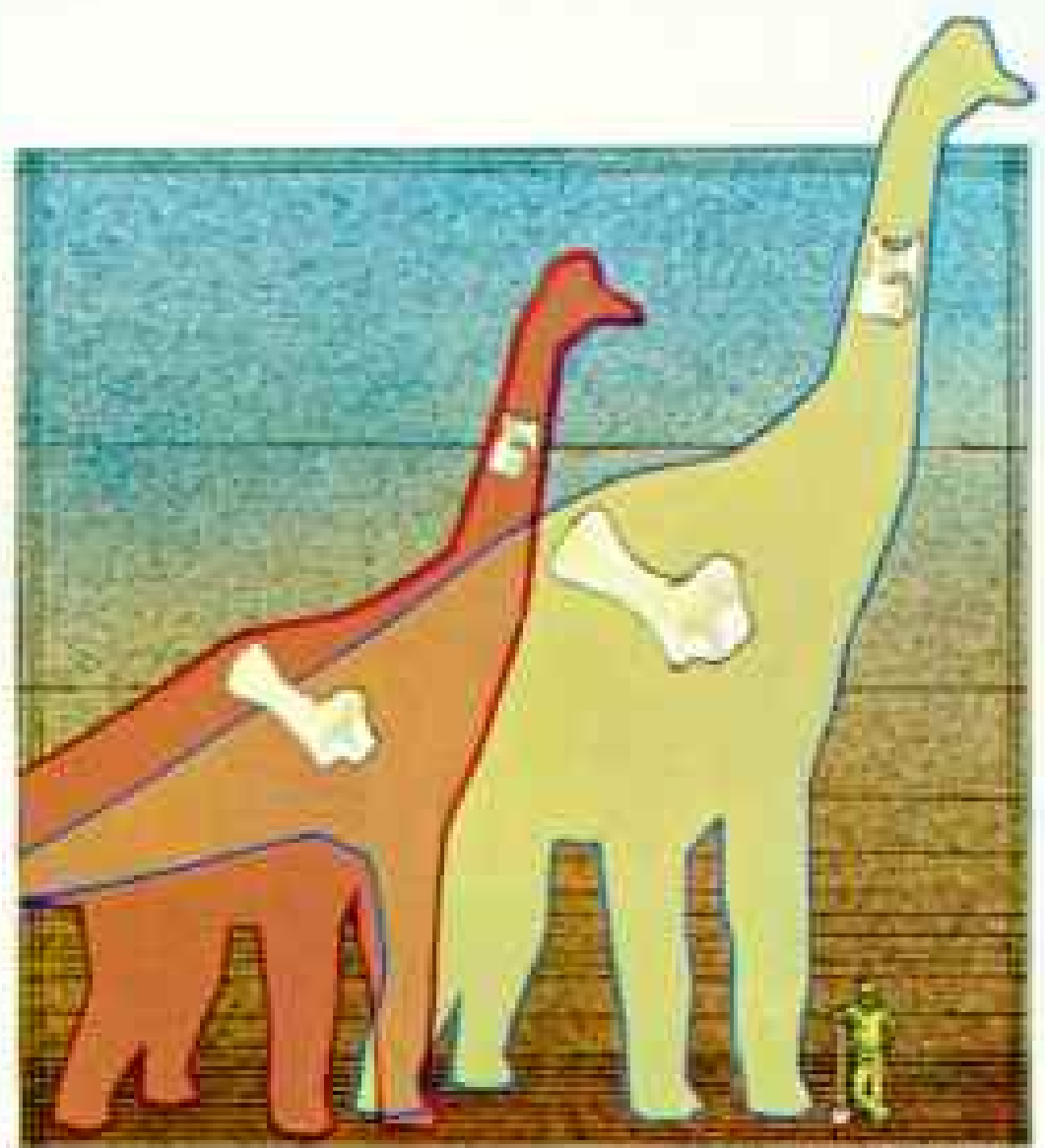
Some critics of the endothermy theory will go halfway. They concede that some dinosaurs might have been warm-blooded, but were unable to regulate body heat internally and thus were not endothermic. They reason that because of their large size dinosaurs, once warmed up by basking, would achieve an almost stable body temperature, a state called homoiothermy.

Thirty-four years ago, in their experiments with live alligators, dinosaur authority Edwin Colbert, herpetologist Charles Bogert, and physiologist Raymond Cowles demonstrated that *if* the large dinosaurs were cold-blooded like alligators, they were probably homoiothermic. The scientists determined that the larger the basking gator, the slower the rate of heat absorption and heat loss. Thus, the much larger dinosaurs of the Mesozoic Era, in a warm and equable climate, very likely had warm and nearly uniform body temperatures, without necessarily being endothermic.

Other quite different evidence may be viewed as supporting their work. An investigation of the curious bony plates along the back of *Stegosaurus* by students James Farlow and Carl Thompson and Professor Daniel Rosner of Yale's engineering department came up with a surprise. The bony back fins of *Stegosaurus* have long been regarded as protective armor against predators. Farlow discovered that these plates were penetrated by a complex network of canals that must have contained large blood vessels. What function could they have served?

Professor Rosner, an expert on heat transfer, carried out experiments on a simulated *Stegosaurus* model and concluded that the

double row of staggered bony plates *could* have functioned as convective heat-loss fins to cool *Stegosaurus* off (page 183). Projecting high above the back, the bony plates, perfused with "overheated" blood after strenuous activity, would be cooled by the breezes—functioning much like the vanes and baffles of an automobile radiator. The staggered, or alternating, arrangement of *Stegosaurus*'s plates, never satisfactorily explained before, happens to be a more effective cooling arrangement than plates symmetrically paired. Though this investigation does not prove *Stegosaurus* was endothermic, it does suggest a frequent need

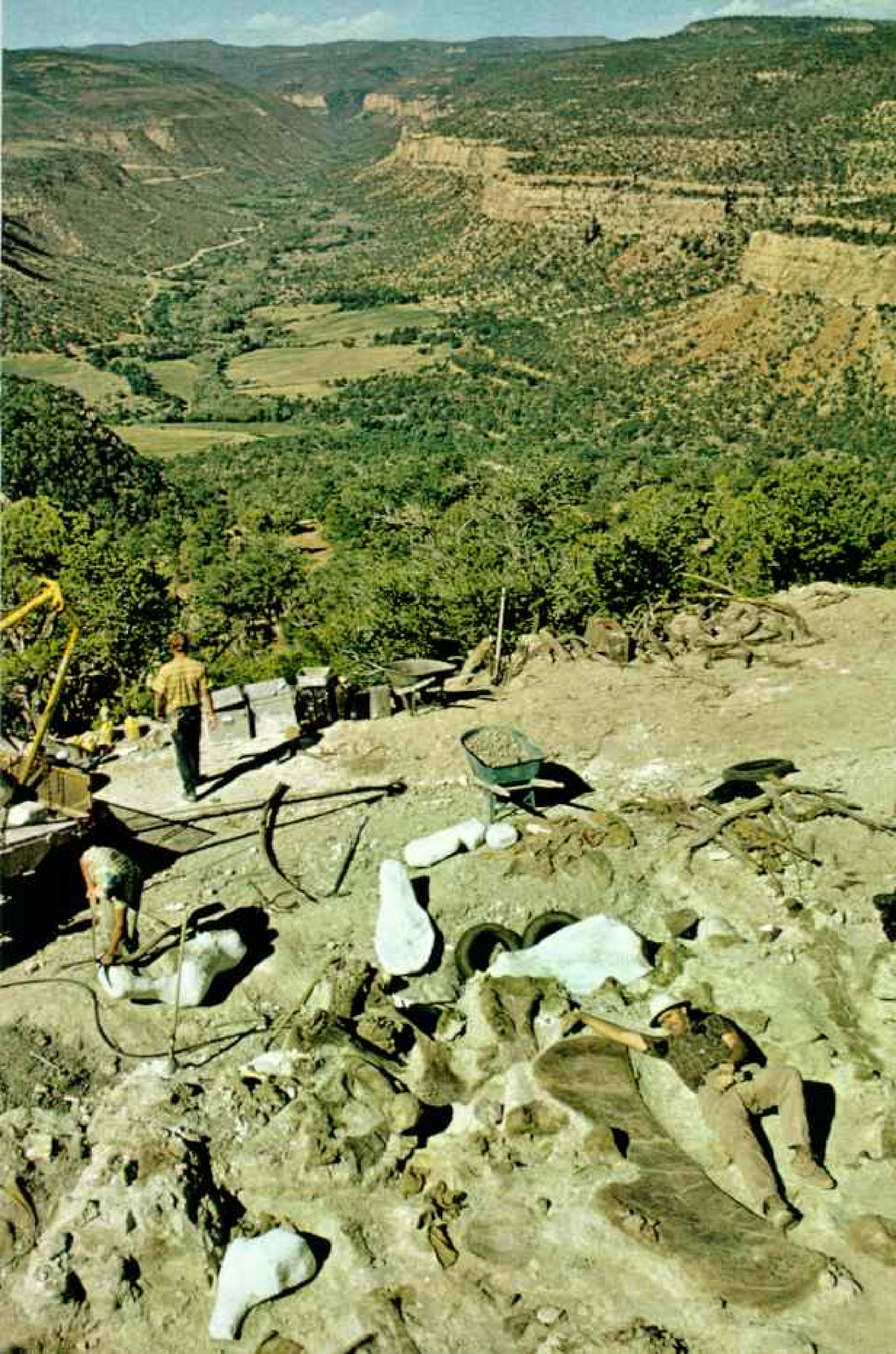


OTTO IRIBODEN (RIGHT)

A MONSTER OF MONSTERS, whose shoulder blade alone is longer than discoverer Dr. James Jensen (right), was unearthed at Dry Mesa quarry in Colorado. Although only this bone and several others have been found, they justify its nickname, "Supersaurus."

If, as seems probable, Supersaurus was a four-footed herbivore built along the lines of *Brachiosaurus*, it thus becomes the biggest of all dinosaurs, as shown in a conjectural drawing (above) with a *Brachiosaurus* and a man for comparison.

Supersaurus may have weighed as much as a hundred tons—equal to a herd of 15 African elephants. If so, it becomes the largest land animal of all time and outweighs most great whales.



to shed excess heat—and that is one critical aspect of temperature regulation.

These various lines of evidence have led some paleontologists, especially Robert Bakker, to conclude that dinosaurs might have been true endotherms. If that were the case, they would have been free of one of the constraints that all living ectotherms must deal with—dependence upon external heat sources to warm up to optimal temperatures. The major stumbling block in this, though, is that an endotherm requires more fuel to generate that heat. And that leads to improbable daily food consumption for an endothermic Supersaurus-size animal, as we have already learned.

Personally, I doubt very much that all dinosaurs were endothermic. Many, or most, probably were warm-blooded as a consequence of subtropical climates and thermal inertia imposed by their large size. The theropods, however, and especially the smaller kinds like *Compsognathus*, *Deinonychus*, and the struthiomimids, I suspect may have been true endotherms. Notice that the theropods are the only dinosaurian group to which all the above lines of evidence apply. And add to that the evidence that *Archaeopteryx* and other birds evolved from a small theropod dinosaur.

The "Great Dying": Why Did It Occur?

The possibility that birds are surviving dinosaur descendants raises the ultimate question: Why did their ancestors and all the other dinosaurs become extinct? What caused the "great dying"? One theory that appeals to me is that of Professor Loris Russell of the Royal Ontario Museum in Toronto. He postulated that the dinosaurs were warm-blooded, but that unlike birds and mammals, they lacked an insulative covering such as hair or feathers. This conclusion has been borne out by fossil specimens showing impressions of dinosaur skin.

According to Professor Russell, as earth temperatures declined from near-tropical levels toward the end of the Cretaceous Period and became more seasonal, dinosaurian temperatures also declined. Without insulation, dinosaurs could not retain their blood heat in the longer and colder winters, and so perished. All reptiles that survived the crisis at the end of the dinosaur era, such as lizards

and snakes, were cold-blooded. Mammals and birds may have survived because they were endothermic *and* insulated.

But why didn't the dinosaurs simply migrate to more hospitable environs as the climates deteriorated? Tropical conditions must have persisted somewhere at low latitudes. Perhaps some did migrate; perhaps they were able to survive for a time in tropical latitudes.

Professors Leigh Van Valen of the University of Chicago and Robert Sloan of the University of Minnesota believe that in North America, at least, dinosaur extinctions may have occurred slightly later in the south than in the north. But they, along with Dr. Nicholas Hotton of the Smithsonian Institution, attribute extinction to gradual replacement by mammals, rather than directly to cold weather.

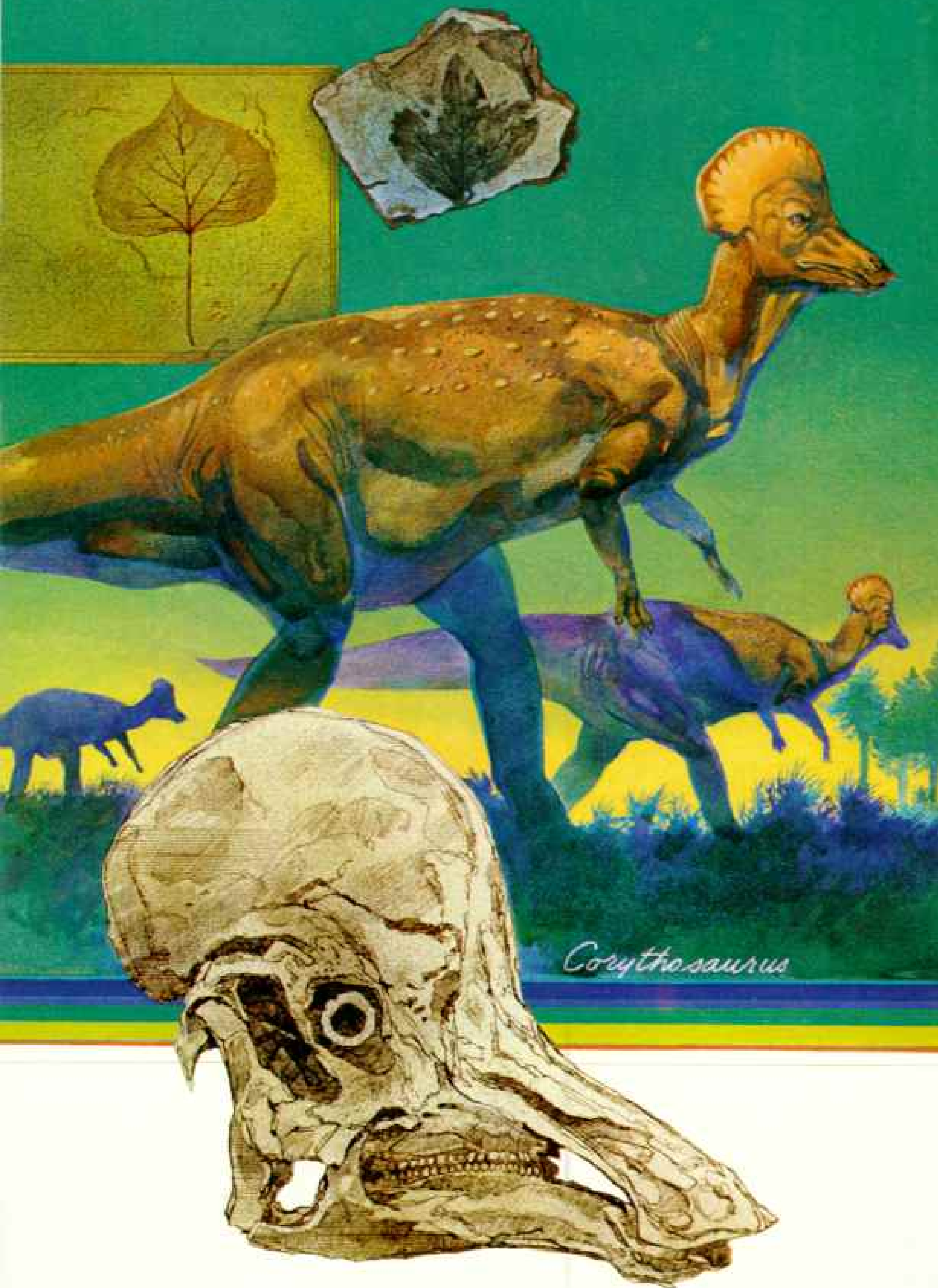
At the same time that the dinosaurs were dying out, a dramatic extermination of other life forms occurred. In the sea the reptilian sea monsters disappeared, together with the coil-shelled ammonites, relatives of the modern squid and nautilus. Massive extinctions occurred in the sea's microscopic planktonic life. On land certain plants vanished, and the flying reptiles disappeared.

Some experts attribute these extinctions to sudden, severe cold weather—which seems to (Continued on page 182)

TOWARD THE END of the reign of dinosaurs, there flourished a group of large duck-billed plant eaters bearing a great variety of bony skull crests. In *Corythosaurus*, an air passage ran from the nostrils through the bill, up into the crest, and exited in the back of the mouth. The passage may have allowed breathing while eating. This would have been an advantage had the animal been a constant feeder, as the large battery of teeth suited to grinding suggests.

The passage may also have contributed to an acute sense of smell—to warn of predators or, as with the shape of the crest, to aid the animal in recognizing others of its own kind.

Once thought to be strictly aquatic, the duck-bill dinosaurs may have been land browsers, perhaps favoring riverbank habitats, with a taste for pine needles.



Corythosaurus

Brontosaurus



FAMILIAR BUT PUZZLING: For many it is *Brontosaurus*, also known as *Apatosaurus*, that springs to mind when they think of dinosaurs. For paleontologists, this 70-foot, 30-ton beast and its ilk present serious problems for thinking all dinosaurs could internally regulate their body temperatures as do mammals. *Brontosaurus* had no special feeding



apparatus like an elephant's trunk. Its teeth were peglike and relatively small, as was its mouth. Even if it did nothing but feed, the intake would seemingly be too low to sustain elephant-style metabolism.

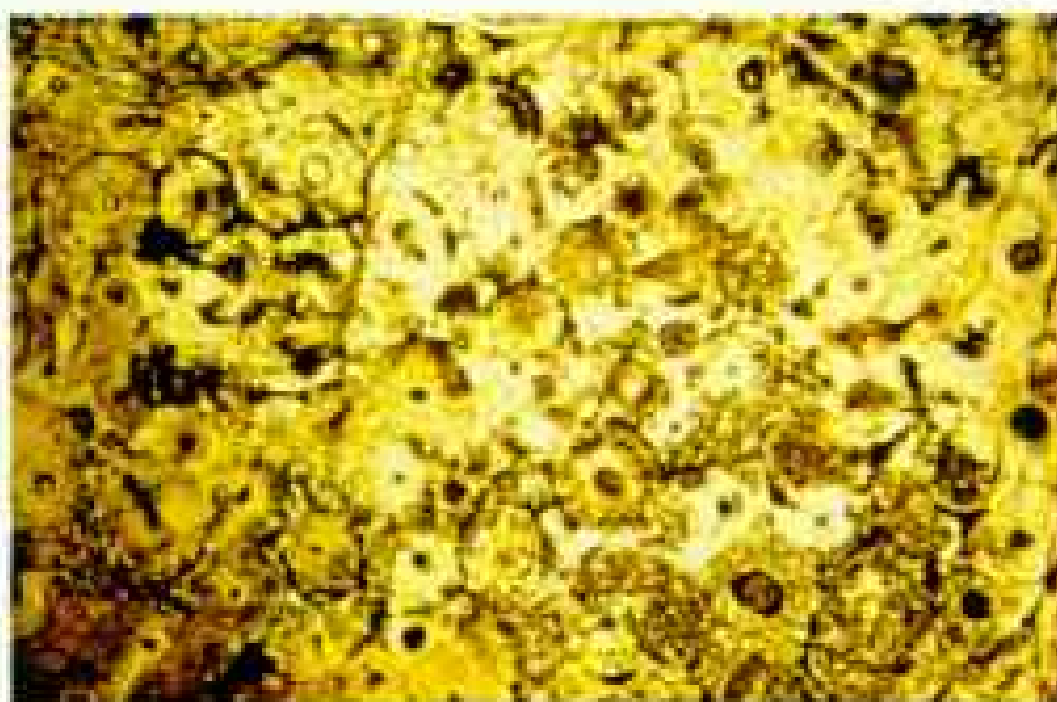
But, the author believes, they may have been warm-blooded in another sense. In a benign climate with little daily or seasonal temperature variation, their huge bodies

may have acted as heat reservoirs. As with a large water tank, once heated, they would cool off slowly and so maintain operating temperature without need for internal heat regulation.

Brontosaurus has often been portrayed as too heavy to walk on land, but comparative bone studies proved its legs could support and move its vast bulk.



OTIS INGOLDEN



ARMAND DE RICQUES, UNIVERSITY OF PARIS, VII

reinforce Loris Russell's hypothesis. But what could have triggered it, especially after tens of millions of years of nearly uniform subtropical climate?

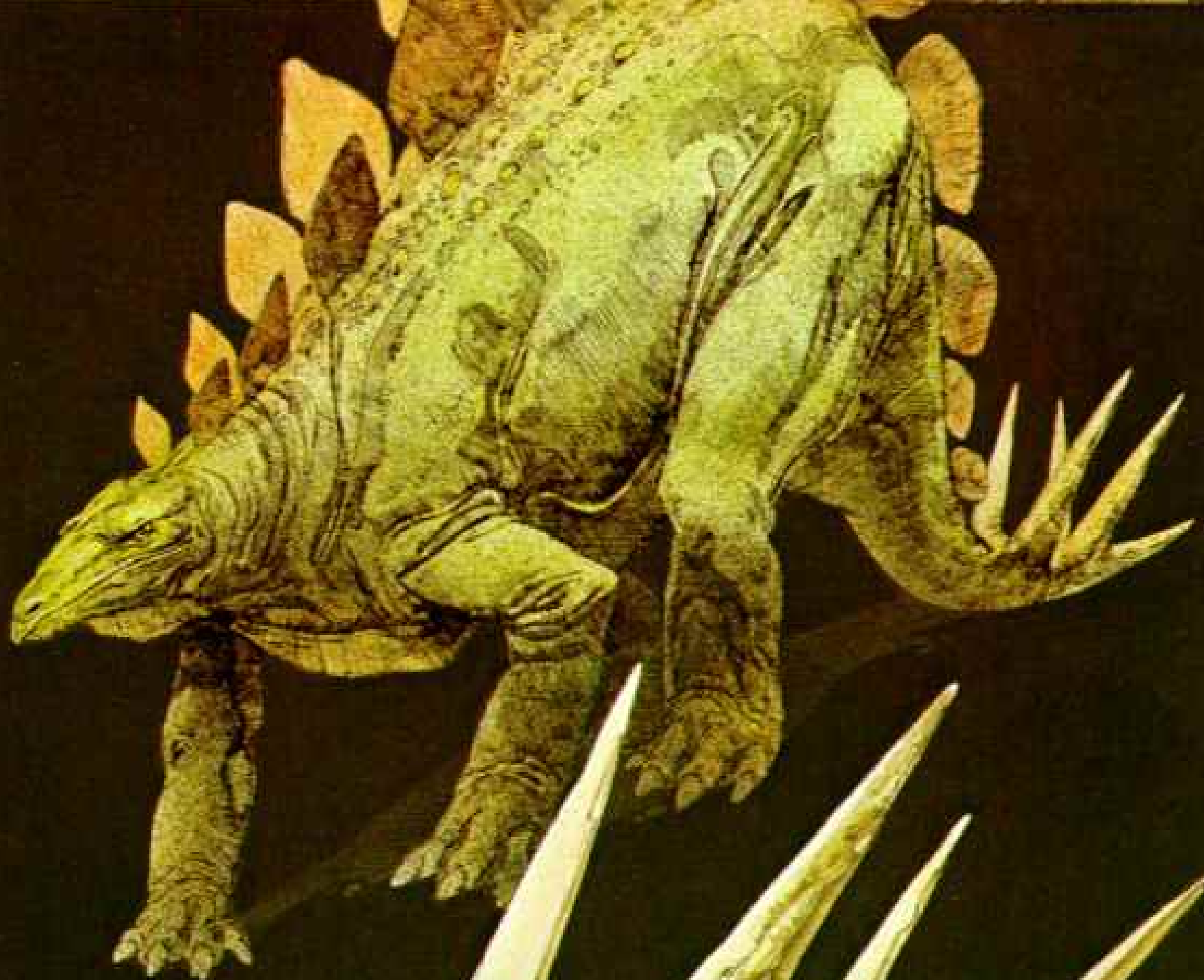
Dr. Dale Russell of the National Museums of Canada in Ottawa (he is no relation to Loris) has a theory. He and other scientists have attributed these biologic disruptions to a supernova explosion—like that of the Crab Nebula witnessed by Chinese astronomers in the year 1054.

According to their theory, a closer supernova explosion, within one hundred or so light-years of our solar system, could flood earth with excessive cosmic radiation for several decades. This might be lethal for many creatures, especially the large forms unable to burrow or otherwise shield themselves. In addition, absorption in the upper atmosphere of high levels of X rays produced by the explosion—perhaps ten thousand times the normal influx—could result in extreme atmospheric turbulence along with severe temperature imbalance. Water-saturated air would be displaced into high altitudes, where ice crystals would form. The ice-laden upper atmosphere would reflect away much of the sun's heat, causing a sudden and perhaps long-lasting drop in earth temperatures.

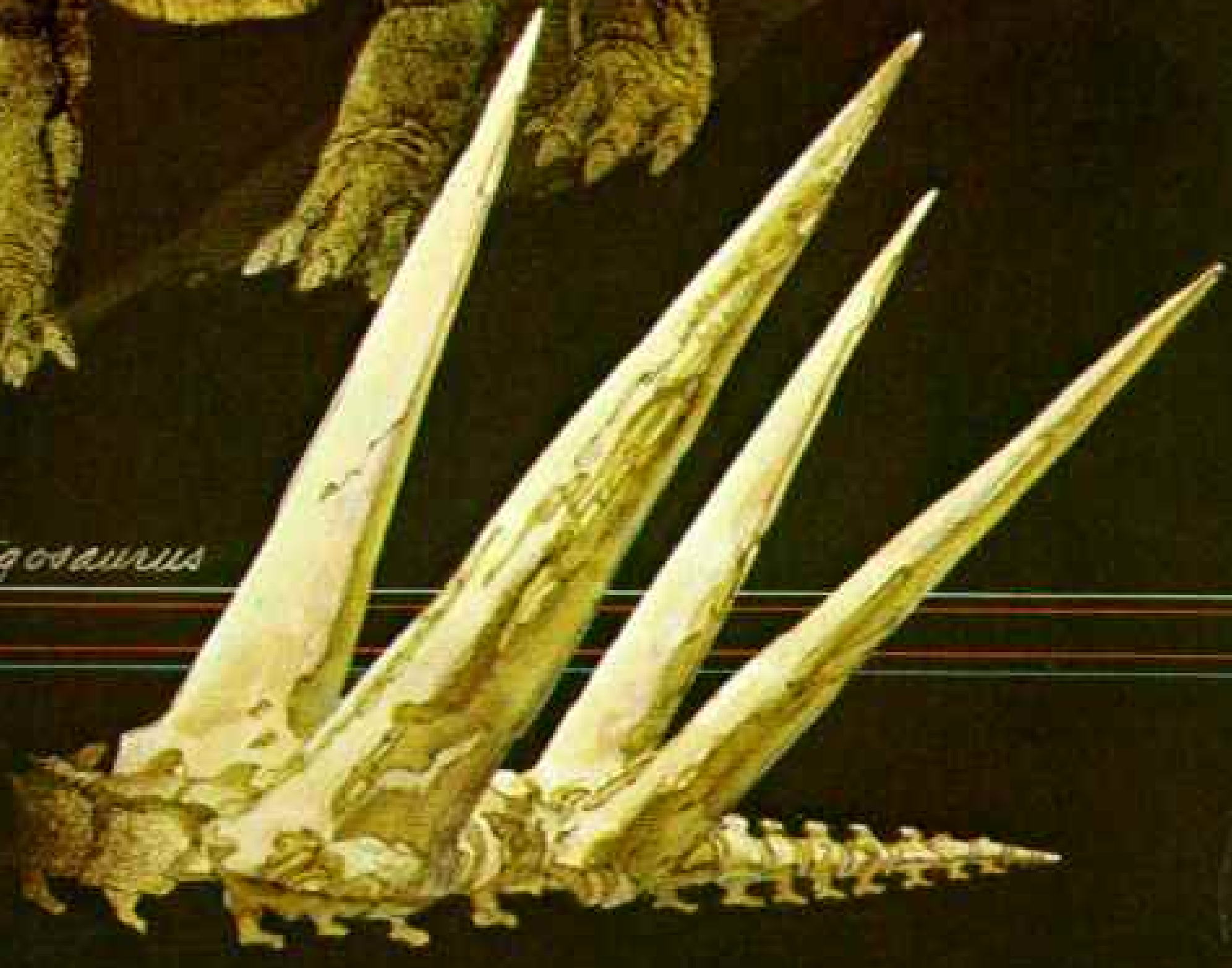
Another view of the great dying relates to plate tectonics, or seafloor spreading. Re-aligned continental masses could have

TO BEAT THE HEAT, the ungainly-looking *Stegosaurus* (right) may have perfected a natural radiator. Laced with channels for blood flow, its back fins are placed alternately rather than in pairs. Wind-tunnel tests on a model showed this to be the most effective array for dissipating heat. The spiked tail's degree of mobility is uncertain. Perhaps its evil appearance was deterrent enough.

Dinosaur bone sections (left, top) shown under low magnification (left, middle) are perfused with pathways called Haversian canals similar to those found in human bone (bottom). There they play a critical part in blood chemistry and, perhaps, metabolism. Though such canals suggest high metabolism in dinosaurs, they do not prove it. Some reptiles have canals; some mammals lack them.



Stegosaurus



caused changes in oceanic and atmospheric circulation patterns, with disruptive effects on worldwide climates. Seafloor spreading could also cause fluctuations in sea level that would inundate or drain low-lying continental regions, changing their climates. I doubt, however, that this scenario fully explains the demise of the dinosaurs.

Robert Bakker has suggested that it was not really the climatic effects of sea-level changes that created havoc with the dinosaurs. It was rather the lack of diversity in the land habitat created by the withdrawal of the seas. As he sees it, this led to production of fewer descendants to carry on the lineages.

No one knows what did the dinosaurs in, but I favor the cooling-environment hypothesis, whether the cold was caused by shifting continents or by an exploding supernova—or a combination of both.

If Professor Loris Russell is right—that dinosaurs were warm-blooded but without insulation, and failed because of cooling climates—the early survival and ultimate success of birds is understandable. Feathered *Archaeopteryx* was likely warm-blooded and probably even endothermic—able to regulate its temperature internally. Insulation made the difference. While larger uninsulated dinosaurians perished, feathered descendants of the small theropods were fit to weather the rigors of “winter.”

Flying Dinosaurs and Multi-ton Birds

The concept of birds as modern descendants of dinosaurs has provoked some amusing thoughts, though they have been offered in all seriousness. Two converts to the dinosaurian-origin-of-birds theory have proposed that our formal classification of birds and dinosaurs be changed: Birds, now in a class of their own (Aves), should be reduced in rank and made a subdivision of the class (new elevated rank) Dinosauria. The reason given is that birds are nothing more than “flying dinosaurs.” Another suggestion is to include birds and their ancestors in a single class—that is, to classify all carnivorous dinosaurs as birds!

While I am delighted to have this support of my theory on bird origins, I prefer not to think of your canary as a dinosaur, or *Tyrannosaurus* as a bird. □

BEFORE WANDERING into oblivion, the armored *Triceratops* had emerged as an ambling fortress with mouth parts uniquely adapted to feeding on fibrous plants like palms. The turtle-like beak could rip fronds; then teeth



specialized for shearing could chop them fine enough to swallow.

Triceratops and other dinosaurs vanished about 65 million years ago. Final extinction may have taken several thousand or several million years. A cooling climate,

sped by the effects of an exploding supernova, may have done them in.

Long suppressed, mammals began to fill the ecological niches vacated by dinosaurs. But birds, their insulating feathers adapted for flight, survived.



Aluminum, the Magic Metal

By THOMAS Y. CANBY

Photographs by JAMES L. AMOS

BOTH NATIONAL GEOGRAPHIC STAFF

IT IS 1942: A Nazi U-boat surfaces in foggy darkness off a lonely Long Island beach and four invaders land stealthily. Armed with sophisticated explosives, the saboteurs seek to cripple America's burgeoning air armada. Among their targets—aluminum smelters in New York and Tennessee. Their plan—destroy the cables that carry electricity for processing the aluminum. Long before power can be restored, the molten metal will solidify in the furnaces so that only blasting can remove it, knocking out the smelters for months.

Before the enemy agents can strike, the FBI scoops them up. But the lesson is clear. The light, shiny metal that began its working life as kitchen pots and pans has emerged as a sinew of industrial society.

Discovered a mere 150 years ago and manufactured commercially just half that long, aluminum today ranks behind only iron and steel among metals serving mankind. The key is incredible versatility.

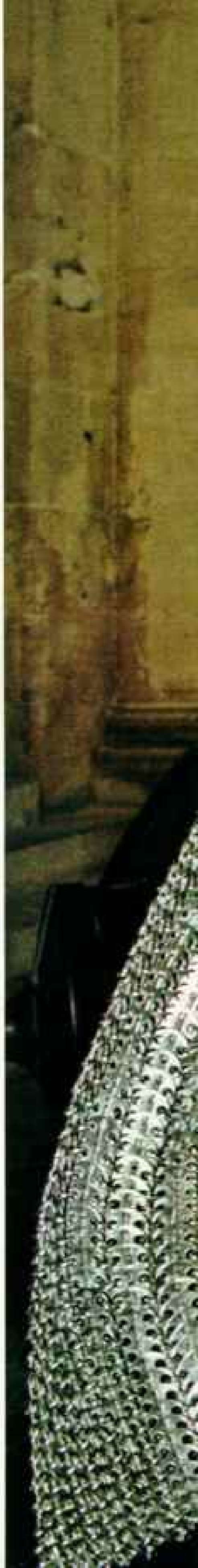
The same filmy metal that makes our kitchen foil (last year we unrolled 20 billion square feet of it) serves as armor for Uncle Sam's battlefield tanks. The stuff of lawn chairs and Little League baseball bats also forms the vitals of our air and space vehicles—most of their skeletons, their skins, even the rivets that bind them together.

Versatile? Spread less than an ounce of aluminum over a thin Mylar sheet and it keeps a sleeping camper snugly warm; spread just a few ounces over an asbestos suit and it keeps a fire fighter "cool." Mix pulverized aluminum in a liquid medium and it forms a durable paint; reduce it to powder and it becomes rocket fuel and a high explosive.

Look around. The magic metal clads trucks, trains, houses, skyscrapers. Look seaward. Aluminum ships in swelling squadrons cleave the waves, from trawlers to pleasure craft; five of the seven yachts fighting for the 1977 *America's Cup* raced on aluminum hulls.

Glance overhead. A vast web of aluminum transmission cables

Aircraft to bicycles to coats and on to zippers—aluminum spans alphabets of useful items in ingenious designs. Paris couturier Paco Rabanne created this aluminum and velvet coat, modeled at the Musée de l'Armée.





feeds the nation's vital electric power grids.

Indeed, just as earlier ages of human development have taken their names from the distinctive material that nurtured them—Stone, Bronze, Iron—there are those who believe our era may be called the Aluminum Age. Cultural analyst Lewis Mumford observes that just as the industrial revolution transmuted “clumsy wooden machines into stronger and more accurate iron ones,” a task of today is “to translate heavy iron forms into lighter aluminum ones.”

Behind aluminum's versatility lie properties so diverse they almost seem to belong to several different metals.

For example, in pure form aluminum is soft enough to whittle. Yet its alloys can possess the strength of steel, though only a third the weight. Thus when sculptor Alexander Calder designed his last mobile—a soaring creation 80 feet long—his choice of aluminum over steel slashed two tons from its weight. Aluminum also assures the

masterpiece virtual immortality: The instant the metal is exposed to air its surface acquires a transparent film of “rust” that seals the interior against further corrosion.

Consider a few more of aluminum's useful properties. Farmers throughout the South and the Southwest, knowing that cows give more milk when cool, nail heat-reflecting aluminum roofs on their dairy barns. Homeowners cherish aluminum siding and gutters, whose durable surfaces can keep paintbrushes on the shelf 15 years or more. Food and beverage packagers revel in a metal so chemically stable that it doesn't react with most foods.

Globe-girdling Strand Possible

No other metal so obligingly takes the myriad shapes that meet our everyday needs. You can roll aluminum and forge it, saw, slit, and shear it, and shape it by extruding—forcing it through a die of almost any shape, much as you squeeze toothpaste



through a tube. By drawing aluminum, you can wind a wire so spiderweb thin that a strand weighing only a few hundred pounds could stretch around the world.

Cast in so many roles, aluminum naturally presents some paradoxes. Among them:

- The smelting process guzzles vast amounts of energy; a medium-size plant in Montana gulps nearly a third of all the electricity consumed in the state. Yet aluminum offers a shining hope for energy conservation. Once made, the metal can be recycled over and over for only a fraction of the energy used in making it originally. Also, by putting our overweight autos on a strict aluminum diet, we can drastically reduce their weight and thus their thirst for gasoline.

- Half of those beverage cans that glitter so malevolently in the litter along our roadsides are aluminum, yet they help shape a new environmental ethic. Spurred by offers of cash for recycling, Americans last year returned an incredible six billion cans—one of



To foil heat, utilize aluminum's reflective quality. Inside an asbestos suit coated with aluminum (above), a fire fighter at Chanhute Air Force Base in Illinois experiences a sweaty but tolerable 85° to 100°F. The inferno of jet fuel rages at 2000°.

An English doctor invented the Silver Swaddler (left), actually a thin film of aluminum bonded to polyester, to conserve body heat in premature or sickly babies.

If aluminum reflects heat, why use it in cooking utensils? In direct contact with a heat source, the metal is an excellent conductor.



World's lightweight champion in the long-distance transport of electricity, aluminum has virtually replaced heavier copper in high-voltage power lines. Unenergized aluminum wires wrapped around steel cores are inspected at a Bonneville



REGGIE RADWICKI (LEFT)

Power Administration facility near Moro, Oregon (above). Dams along the Columbia River system provide a third of the power needed for U. S. aluminum smelting—pound for pound the heavyweight electricity user among major industries.

To leave an Idaho farm and wilderness area relatively undisturbed, as well as to cut costs, the Pacific Power & Light Company airlifts aluminum towers (left), only about a third as heavy as conventional towers of steel.

Refining bauxite to alumina...

1 MIXING Crushed and mixed with caustic soda, bauxite (aluminum ore) is pumped into huge digesters.

CAUSTIC SODA SOLUTION

SLURRY MIXER

DIGESTER

CALCINING KILN

FILTER

5 CALCINATION

The aluminum hydroxide crystals are roasted at more than 1800°F to remove the water. A fine white powder, alumina, remains — half aluminum and half oxygen — ready for transport to a smelter.

2 DIGESTION

Under high pressure and heat, the caustic soda dissolves the alumina, or aluminum oxide, in the bauxite to form sodium aluminate.

PRECIPITATORS

THICKENER

PRESSURE REDUCER AND HEAT EXCHANGER

3 CLARIFICATION

While the sodium aluminate remains in solution, iron oxides and other solid impurities drop to the bottom of the settling tank, where, as red mud, they are pumped to a disposal pond.

SETTLING TANK

← RED MUD TO DISPOSAL POND

4 PRECIPITATION

After the liquid sodium aluminate is further cooled, it is agitated and seeded with aluminum hydroxide crystals. These form larger crystals, which gradually settle out of the solution. Seed crystals and sodium aluminate remaining in solution are recirculated.

FILTER

every four aluminum cans manufactured.

- Scoop up a handful of soil in your backyard and you probably hold a fair amount of aluminum, for it forms a 12th of earth's crust. Yet most of the richest ores are controlled by an association largely composed of Third World nations. U. S. policymakers include aluminum among such sensitive strategic materials as oil and cobalt.

"Contrariness" Put Off Discovery

How could the most abundant metallic element on earth remain so long undiscovered? The answer is that this obliging metal is also extremely contrary. As early as

the 1700's European chemists realized an invisible metal lurked in certain soils they called clays. Later a particularly rich source was found in southern France, near the medieval town of Les Baux—thus the name bauxite, as all similar ores are known.

But unlike long-familiar copper or iron, aluminum does not occur naturally in metallic form. It exists only in combination with other elements, primarily oxygen, with which it forms an extremely hard oxide known as alumina. When tinted by traces of other elements, alumina can take the form of gems such as rubies and sapphires.

The challenge of liberating this "metal of

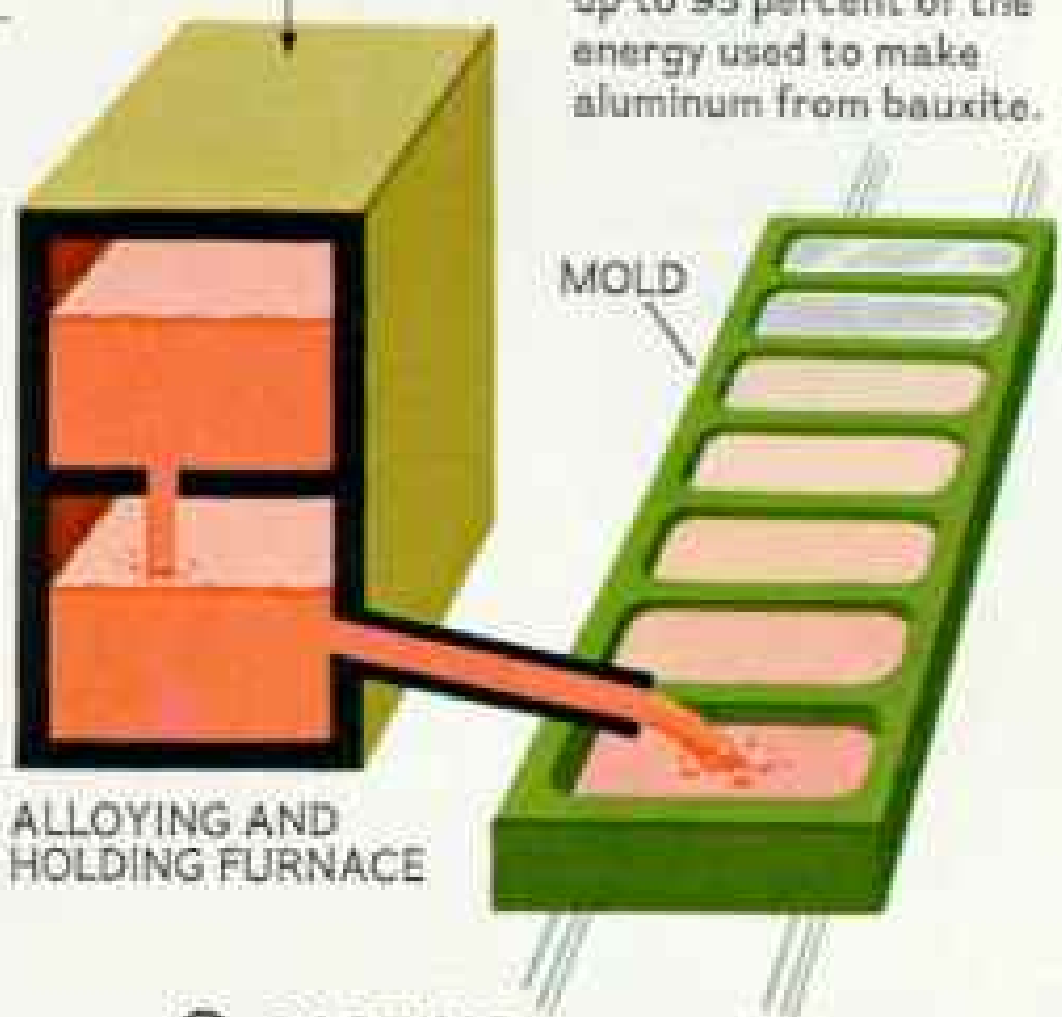
smelting alumina to aluminum



9 RECYCLING
 Nearly indestructible, aluminum can be remelted over and over. Depending on energy used to collect and transport cans and scrap, recycling saves up to 95 percent of the energy used to make aluminum from bauxite.

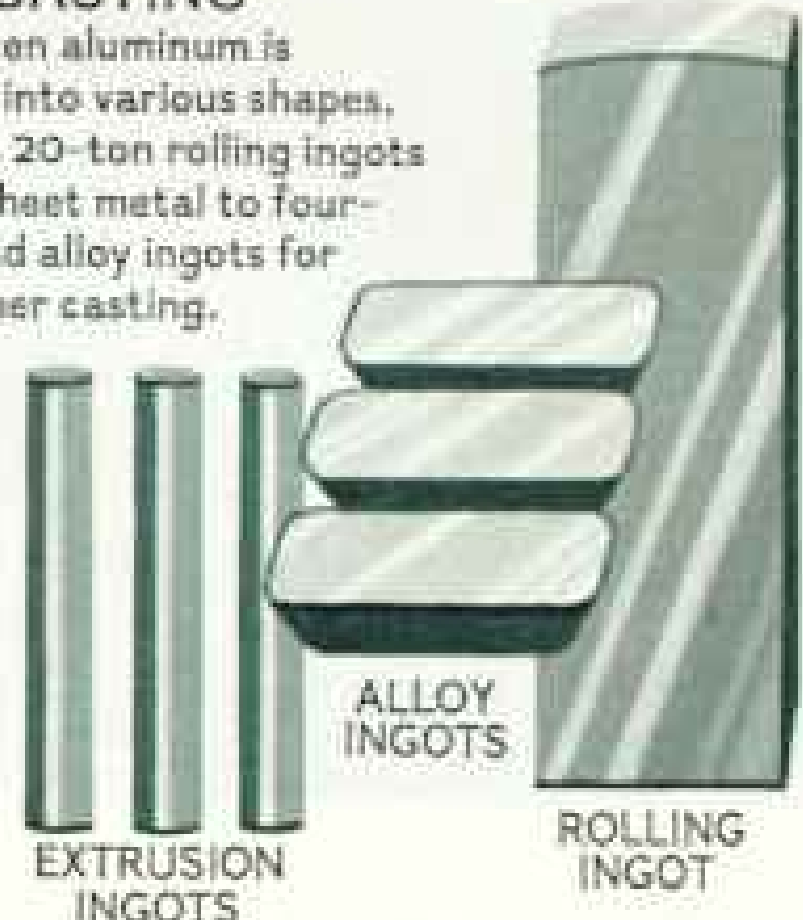
6 REDUCTION
 The alumina is dissolved in a molten cryolite bath that acts as an electrolyte, in which a powerful electric current wrests aluminum from the oxygen. Molten metal settles to the bottom of the pot.

7 ALLOYING
 Carried by crucible to a furnace, aluminum is alloyed with small amounts of other metals. Copper adds strength; magnesium imparts additional marine-corrosion resistance.



ALLOYING AND HOLDING FURNACE

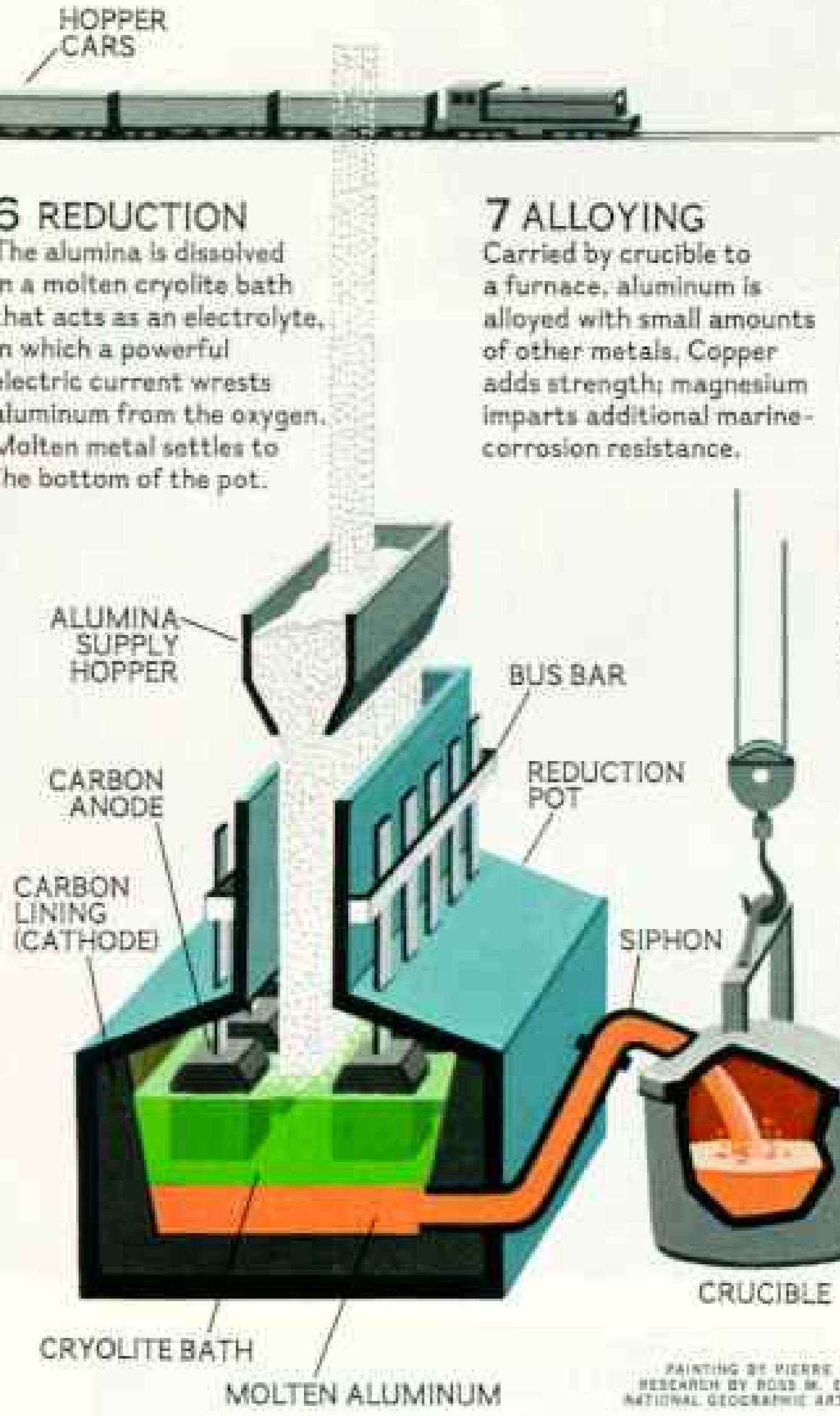
8 CASTING
 Molten aluminum is cast into various shapes, from 20-ton rolling ingots for sheet metal to four-pound alloy ingots for further casting.



EXTRUSION INGOTS

ALLOY INGOTS

ROLLING INGOT



PAINTING BY PIERRE MIDY
 RESEARCH BY ROSS W. EMERSON
 NATIONAL GEOGRAPHIC ART DIVISION

clay" defeated a procession of European chemists. One, Sir Humphry Davy of England, nevertheless gave the elusive metal a name—aluminum. His spelling prevails in the U. S. and Canada; almost everywhere else it's spelled aluminium.

In 1825 Danish physicist Hans Christian Oersted, already famous for discoveries in electromagnetism, turned his genius toward isolating the stubborn metal. Treating alumina with carbon and chlorine, then an amalgam of potassium, he at last obtained a mix of aluminum and volatile mercury. Boiling away the mercury, he suddenly gazed in awe at the long-sought quarry—a minute

residue of powdery metal that "in color and luster somewhat resembles tin."

Now scientists turned to the task of producing the metal in commercial quantities. Once again it proved stubborn. Napoleon III, perhaps envisioning his armies equipped with lightweight aluminum helmets and breastplates, personally promoted the research. Production costs dropped, but aluminum remained a semiprecious metal.

And so it was in 1884, when the U. S. prepared to dedicate the newly completed Washington Monument. To crown the great obelisk in Washington, D. C., a metallurgist created a gleaming pyramid of



Stained rust red by iron compounds, alumina-rich bauxite is scooped from a mine (above) owned by Alumina Partners of Jamaica near Mandeville. Jamaica and ten other bauxite-producing nations make up the International Bauxite Association, organized in 1974, which seeks higher prices for its ore.

With members as diverse in interests as Australia and Yugoslavia, the IBA faces difficulty in achieving united action. Still, the threat remains—and individual countries already have nationalized some foreign-owned mines and raised the levies on bauxite exports.

“We want to sell bauxite,” Henri A. M. Guda (right), then secretary-general of the IBA, told the author in Kingston, Jamaica, “but it only makes sense for us to get the most for our resources.”





Hungry for aluminum but lean on rich bauxite deposits, the United States digs into its own backyard for other alumina-bearing substances. There's no shortage: Constituting 8 percent of the earth's crust, aluminum is the most abundant of metals, as well as one of the hardest to produce. To manufacture aluminum, you must first have alumina.

Billions of tons reside in kaolin in Georgia, anorthosite in Wyoming, alunite in Utah. Because these materials contain less alumina than bauxite does, the problem is to find ways to process the metallic ores economically.

In Boulder City, Nevada, a U. S. Bureau of Mines miniplant—bigger than a laboratory, smaller than a production unit—seeks an economically feasible process for freeing alumina from kaolin (right).



The heat's on at Eastalco Aluminum Company in Frederick, Maryland, as molten aluminum at 1300°F flows from a star-shaped trough into vertical molds, where it solidifies. The cylinders are later reheated and forced through dies—toothpaste style—to make everything from tubing to sections for subway car bodies.

aluminum—at a hundred ounces one of the largest chunks ever assembled. Before the ceremony it sat in a window at Tiffany's in New York City, awing sidewalk throngs.

Today, when your eye climbs the 555-foot stone shaft, it comes to rest on that same aluminum apex, still intact after nearly a century of battering by the elements (page 207).

By a series of unlikely coincidences the aluminum age was about to dawn.

Woodshed Laboratory Led to Discovery

In the quiet college town of Oberlin, Ohio, student Charles Martin Hall became obsessed with finding an inexpensive way to produce aluminum. On graduating, the slight, intense son of a Congregationalist minister set up a crude laboratory in a woodshed behind the parsonage. His equipment included a skillet, a secondhand gasoline stove, and homemade crucibles.

Hall chose the process known as electrolysis—the use of electric current—in his effort to isolate the metal. The technique had failed Sir Humphry Davy eighty years before, but the youth added a step: Before unleashing the current, he dissolved the alumina in a molten solvent known as cryolite.

On February 23, 1886, a few months after his 22nd birthday, Hall connected a battery to a crucible of alumina-cryolite solution. Then he let the writhing current work. When the mix cooled, he shattered the congealed mass. In it glinted a clutch of silvery pellets—the seeds of an industry (page 198).

Incredibly for an event so long in coming, the same discovery occurred at almost the same moment, this time in Gentilly, France. Like Hall, Paul L. T. Héroult was 22 years old, worked in a makeshift lab—his was tucked in a tannery—and also used molten cryolite to dissolve the alumina. Completing the strange parallel, both inventors died the same year, 1914.



Today virtually all the world's aluminum is smelted by the Hall-Héroult process. Taking the place of their simple crucibles and batteries, great steel vats arranged in long potlines hold the dissolved alumina, and powerful electric currents tear it apart. Last year Hall-Héroult smelters around the world poured 16 million tons of aluminum, a third of it in the United States.

The infant industry spawned by Charles Hall depended upon two key ingredients—bauxite, which could be mined in Arkansas in ample quantity, and abundant electric energy to refine it. By chance, the evolution of electric power virtually paralleled that of aluminum. When the United States' first large-scale hydroelectric plant spun to life at Niagara Falls in 1895, Hall's fledgling



company was among the first customers.

"Our needs today are the same as they were then—bauxite and energy," said Alfred M. Hunt, a vice-president of Alcoa, the mighty Aluminum Company of America. His firm is the direct descendant of the enterprise based on Hall's discovery.

Niagara Falls Wasn't Enough

"Soon we needed more power than Niagara could supply," he explained, "and we built our own hydroelectric plants from Canada to Tennessee. Starting in 1939, we plugged our smelters into the hydroelectric facilities burgeoning along the Columbia River in the Pacific Northwest. Today that area accounts for a third of all the aluminum manufactured in the U. S.

"We've developed natural-gas fields and lignite deposits in Texas, purchased coal-fields in Kentucky and Indiana, and tapped the hydroelectric resources of Norway. We also developed hydropower in Surinam. Today the industry, which uses one percent of the nation's total energy budget, generates a quarter of the electric power it consumes."

In the early days of hydropower development, aluminum smelters were welcome customers for surplus power generated by Government-built dams. Now, as competing demands of residential and other users soar, the aluminum companies encounter resentment of their heavy consumption and the low electricity rates they pay, often criticized as amounting to public subsidy. Some could face power cutbacks. In 1977 drought



ROSENBERG CASTLE, COPENHAGEN

Prince among metals just a century ago, aluminum teamed up with gold in a helmet (above) worn by King Frederick VII of Denmark, and in a baby's rattle made for the son of Napoleon III (facing page).

Aluminum became a commoner in 1886 when Ohio inventor Charles Hall passed an electric current through alumina dissolved in cryolite and produced pellets of the metal (below). At about the same time, in France, Paul Héroult also discovered the process—which today produces virtually all the world's aluminum. Hall helped form a small company in Pittsburgh known now as Alcoa—the Aluminum Company of America.



in the Pacific Northwest curtailed power production, forcing plants to close potlines.

"Long before the energy crisis started," Mr. Hunt reminded me, "we were searching for ways to cut consumption. Since 1940 the industry has reduced by a third the amount of electricity needed during smelting. Also, Alcoa scientists developed a new smelting process requiring 30 percent less energy than the most efficient Hall-Héroult plant. In 1976 we opened a demonstration facility in Palestine, Texas."

The Alcoa process, using chloride instead of fluoride in reducing alumina, could also alleviate a vexing pollution problem that the industry has strived to overcome. Decades ago farmers noticed that vegetation near smelters sometimes became blighted. Worse, cattle that fed on affected plants became lame, and their teeth began wearing down rapidly. News reports dramatized the plight of afflicted animals, and court cases known as "cow suits" ensued. The pollutant proved to be excessive fluoride emissions. Many companies sought to control such emissions, and today antipollution devices are prominent features at most smelters.

Caribbean Barony of Bauxite

To inspect a bauxite mine, I visited the Caribbean isle of Jamaica. From this small nation, less than half the size of my native Maryland, comes nearly half the 12 to 15 million tons of bauxite that U. S. plants devour each year. U. S. and Canadian refineries on the island process another six million tons into alumina. As a result, Jamaica ranks second only to Australia among exporters of bauxite and alumina.

Raw, red bauxite showed in road cuts and plowed fields as I traveled Jamaica's tortuous roads toward mines of the Kaiser Bauxite Company, subsidiary of the giant U. S. aluminum and chemical firm. From the crest of each successive ridge I saw another valley emptied of bauxite. Some had been small pockets that yielded a few thousand tons, some huge basins that had disgorged millions. Many mined valleys showed grassy floors—beneficiaries of reclamation laws enforced since the early 1950's.

American geologists estimate that a billion tons of bauxite still can be scraped from the island's limestone skeleton. Jamaican





The magic metal plays second fiddle to wood in violins, though aluminum tennis rackets and baseball bats are smash hits. Trying an aluminum violin made in Germany in the 1930's, now owned by Alcoa, concertmaster Fritz Siegal of the Pittsburgh Symphony called its tone "surprisingly good"—but returned to his Stradivarius.

estimates are double this, enough for 140 years of mining at the present rate.

Prodigious as these amounts are, they pale beside the deposits in Australia and Guinea; together they may possess half of the world's reserves. They may be rivaled by new discoveries in Brazil, while neighboring Surinam and Guyana have exported bauxite for decades. Indonesia, India, and Cameroon also possess immense deposits.

Torrential Rains Bare Bauxite

Europe and North America claim modest amounts of bauxite; Arkansas supplies about 10 percent of U. S. needs. But the great bonanzas lie in tropical and subtropical nations, and for a reason. Torrential rains have leached away other minerals, leaving durable alumina-rich bauxite.

As a result of continuing new bauxite

discoveries, estimates of world reserves have risen from a billion tons in 1945 to 25 billion today. Why, then, do U. S. Government officials worry about shortages?

"Look at the import figures," advised Ralph C. Kirby, the Bureau of Mines' assistant director for metallurgy. "Those 14 or so million tons of bauxite the U. S. aluminum industry imports each year are its lifeblood—90 percent of all it uses.

"Now," he said, holding up a chart of the Atlantic and pointing to a constellation of X's, "look at these merchant-ship sinkings during World War II. In 1942 German U-boats torpedoed nearly one of every four bauxite carriers coming from South America, striking at our aircraft production. We learned then how vulnerable we are.

"Even in peacetime," Ralph continued, "we're vulnerable. Most bauxite nations are

relatively poor, and they want to process the bauxite to create jobs and capital. But if we had to import only alumina, or worse yet the finished metal, the effect on our balance of payments could be catastrophic.

"Further, several of the bauxite countries are taking over operations within their boundaries. Guyana recently nationalized the substantial Reynolds holdings there. And Jamaica. . . ."

Jamaica Flexes Some Muscle

By all accounts the great corporations find a worthy adversary in small Jamaica. In 1974 it hiked taxes fivefold on bauxite, and tied future taxes to U. S. aluminum makers' prices. Now Jamaica is peaceably but relentlessly hammering out agreements for part ownership of the firms' investments, totaling nearly a billion dollars.

"Also," admonished Kirby, "don't forget the IBA."

Patterning themselves after the oil nations, 11 ore-producing countries have joined hands as the International Bauxite Association. The members control 75 percent of all bauxite production—a higher proportion than that of oil controlled by the Organization of Petroleum Exporting Countries—OPEC.

"They've already agreed on a minimum price," Ralph told me. "There's no telling what lies ahead."

To find out, I sought out the secretary-general of IBA in his elegant office in Kingston, Jamaica. Henri A. M. Guda (page 194) was suave, articulate, and—to a citizen of the world's biggest bauxite-buying nation—somewhat reassuring.

"It only makes sense, of course, to get the most for our resources," said the tall, slender native of Surinam. "Most of our member nations are capital-shy, and either we ask for handouts from Big Brother to the north [the U. S.] or we try to help ourselves.

"But we know we can't price ourselves out of the market. Above all we want to sell bauxite; we don't want to leave it in the ground."

In this high-stakes global game, the U. S. is not without a trump card or two. I got a peek at a hand during an extraordinary rendezvous of industry and Government in the desert town of Boulder City, Nevada.

Around a long table sat spokesmen for aluminum titans here and abroad—Alcoa, Alcan, Reynolds, Kaiser, Anaconda, Alumax, and others. With them sat representatives of companies that depend on alumina for making furnace linings and other non-metallic products, and a Bureau of Mines delegation headed by Ralph Kirby.

One by one, Government and industry spokesmen brought their colleagues up-to-date on their work in the desert. They spoke their own language, using terms such as sparging, elutriation, and centrifuge cake.

Finally the group adjourned to a nearby building to inspect the apparatus they had been discussing—a complex maze of pipes and tanks called the miniplant. Jointly financed by the bureau and the companies, the miniplant is an experiment in processing domestic, non-bauxitic ores into alumina—making aluminum without bauxite.

"We think we now have the technology to do it," said Kirby, "and the cost begins to look competitive with bauxite."

In a nearby bin I examined one of the ores on which they pin their hopes—a fine white Georgia clay called kaolin. Mammoth deposits lie a few score feet beneath Georgia's famous red field clay, in a great arc stretching across the state below the fall line.

"We estimate anywhere from one to five billion tons," Ralph explained. "No one really knows. It averages about 35 percent alumina, two-thirds the richness of typical bauxite. At present rates this is enough to supply the U. S. for decades. Several aluminum companies are buying up land." Energy requirements, though, would be substantially higher, and many experts fear the impact on the environment.

Even Fly Ash Could Work

Georgia kaolin, I learned, represents only a fraction of the nation's potential ores. Huge reserves of aluminum-rich rock known as alunite and anorthosite lie in Wyoming, Utah, and other parts of the West. Laterite, a low-grade bauxite, occurs in Oregon, Washington, and Hawaii. Aluminum lurks in western oil shale and could someday become a petroleum by-product. Even fly ash from the nation's coal-burning furnaces could become a source of aluminum.

Turning to the business world, I found





executives confidently eyeing a tempting market, the voluptuous American auto. I learned the logic of it from one of the aluminum industry's leading figures, David P. Reynolds, head of the giant Virginia-based firm that bears his family's name. I felt fortunate to catch him; the next week he would be off to Brazil, looking into bauxite.

"The oil crisis of a few years ago," he explained, "underscored the relationship between weight and energy consumption. It takes energy to move weight; EPA figures show that a 4,200-pound car gets only 17 miles to the gallon compared to 32 miles for a 2,000-pounder. With mileage requirements going up, weight must come down. To us this means more aluminum parts."

Aluminum Car Parts Cut Gas Guzzling

The genial executive strode to shelves crammed with aluminum wares that gave his office the flavor of a retail store. "We're already producing aluminum parts," he said, jabbing a finger at assorted bumpers, pistons, grilles, and trim (page 205). "This year's automobiles carry more than a hundred pounds. We think they'll have close to two hundred by 1980. This will reduce a car's weight by 450 pounds and save six hundred gallons of gas over ten years.

"And don't forget: The more aluminum in the vehicle, the more value it will have on the hoof when it comes to recycling."

Recycling. How alluring the prospect, how elusive the goal. The litter and landfills of our throwaway society stand as a reproach to a way of life we know to be both wrong and immensely costly. Americans, notes the National Association of Recycling Industries, spend about four billion dollars each year to discard 140 million tons of solid waste rich in recyclables.

In reality, of course, we have always

Subduing the waves, aluminum alloys not only combine lightness with strength but stoutly resist salt water's corroding bite. *Tenacious*, built by Palmer Johnson Inc. and skippered by Atlanta sportsman Ted Turner, drives to windward in last year's Miami-to-Nassau race with an aluminum hull, deck, and mast. Turner also piloted the aluminum yacht *Courageous* to victory in the 1977 *America's Cup* race.

practiced a degree of recycling. The Bible speaks of beating swords into plowshares—recycling them; the Liberty Bell is cast of bronze twice melted down from earlier models. Today recycled waste yields nearly half our lead, 20 percent of our copper, and 5 percent of our aluminum.

To a homeowner watching a truck haul away his voluminous trash, however, grass-roots recycling seems long in coming. But there are those who believe that a recycling society is on the horizon, and that aluminum will serve as a catalyst in its coming. One such person is David Reynolds.

Putting Energy in the "Bank"

"When we recycle aluminum," he explained, "we save 95 percent of the energy needed to make new metal from bauxite. Once you make aluminum it becomes, in effect, an energy bank that you can tap over and over again. Three billion pounds of the metal are being thrown away each year—an amount equal to the entire U. S. output in 1958. Getting that back would save 20 billion kilowatt-hours of electricity—one percent of the electric power used in the U. S.

"This energy saving makes scrap aluminum relatively valuable. And the largest single source is beverage cans."

The company has zealously plunged into can recycling. Offering 17 cents a pound (about 23 cans), it last year recycled an astonishing 2.9 billion containers—48 percent of those collected nationwide—and paid out more than 20 million dollars in return.

With animation Reynolds recalled early days of what he terms "the movement."

"We started off with a couple of failures—simply the wrong approach. Soon after we adopted the 12-ounce aluminum beverage can, we set up a pilot recycling center in Miami. We offered gasoline coupons for cans, but got little response. We tried earmarking can money for a hospital and the Goodwill Industries, but this failed too.

"We shifted to Los Angeles and offered a

straight cash payment of ten cents a pound. Cash on the barrelhead did it—the cans rolled in. Today we have 73 permanent recycling centers around the nation, plus 150 mobile units that buy at 800 locations."

Hankering for cash on the barrelhead, my sons, Yellott and Vert, began scouring Maryland roadsides for cans. Before long their accumulation cluttered our porch and toolshed, and on a bitter-cold January day we loaded the car and drove north to a shopping center in nearby Frederick. Two Reynolds recycling trucks waited side by side in the parking lot, their open rear doors each framing a hanging scale, with a line of recyclers behind each truck.

"This is the recyclingest town in my district—18,000 pounds last month alone," boomed Henry Lancaster as he hefted can-filled plastic bags onto his scale, sang out their weights, and paid each customer in turn. Yellott and Vert swung up their bags—62 and 49 pounds respectively—and happily pocketed their cash.

Behind them came the day's high scorer, steelworker Larry Ahalt, his pickup truck loaded with cans. As Larry heaved up the bags, his wife recorded the weights on their new Christmas calculator. The final tally: 763 pounds for \$129.71. Then they were off, to begin collecting for next week's turn-in.

Money—the Ultimate Incentive

As I talked with these and other recyclers, I detected a common thread of motivation. Money is the vital incentive, but the recyclers also feel they play a role in improving the environment. "Since recycling began," volunteered Larry Ahalt, "the roads around Frederick are definitely cleaner."

Other companies, too, push grass-roots recycling. From its distribution area of only 14 Western States, the famous Adolph Coors brewing company accounts for an astounding 33 percent of all cans collected in the nation. Energetic Pearl Brewing Company of Texas recycles a surprising 4

Weight-watchers by federal decree, carmakers turn to more aluminum parts for lighter vehicles, to satisfy Government mileage requirements. Some shining examples, photographed at Greenfield Village in Dearborn, Michigan, include aluminum rims, radiator, and an engine block. But the aluminum car, like this demonstration 1925 Pierce Arrow, may never hit the road. Steel is stronger and costs less.







AP/WIDE WORLD

To top off the Washington Monument in 1884, when aluminum was still as valuable as silver, architects chose a hundred-ounce pyramid of the metal, shown here in a later photograph (left). Eight platinum-tipped lightning rods surround it. Before installation the regal chunk was displayed at Tiffany's in New York City. "The uses of the metal are almost illimitable," prophesied the *New York Times*.

The construction industry alone consumes about a quarter of the nation's output. Aluminum panels sheathe the World Trade Center in New York (far left). Aluminum siding and foil-backed insulation refurbish a Civil War-era house in Gloucester, Virginia (below).

Contractors can use aluminum nails, screws, and bolts to install aluminum storm doors, screens, flashing, gutters, downspouts, shingles, awnings, and venetian blinds—some 200 building products in all. Appropriately, the Aluminum Association uses aluminum foil wallpaper at its Washington, D. C., office.





Can-do dog named Bubba retrieves aluminum cans for Thomas Turner of Tampa, Florida (left). A Reynolds recycling center nearby offers 17 cents a pound for such refuse.

Mrs. Therese Daubenthaler (right) canvasses Cape Coral twice a week. When a plastic bag once burst, orchestrating a "symphony of beer cans" on the pavement, a deputy sheriff tried to ticket her for littering. "Listen," she said, "instead you should give me an award for cleaning up." The officer helped her pick up the cans.

Last year Americans turned in more than six billion cans for recycling and earned 45 million dollars. Meanwhile, Government and private industry devise ways to retrieve the metal from urban waste. A metal separator built by the Raytheon Company is tested at a Bureau of Mines facility in Maryland (below). Eddy currents created by magnets help sweep aluminum and other nonmagnetic metals into the narrow channel at right.

percent. Alcoa is heavily involved in secondary collection—providing a market for collectors such as Coors and Pearl.*

Skeptics of the push for can recycling say it is aimed in part at heading off national legislation that would impose deposit fees on all beverage containers—legislation already in force in Oregon and Vermont, and soon to take effect in several other states. This view finds voice in Dr. Bruce Hannon of the Center for Advanced Computation at the University of Illinois, who also contends: "Energy-wise, aluminum is misused in beverage containers and packaging."

Prospectors discover another bonanza in "urban ore"—the millions of tons of garbage that cities and counties struggle to sweep under the rug of countless landfills. A growing galaxy of corporations—Raytheon, Teledyne, Grumman, Boeing, American Can, and others—are plunging into the

*For the nearest aluminum-can recycling center, call toll free: 800-223-6830; in New York State call collect: 212-765-8003.





construction of plants for plucking aluminum and other recyclables from refuse.

To hasten the day when this scrap becomes available, the big aluminum firms and other industries set up the National Center for Resource Recovery in Washington, D. C. Its head is dynamic Dr. Rocco Petrone, former director of the NASA Apollo program that put man on the moon.

"This is a complex technology," said the burly engineer as we toured the center's pilot plant in Washington. "In mining refuse we have to work with everything from banana peels to car axles. One thing that helps is the aluminum magnet."

Aluminum *magnet*? I knew that one property the magic metal lacks is magnetism.

"We set up a strong magnetic field," explained Dr. Petrone. "When a nonmagnetic metal such as aluminum moves through the field, it is repelled—kicked aside. By placing a cluster of magnets alongside a conveyor belt in a recovery plant, we can kick the aluminum scrap right into containers."

I set forth to inspect the nation's first complete resource-recovery operation—in pleasant Ames, Iowa.

In 1971, I learned, the city's landfill was overflowing, and neighboring farmers balked at surrendering lush cornland for another site. Garbage, lamented an official, is something "everyone wants you to pick up, and no one wants you to put down."

Recovery Plant Welcomed Downtown

Finally the town fathers agreed on a resource-recovery plant, located right downtown. In 1975 the 5.6-million-dollar installation began ingesting its first garbage.

Standing beside a control panel studded with dials and lights, I watched garbage trucks bring in the plant's daily intake of 150 tons. "Those are our ore trucks," noted superintendent Jerry Temple as he led me through the facility.

Merciless flails shredded the refuse, and magnets snapped up iron and steel. An air classifier winnowed glass and the remaining





metals by weight. Then a long belt carried fragments past an oblong, boxlike device. "That holds the aluminum magnets," noted Jerry. As I watched, pieces of cans and other aluminum debris miraculously shot to one side and fell into a collection bin.

At the end of the line we saw the final unrecyclable remnants—food and paper scraps, plastics, fabrics. These were ground into fine particles and piped as fuel to a nearby municipal electric-generating plant. There every two pounds of waste gave off the heat of a pound of coal.

Some experts contend that laws and freight rates place recycling at a disadvantage in competition with natural resources. An EPA report notes that "federal subsidies for raw materials exploration, research, and development . . . tend to discriminate against recycled materials."

Recycling Bandwagon Attracts Major Cities

Nevertheless, officials foresee a steady growth of plants, such as the one in Ames.

When? More by evolution than revolution, they agree, but the process already is well under way. Plants now operate in New Orleans, Milwaukee, and other cities. A dozen more metropolises have facilities planned or under construction.

Where will it all lead?

I frequently heard approval of the goal expressed by Nobel Prize-winning chemist Glenn T. Seaborg, former chairman of the Atomic Energy Commission. Dr. Seaborg envisions a society in which "the present materials situation is literally reversed; all waste and scrap—what are now called secondary materials—become our major resources, and our natural, untapped resources become our backup supplies."

When and if this day comes, versatile aluminum will be playing a role—or maybe two or three: □

Aluminum takes off. Some 110 tons in this Boeing 747 and its backpack, Rockwell's Space Shuttle orbiter, test-fly at Edwards Air Force Base in California.

Powered by a part-aluminum engine, another aircraft took off from a North Carolina beach 75 years ago. It was called the Flyer. Its pilot was Orville Wright.



Raising its skyline along with its sights, Atlanta has built new office towers and hotels, capped by the 72-story Peachtree Center Plaza Hotel, to play its role as

Georgia, Unlimited

By ALICE J. HALL SENIOR EDITORIAL STAFF

Photographs by BILL WEEMS



capital of burgeoning Georgia and the Southeast. Now, supported by one of the busiest airports anywhere, it aims to be a convention and trade center to the world.

“THERE HAS BEEN A CHANGE in the last couple of years,” the speaker intoned with a rhythmic inflection, “an insistence on the part of the average person who’s not powerful, who’s not rich . . . to control his own future.”

Several hundred south Georgians stirred at an Albany Junior College conference that muggy July day seven years ago. In this most conservative region of a state long bruised

by history, many had grown up with built-in feelings bordering on defeatism; Yankees, they’d been told too often, had all the brains, the money, the opportunities.

Now their governor—a blue-eyed man of modest stature in his mid-40’s—was insisting: “God has not put any limit on what we can do in Georgia.”

As if to prove his point, five years later he became President of the United States.

The ascension of Jimmy Carter from the trackside village of Plains to Washington's White House has bathed his home state in a bright beam of international attention. For weeks, I too focused on this largest state east of the Mississippi, marveling at its varied landscapes. And whether or not God has "put any limit" on what Georgians can achieve for themselves, their former governor is right to this extent: There has, indeed, been a change. . . .

Georgians Scale Economic Ladder

Once famous largely for peaches and pecans, segregation and sharecroppers, and an epic novel, *Gone With the Wind*, this state to many visitors was simply a pine-and-cotton corridor on the way to the golden sands of Florida. Many Georgians themselves fled to seek opportunity elsewhere.

Yet, quietly, out of the public glare, Georgia has been progressing beyond stereotypes and unlocking its resources until it is—in most areas of life—approaching that great golden mean, the national average. The dramatic events that led to the end of segregation in the 1960's, which proved liberating to both races, coincided with an economic upswing. Now blacks and whites alike press upon me the idea that "times are better than ever" and "Georgia has a great future." Naysayers grumble, "It's getting just like everywhere else."

For all this newfound averageness, there is little that is ordinary, to these Yankee eyes, about Georgia. The largest city has developed an edifice complex, while the oldest doesn't want to tear *anything* down. It's a state where mayors play cameo roles in movies, and the governor—George Busbee—prospects from Brussels to Tokyo for investments. Where black students enter essay contests sponsored by the United Daughters of the Confederacy. Where Southern Baptists advertise a youth convention as a "Soul Bowl." (And where, in a small town at least, it's easier to find a mule egg than an atheist.)

It's a place, too, where the last fiscal year ended with a remarkable budget surplus of 118 million dollars. And where the most common question of more than six million visitors who stopped at the state's welcome centers was: "Where is Plains?"

Driving south of Macon on Interstate 75, I





Georgia

GEOGRAPHY determined destiny for the settlers of the 13th colony. Moving up its rivers to the fall line—the limit of early navigation—they established a string of cities that still remain centers of growth. South of the fall line, 98 percent of Georgia's water lies underground, available for the drilling. Drill bits have often turned up sharks' teeth, proof that this region once lay under ancient seas that left fertile sedimentary soil.



AREA: 58,576 sq. miles. **POPULATION:** 1976 est., 5,011,300. **ECONOMY:** Lumber, light industry, peanuts, pecans, kaolin clay. **MAJOR CITIES:** Atlanta (pop. 550,000), capital; Columbus (pop. 155,000); Macon (pop. 120,000); Savannah (pop. 118,000), major port.

Oil companies explore offshore; liquefied natural gas from Algeria stored on Elba Island

Elba Island
FORT PULASKI
NATIONAL MONUMENT

Wassaw Island

Ossabaw Island

St. Catherines Island

Intracoastal
Waterway

Sapelo Island

Saint Simons Island

Sea Island

SHELLFISH
Jekyll Island

CUMBERLAND ISLAND
NATIONAL SEASHORE

Atlantic Ocean



MAINTAINED BY JAMES QUINTERO
COMPILED BY OLIVER S. A. M. PAPPAS AND GUY PLAYS
NATIONAL GEOGRAPHIC ART DIVISION

NORTH CAROLINA

Wolf Sky Valley resort
Fork Valley

Clayton Blue Ridge
Chattooga River

Spectacular views of
600-foot-deep chasm
Tallulah Gorge

Alto
CHICKENS
Hartwell Lake

SOUTH CAROLINA

Athens
Bethlehem
Clark Hill Lake
Site of Masters
Golf Tournament

Sharon
Thomson
Augusta
Savannah

Far Gordon
Fall line
KAOLIN
SOYBEANS

Milledgeville
Piedmont National
Wildlife Refuge
OCMULGEE NATIONAL MONUMENT

Macon
Warner Robins
Dublin
Statesboro
CORN
SOYBEANS
HOGS

Center for agricultural
research and home of
Agrirama, a demonstration
post-Civil War farm
and village

Tifton
Douglas
Waycross
Brunswick
Marshes of Glynn
PULPWOOD

Valdosta
Suwannee River
Okefenokee Swamp
OKEFENOKEE
NATIONAL
WILDLIFE
REFUGE

TOBACCO

TOBACCO

TOBACCO

TOBACCO

TOBACCO

FLORIDA

Jacksonville

The rain of tourists in southwest Georgia falls mainly on Plains, hometown of U. S. President Jimmy Carter. One tour train (right) starts at the gas station of brother Billy, who sometimes makes a personal appearance to sign autographs (below). Cousin Hugh imports antiques from up north to sell to visitors—from up north.



pass endless fields of corn and soybeans, pastureland, and pine plantations. Graying, abandoned sharecropper cabins sag into oblivion, shrouded in kudzu vines. No one can miss the turnoff to Plains, where a billboard proclaims, "Thanks Jimmy Carter, President."

"You should have seen Plains before," laments bookkeeper Sue Chambliss, blond mother of four, pausing at the adding machine in the Carter Peanut Warehouse. She shakes her head at what fame and money have done to the sleepy Georgia hamlet.

The name Plains comes not from the flat surroundings but from the Bible: the Plain of Dura, where Shadrach, Meshach, and Abednego declined to worship the golden idol set up by Nebuchadnezzar.

Georgia's Plains started as a rail depot,

and for generations its block-long main street with a grocery, hardware store, offices, and warehouses has overlooked the tracks in peace and quiet.

The town counts 641 residents, give or take a dozen, depending on which members of the Carter clan are around. But now visitors often outnumber residents four to one. Main Street has become one vast souvenir shop (above); beside Billy Carter's gas station, jitney buses begin a town tour, with drivers spicing fact and fancy.

"The souvenir businesses began after Jimmy was nominated," Sue recalls. "People wanted anything; I even saw a woman scoop up a handful of dirt to take home."

Sue herself came up with an idea for a deck of cards bearing Carter's picture. "Jimmy said that was fine. They sold well for a



while; then everyone got on the bandwagon with cheap trinkets.

"Anybody looking for something spectacular won't find it here," Sue admits. "Still, I think Plains makes people glad to see the President came from an ordinary place."

Atlanta Rebounds From Overbuilding

But Plains is no longer ordinary. Neither is Atlanta, Georgia's booming capital. No one calls it an overgrown country town anymore.

Metropolitan Atlanta sprawls over 15 counties—an area of gentle climate and gentle hills, of small towns and vast subdivisions, and trees enough to gratify John Muir. It is home to nearly two million, and at its heart is the city: "a new place—modern, democratic—a fresh production, wholly

practical, without antiquities or prejudices." That's how Atlanta billed itself in the 1880's, and the description has never fit better than now.

Settled in the 1840's around a railroad terminal, it is today the Southeast's leading city, its hub of finance, transportation, communications, federal agencies, and trade.

"Back in the sixties, we were known as the 'Cinderella City,'" recalled John Portman, a native-born, world-renowned architect, as he welcomed me to his downtown office suite, a vista of bronze-colored carpet, modern sculpture, and yellow chrysanthemums. "The word was that you could build anything in Atlanta, even build it backward, and it would succeed. Well, we overbuilt, way beyond the point of need."

I thought of the ride I had just taken in



Creativity wears many faces in Atlanta, the town that Union General Sherman burned down and each generation has built anew. In 1967 Atlanta architect John Portman designed his first hotel, the Hyatt Regency Atlanta, with a revolving rooftop restaurant, reflected in the glass of the Coastal States office tower (above).

"Swing low, sweet chariot," sing the Gospel Conveyors (upper right), but they swing high on a bridge above the ice rink at Omni International. One of the city's breathtaking megastructures, it includes offices, a hotel, and a convention center, as well as a sports coliseum. With entertainment, restaurants, shops, and discotheques, such complexes draw millions of

tourists and convention delegates each year, as well as countless Atlantans from the suburbs.

Holding his finger on the political pulse, second-term Mayor Maynard Jackson—here with his wife, Valerie—fosters the traditional alliance between city hall and the business community while seeking to revitalize neighborhoods and boost local arts. He has spearheaded multimillion-dollar construction projects for the city—rapid transit, a new central library, airport expansion—while insisting on participation by minority contractors. Despite a police cheating scandal that has made him a target of criticism, the mayor believes Atlanta can become a "model of urban excellence."



Portman's first hotel, the popular Hyatt Regency Atlanta. Through the atrium lobby I zoomed up 22 stories in a glass-bubble elevator right through the roof into a revolving satellite restaurant (preceding pages). With such innovative design, Portman in 1967 helped set the tone of Atlanta's renewal. A boom in hotel building ensued, attracting a profitable convention trade that now draws more than 700,000 delegates a year.

By 1974 overbuilding, overspeculation (even by major banks), the oil embargo, and a national recession all took their toll. Atlanta's boom, it appeared, might turn to bust.

"No way," Portman assured me. "This year has seen a turnaround. Speculative ventures have gone under, losses are being absorbed, construction is starting again. We could even use another hotel downtown."

Portman's newest hostelry, the 72-story glass cylinder of the Peachtree Center Plaza Hotel, thrusts Atlanta into the clouds (pages 212-13). Inside I had relaxed on a cushioned "conversation pod," like a private lily pad,

on the half-acre lake that is the lobby. The architect explained: "My design philosophy is to bring people together in interesting, unexpected ways. That really comes from being in Georgia, with its southern ideas of friendliness and courtesy, and the recognition of fellow men as individuals."

Like any conventioneer I experienced the wonders of the other hotel megastructures. I skated at the Omni's Olympic-size ice rink, dined on pheasant at Nikolai's Roof at the Hilton, and then tried to burn off the calories at its tennis courts. At Colony Square I shopped at boutiques and admired an abstract fountain sculpture.

Into a Living Time Capsule

Not everyone appreciates the new look. One disappointed visitor wrote back to the *Atlanta Constitution*: "In two hundred years Atlanta . . . will only be remembered for glass elevators, stark concrete, and conventions . . . another center for the fast-buck franchise." The letter writer did,



"I just like to run," says high-school sophomore Vicki Whitlow. Joining more than 6,000 others, she finished well in last year's 10,000-meter Peachtree Road Race, an increasingly popular Atlanta tradition on the morning of the Fourth of July.

"It's a celebration of America and the values that we prize in our part of the country," says Max Cleland, head of the Veterans Administration, of the Fourth of July parade that in 1977 honored Georgians in Washington. Cleland, who holds a master's degree in history from Emory University, was disabled in Viet Nam but came home to win election to the state senate in 1970. He believes the Carter election to the Presidency affirms that "no longer must all political talent come from the North and West. The South has been developing. Now the seeds are bearing fruit."

however, laud the city's efforts to preserve its heritage—underground.

To see what's left of Atlanta's early days as a rail center, one must go below. As the town grew, it built bridges and viaducts over track crossings, covering entire city blocks and forcing businesses to move up to sunlight. In the late 1960's entrepreneurs transformed the decaying area into Underground Atlanta, a shopping and entertainment district that evokes the Gaslight Era.

At dusk I descend into Underground Atlanta, as into a time capsule. Streetlights cast dancing shadows over the brick storefronts along Old Alabama, the city's first thoroughfare; Muhlenbrink's Saloon and Dante's Down the Hatch promise extraordinary delights within. A rinky-tink piano sounds and fades. Then, breaking my reverie, evening's fun seekers fill the street, but not to overflowing, for Underground is suffering hard times.

Peering through a wooden gate on the north side of Old Alabama, I see one reason

why—the maw of a construction site for MARTA, metropolitan Atlanta's rapid-transit system. The 53-mile, 2.1-billion-dollar rail network, financed by county sales taxes and federal grants, is the largest public-works project in the South since TVA. Scheduled to shuttle its first passengers in December, the system should relieve the traffic congestion and air pollution that now plague downtown Atlanta.

"But demolition for MARTA destroyed a third of Underground and really hurt business," complains G. David Hawthorne as he shows me through his wax museum. His crisp British Columbian accent marks him as one of the Atlanta majority that hails from somewhere else. He brightens. "Still, we have to think positive about MARTA. In less than two years the central terminal will open and connect to us by a 200-foot tunnel. Then Underground will rise again."

Exploring beyond the business district, I met a kindred spirit who believes, as I do, in the city neighborhood. Tall, soft-spoken



Merlissie Middleton teaches sociology at Morris Brown College, founded in 1881 by the African Methodist Episcopal Church. The college is now a part of Atlanta University Center, a six-school consortium focusing on higher education for blacks.

As we talked, a girl burst into the office to share the news that she'd pledged the sorority of her choice. Mrs. Middleton congratulated her and assured her that a formal dress mailed from her Delaware home would arrive in time for the initiation.

"Our students come from all over," she explained. "Parents like the idea of a Christian college, students like the small size, and most think Atlanta is paradise itself."

The city, now 60 percent black, enjoys a relatively high degree of racial cooperation. While white businessmen hold economic power, black leaders control the political and educational machinery. Mayor Maynard Jackson (page 219), elected easily to his second term last year, encourages neighborhood revitalization and cultural activities. Black and white leaders meet in many forums to work out city problems. And even the rigid lines that once separated sections of the city are blurring.

Dr. King's Dream Began Here

"Take my neighborhood," Mrs. Middleton said. "Cascade Heights was white until about ten years ago. Then black families started moving in. Now even the churches have changed from white congregations to black. But there are still seven white families on my street. They get along fine."

We drove along her street, a place of large ranch houses with rambling yards, many ending in woodland. And we drove through a few of the city's other neighborhoods. There are more than a hundred, ranging from the affluent quietude of predominantly white Buckhead and predominantly black Collier Heights to poor-black Vine City and poor-white Cabbagetown. We heard the ring of hammers as people restored homes in

integrated Inman Park and West Side, and we listened to the bittersweet sound of soul on black Auburn Avenue—"Sweet Auburn." There we paused in silence at the simple grave and memorial to Atlanta native Dr. Martin Luther King, Jr., recalling the immense social revolution he led.

Later, the Reverend Bernard Lee, one of King's aides, told me: "Georgia has come a long way; it's desegregated, and it has elected 260 blacks to public office. But the dream has not been realized. There are still the old attitudes of hostility around. In some rural counties where blacks predominate, they face intimidation by whites in power. We are still holding voter-registration drives. And among the poverty stricken, there is a pervasive apathy."

Sculpture in a Bucket

There may be poverty in the Atlanta neighborhood called Mechanicsville, but I found little apathy and plenty of creativity one soggy afternoon when I entered its Neighborhood Arts Center. The roof was leaking. The drops plopped cheerily into huge paint buckets, and the "creation" had been labeled "Natural Water Sculpture."

Center director John Riddle, himself a painter-sculptor, spoke with quiet enthusiasm. "The city was going to tear down this old elementary school until some 150 neighbors protested to the city council. The school board leased part of the building to us, and we've hired a staff of 33, mostly unemployed artists, with federal funds." (Atlanta is one of the few places that funnels money from the Comprehensive Employment and Training Act [CETA] into the arts.)

Center artists divide their day between their own endeavors and teaching free workshops, giving demonstrations, and contributing to exhibits and publications.

"See how we deal with broken windows," Riddle said, pointing. A pane had been repaired with plastic resin to resemble a stained-glass window, and the pattern

Suited to his work, microbiologist James Lange wears a protective pressurized-air suit to study highly contagious exotic viruses at the new Maximum Containment Laboratory of the Center for Disease Control, in Atlanta. The national center, growing out of a World War II agency for controlling malaria, investigates diseases around the world and trains 11,000 health workers a year.



was a delightfully multicolored crocodile.

As a cultural center, Atlanta has come a long way from 25 years ago when it had only a few good restaurants and one museum; people entertained at home. Now Robert Shaw conducts the top-notch Atlanta Symphony Orchestra and the renowned Atlanta Ballet Company flourishes. New dance, mime, and theater groups spring up as frequently as new restaurants. The city supports major-league basketball, baseball, football, and hockey teams, and prestigious traveling exhibits come to the Memorial Arts Center. As many as half a million people attend the annual nine-day May Arts Festival in spacious Piedmont Park.

Rural Georgia Spawned Literature

"I see Atlanta as a new Left Bank. You'll find a large community of creative people here, just like Paris in the twenties," said Margaret Anne Barnes, red-haired author of the book *Murder in Coweta County*, a true story of Georgia justice in 1948. We were driving the forty miles from Atlanta

past raw subdivisions and aging small towns to the book's locale, Margaret Anne's childhood home of Newnan, a former mill town that now makes everything from underwear to water towers. The joys and heartaches of such communities have inspired much of southern literature, which, as novelist James Dickey has observed, comes right off the front porch.

Among Georgia's great storytellers one thinks not only of Dickey, but also of Flannery O'Connor and Carson McCullers.

"And Margaret Mitchell, of course," Margaret Anne added. "She had heard Civil War stories all her life. In *Gone With the Wind* she dramatized them to show how the white Southerner survived defeat."

The Civil War lives on in more than the epic novel. Before the Greek Revival courthouse on Newnan's main square stands a marble statue of a Confederate soldier. And Margaret Anne had a story: "Before Georgia developed her own marble industry, Yankees came through selling statues to most every town in the state. Miss Helen Long,



Japan comes to Georgia and likes what it finds: climate, transportation, willing workers, and a friendly welcome. At Texprint, Inc., a Japanese textile-printing plant in Macon, Manabu Kiyama, a technician who brought his whole family to Georgia, adjusts print rollers with foreman Henry Jackson. Georgians respond well to Japanese management policies, which consider workers' problems and ideas.

who organized the United Daughters of the Confederacy chapter in Newnan, ordered this one, but when they set him up she discovered he was wearing a Union cap. Well, she quickly covered up that awful error with a garland of flowers until she could get him out of town to be remade.

"Even now, the past is important to many Georgians. On April 26th, Confederate Memorial Day, UDC ladies decorate the statue and the graves of both Confederate and Union soldiers in the Newnan cemetery. A lot of people will always remember."

Outside Industry Comes Knocking

A lot more are too busy concentrating on present prospects to look backward. People like Arthur "Buddy" Ball of Gainesville. "It's Georgia's turn now," he commented, intimating that North and West may have passed their prime. I visited across the hood of a 1968 Dodge with this solidly built 36-year-old, who, with his propensity for the outdoors, good food, and civility, could easily pass for the prototype good ol' boy.

"You'll have to excuse this shaggy beard, ma'am. I'm letting it grow for deer season."

We talked in the auto body shop of Lanier Area Technical School, where Buddy devotes 12-hour days to tailoring courses to the needs of incoming industries. And in they pour—1,675 since 1970.

Heinz is making frozen pizzas in Lithonia; Brown and Williamson is rolling cigarettes in Macon, where YKK, a Japanese firm, makes more zippers than any other company in the world. Wrigley's manufactures chewing gum near Gainesville. Aggressively the state searches worldwide for diverse, high-technology, low-polluting companies, and maintains offices in Brussels, Tokyo, São Paulo, and Toronto.

Georgia, like several other Southern states, offers a free program called Quick Start that screens and trains prospective employees to meet newcomers' needs.

"That's a main reason why we came," admits Dick Freeman, manager of Marlin Rockwell, a division of TRW, Inc.; the plant makes ball bearings near Gainesville.



Mr. Coca-Cola, Robert W. Woodruff led the Atlanta firm from 1923 to 1955, the years when the soft drink became the world's most publicized product. Behind the scenes he engaged in an astonishing philanthropy, quietly donating so many millions of dollars to the creation of Georgia art centers, medical facilities, and parks such as the Ossabaw Island wildlife preserve that he is also known as Mr. Anonymous Donor.

When the division needed to expand from its Jamestown, New York, headquarters, it liked Georgia's warmer climate and the state's right-to-work law. "In fact, we have used the nonunion situation to restructure the whole operation."

In a variation of the team-assembly concept pioneered by Volvo in Sweden, workers are divided into teams that help plan production, apportion work, set hours, and evaluate members. Any man or woman can climb the salary scale by mastering increasingly complex skills.

Each employee is responsible for quality, and in the unusual Marlin Rockwell system

actually handles customer relations. Thus, when a Detroit customer complained, two workers, Shirley Reeves and Dorothy Walden, boarded a plane, dealt with the problem, and returned with ideas for avoiding it the next time.

Jim Hamerstone, a Massachusetts Yankee who teaches group dynamics to employees, says: "They grasp team management as quickly as students in doctoral seminars at Harvard. They aren't afraid to ask questions. On other jobs they often knew when something was wrong. But former employers didn't hire them to think."

Here thinking pays—in more interesting



work and higher productivity. He adds, "We're not in this for fun. If we don't make a lot of ball bearings, the Japanese will."

And they might even make them in Georgia. Through a curious quirk in the world economy, the Japanese are faced with such high inflation at home and rising import quotas in the U. S. that they have begun to build factories in this country, more than a dozen so far in Georgia (page 224).

Georgia Goes Hollywood

Perhaps the most interesting new industry from outside the state is the movies. More than a hundred films have been shot

here since 1971 when James Dickey helped transform his violent novel, *Deliverance*, into a film. That twelve weeks of movie making along the Chattooga River brought windfall profits and publicity to the scenic northeast corner of the state. (It also brought thousands of rapids runners; the treacherous Chattooga has since claimed 15 lives.)

Georgia's director of tourism, Ed Spivia, recalls his early efforts to promote the entire state as a movie locale. "I started by going to New York and Hollywood to drum up interest; now producers come to us. We scout cities and farms, obtain police permits, set up accommodations, and even handle the



Georgia's gift to golfdom, the famed Masters Tournament drew 30,000 spectators to Augusta last April. The invitational competition, started 44 years ago by Georgia golf great Bobby Jones, unfolds on the extraordinary course he helped build. Here at the 18th hole, 1977 Masters champion Tom Watson attempts a crucial approach shot (left) that would have put him in the lead. But this year Gary Player of South Africa, after a dramatic come-from-behind victory, donned the coveted green jacket (above) and received the congratulations of his daughter and son.

weather. . . . Well, we get official forecasts."

Organized hospitality has paid off in 60 million dollars spent by filmmakers in this decade, in jobs, and in fame as the most favored back lot after California and New York. Fans are surprised to learn that such diverse films as *Smokey and the Bandit*, *Roots*, and *Grizzly* were shot in Georgia.

Following a Trail of Melons

With most young Georgians in school or factory, office, or studio, who's tending the farm? On a hot July day I enter that agricultural heartland known as south Georgia to find out. The road I travel is lined with smashed watermelons, like some trail blazed by a profligate giant. At the State Farmers' Market in Cordele, I find the reason. Hundreds of pickups, parked nose to nose in tin-roofed shade, bear pyramids of melons. From many the apex is missing, having rolled off to roadside oblivion.

The owners jaw with dealers from up north; semitrailers gobble up 40,000-pound loads bound for distant picnic tables. Exactly 194,731,380 pounds of watermelons are to change hands here during the season—for exactly \$4,868,284.

I stroll the market, admiring the varieties with names as colorful as those of racehorses: Cobb Jim, Black Diamond, Jubilee, Charleston Grey. I select a small striped Crimson Sweet. "Only 50 cents. It cuts so pretty," a proud farmwife tells me.

"Watermelons are just dessert for the Georgia farmer, a specialty cash crop on top of the regular harvest of staples," explains John Bullington. The young, sandy-haired, third-generation farmer volunteers to show me around this fertile farming region. I remark on the gun rack as I climb into his dusty white pickup. "They're not my best guns," he allows, in that soft drawl. "I just keep 'em there to shoot turtles in farm ponds



and wild dogs." (In rural Georgia, guns are as everyday as grits.)

We drive along well-paved county roads past fields bursting with near-tropical lushness: tobacco, corn, cotton, soybeans, and peanuts, a crop sometimes so profitable it earns the sobriquet "mortgage breaker." Many farmers here harvest two crops during the March-to-October season; farther south, even three.

Farm Earnings Lag Behind

I remember the past and I marvel. During the Depression, you couldn't give cotton away; sharecroppers were locked in spirit-sapping poverty portrayed by Erskine Caldwell in *Tobacco Road*, a novel set near Augusta. President Franklin D. Roosevelt, frequent resident of Warm Springs, labeled Georgia and its neighbors "the Nation's No. 1 economic problem."

Gradually federal money flowed in, and

erosion control, crop rotation, fertilizers, and pesticides took hold. Now farmers—and there are only three in any crowd of one hundred Georgians—have moved the state into 15th place as an agricultural producer. Yet while costs soar (a 400-acre farm near Cordele represents a half-million-dollar investment), earnings average only \$14,000 a year. "We have to grow—add more acres or boost our yield," John notes, "or we die."

Most sharecroppers and many marginal farmers have left for city jobs. Yet those still unable to escape poverty account for 15 percent of the state's families, a shadow on Georgia's success story.

Suddenly I am squinting as the setting sun glistens through a silvery arch moving over a dark-green sea—almost a scene from an Oriental scroll. It's an automatic sprinkler, working its way across a neighbor's peanut field, scarcely disturbing elegant white cattle egrets feasting on insects.



ERIC LEBEL, WENDELL HETICH

"Heaven's right here on earth," many Georgians say of their protected wilds, such as Okefenokee Swamp (left) and the Marshes of Glynn (above). Old-timers recall exploitation: "We skinned alligators, cut down trees. We didn't know better."



Lip-smacking miscellany of a country store in Clayton (above) and a roadside stand in Alto (upper right) belies the hard row that dirt farmers of north Georgia still hoe. Vendor Tommy Wagner, along with seven brothers and sisters, helped plant and harvest the produce he sells. Drought last year wiped out 45 acres of sweet corn, and now "we're barely feeding ourselves," his father asserts. "Everybody else around here has another little job somewhere."

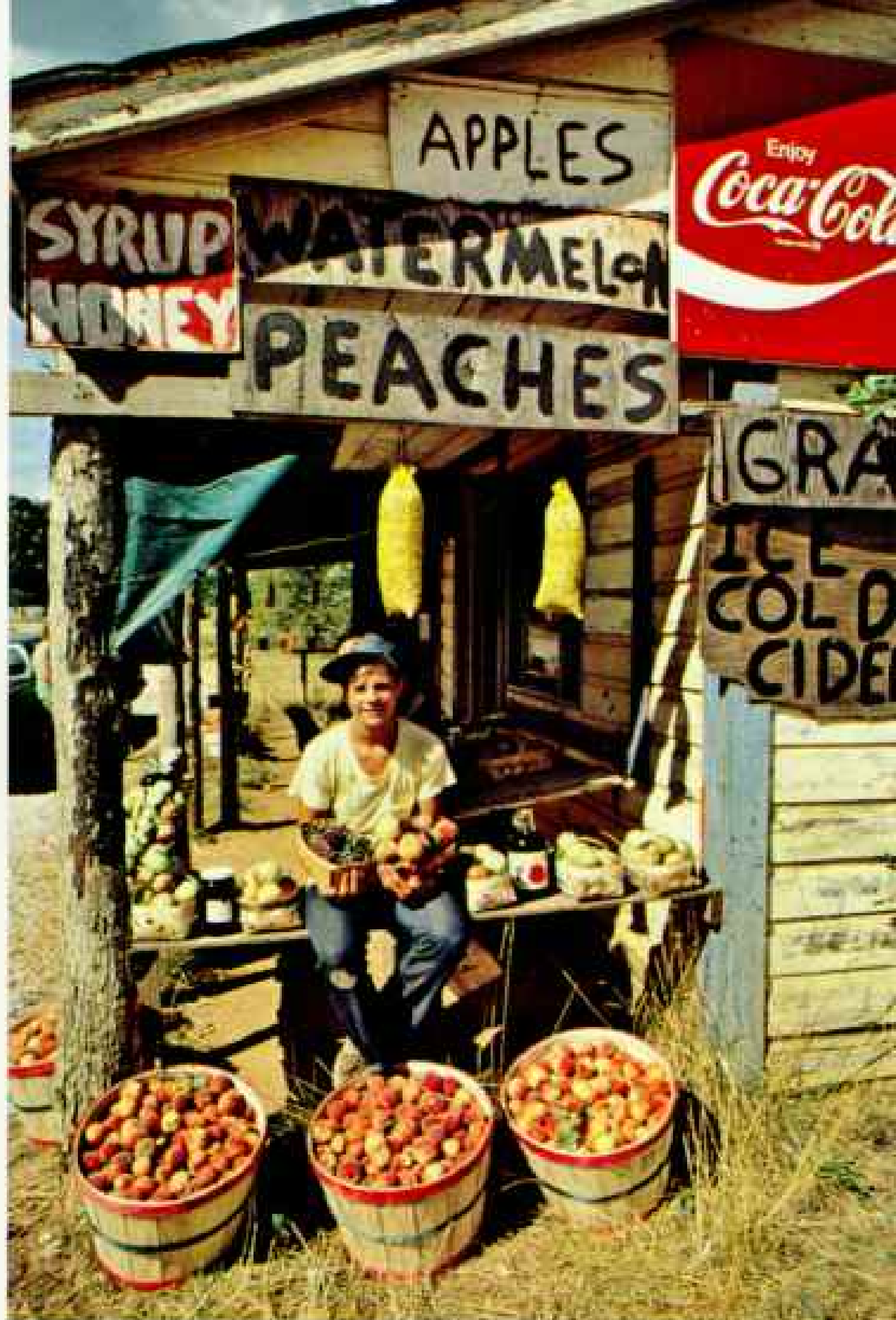
Indeed, only 3 percent of Georgians are farmers. But the Wagners persist. "It's like gambling," Mr. Wagner says. "You get hooked on working the land."

The water, pumped from aquifers 20 to 1,000 feet deep, is setting off another agricultural revolution hereabouts. But like many other farmers, John hasn't purchased the costly irrigation pipes yet. "We just trust in the Lord to bring us water."

John may well change his mind. By fall one of the worst droughts in living memory had withered his crops. This, plus low prices resulting from bumper crops elsewhere, left John and his neighbors in the red and spurred unprecedented action: Georgia farmers went on strike.

"We hate that word," John told me later. "Farmers think labor strikes cause our inflation problems. But something just has to change—for us."

In December, instead of plowing his



fields, he fired up his tractor to join a cavalcade heading for Atlanta. There, with 6,000 other farmers, he circled the capitol in one of the largest farm protests in American history (page 234).

Hard Road for Rural Blacks

Sixty-five-year-old Daisy Mae Street has no intention of going on strike, expanding her farm, or losing her hundred acres in south Georgia's Crisp County. She seems as firmly rooted to her land as the live oak that shaded us on a July afternoon. She had just watered her garden and gathered cabbage, and the fecund odor of living earth surrounded us. While millions of black Southerners have left for opportunities elsewhere, millions more like Mrs. Street have stayed

home to work a patch of native ground.

"My granddaddy-in-law and his relatives bought this land in the 1880's for \$1.50 an acre. They skinned the trees and cleared them. I grew up next door in Dooly County, raised hand-to-mouth. We walked four miles to school in an old church that never had but two books. I had to quit at 10 to go to work. I came here as a bride in 1930."

Mrs. Street beams when she speaks of raising three children to self-sufficiency: a son who owns an auto body shop in town; a daughter who teaches in Atlanta; another daughter, who died, leaving two teenagers in Mrs. Street's care.

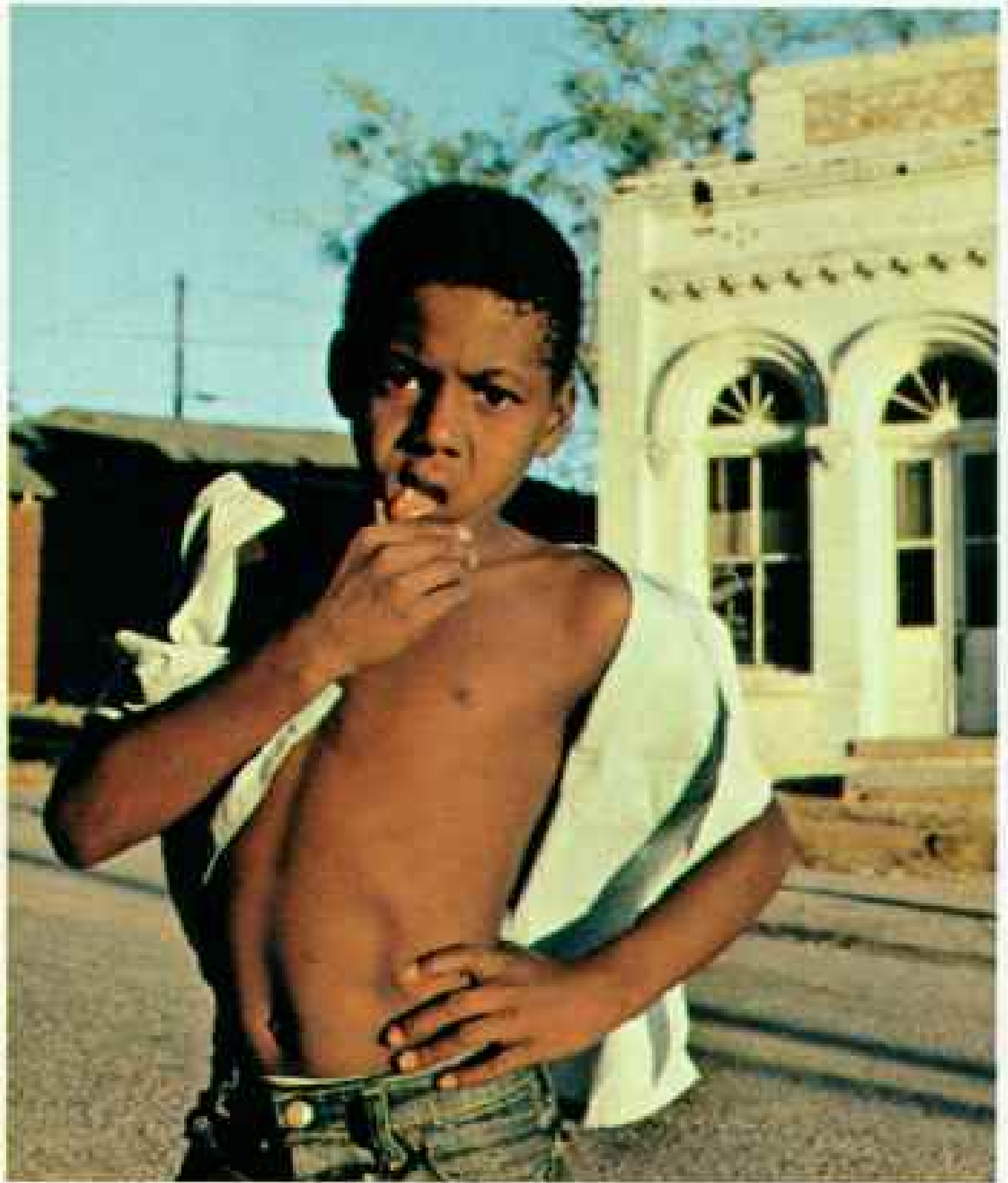
"My husband passed without insurance, and I tried to farm myself, but the help was no good. If *(Continued on page 235)*

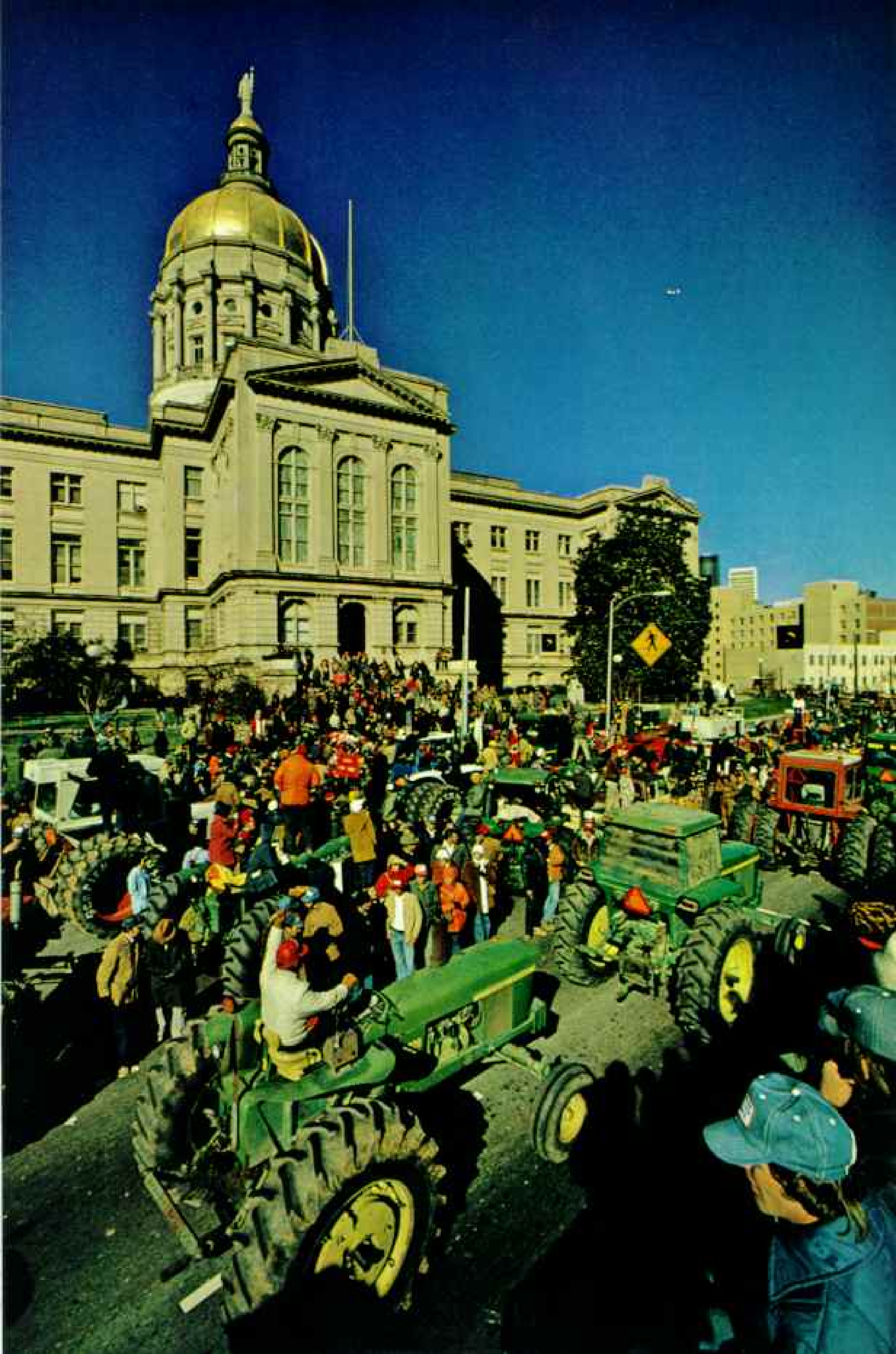


Foggy mountain reverie: Appaloosas (left) await their owner, Rabun County horseman Frank Rickman, whose homeland is crisscrossed by riding trails.

In rural Georgia, as elsewhere in America, the picturesque sometimes masks a deep poverty. Before the boll weevil toppled King Cotton and the trains shut down, villages with Biblical names like Sharon and Bethlehem flourished. Then dispossessed farmers migrated to cities, and the towns shrank to a grocery and a filling station, or a post office (below).

Those who remain often become commuters—traveling to larger towns for jobs and education. Ten-year-old Curtis Harris (right), playing beside the closed-down bank in Sharon, must ride a bus to attend a county school.





I didn't watch, they'd just go off in the woods and smoke. Now I rent out most of the land to a white man who has equipment. I just raise a few beans, tomatoes, okra, squash, cucumbers, and so on. Honey, it's been rough," she said, shaking her graying head, "but we made it."

No Facilities for Hangman

"You Yankees, you'll pardon the expression, ma'am, have heard a lot about southern injustice. Well, that's changing." Deputy sheriff Sam Pierce leaned forward and spoke fervently, like a Methodist minister with a sinner in tow. I met the young, non-nonsense lawman in jail. I had mistaken the Glynn County Detention Center for a new motel in the coastal town of Brunswick. Anyone could make such an error. Two attractive concrete stories with tinted-glass windows rise above arched walls of tabby, the local concrete made of ground seashells.

At the booking desk, I found a woman motorist handing some money to the stocky former federal marshal.

"What's this for, ma'am?"

A small child piped up, "Mummy went through a red light."

Pierce carefully recorded the \$22.50 fine, and then proudly showed me through his new center. "You should have seen our old wooden jail from 1800-something. Full of rats and roaches. The floors buckling. It even had a trapdoor for hangings. A grand jury condemned it, and voters approved this replacement for three million dollars. Then one of our prisoners brought suit, saying we violated his rights by not having recreational facilities, so we're adding a million-dollar rooftop exercise area. Next, it will be a color TV and a law library. Seriously."

Despite such local progress, much of Georgia's penal system still suffers from overcrowding and violence, conditions that frustrate attempts at reform.

Yet the state has moved ahead of most others in some aspects of law enforcement,

requiring all officers to undergo intensive training and setting standards for elected sheriffs. Its governors have closed down speed traps, and its crime labs and academies rank with the best in the nation.

With all the demands on a modern lawman, how does he relax? The same way most Georgians do—by getting out in their great outdoors. Pierce led me to an east-facing window and pointed to the horizon. "I've got my boat over there by Blythe Island, and I go fishing every day."

The bracing tang of salt air draws me into that labyrinth of rivers, marshes, and barrier islands, the hundred-mile coastline that is the flip side of the Georgia coin.* Here you find some of the most extensive salt marshes in the country.

One could happily spend a lifetime exploring this wilderness. Charter-boat captain Frank Mead has made just that choice. Raised in rural Virginia, he fell in love with the Georgia coast and moved his family to St. Simons Island seven years ago. Now he guides fishing parties from the Cloister, the exclusive resort on Sea Island.

Public Protection for Marshlands

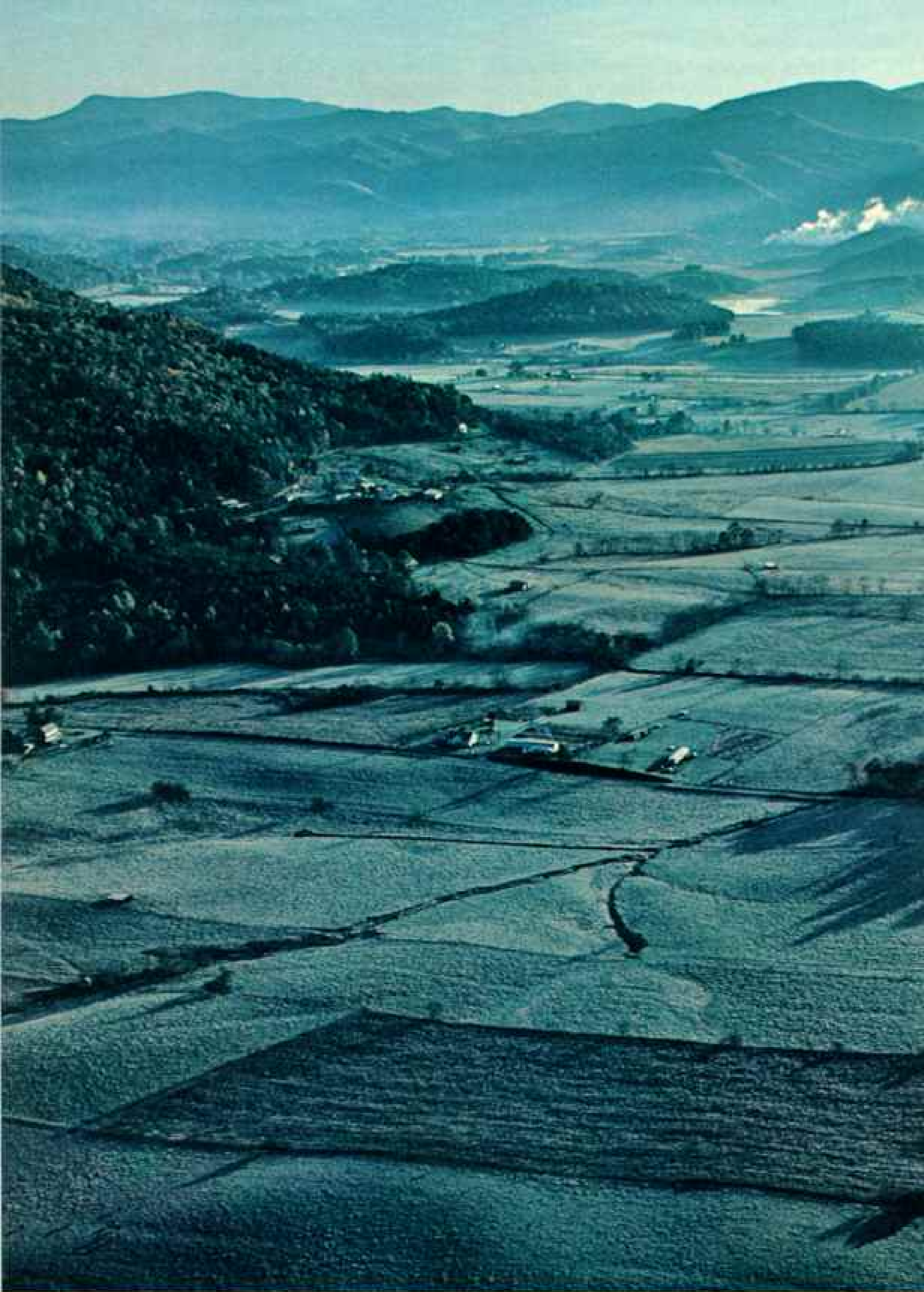
On a summer morn when the air is as still as the backwaters, Frank takes me on a boat trip through the marsh-grass realm of blue heron, osprey, and pelican. "There's mink, raccoon, and otter out there too," Frank tells me. "But like fish, they either come out for you or they don't."

He beaches the boat on shell-littered Pelican Spit to check a nesting colony of skimmers, distinctive white-vested black marine birds with bright-red bills. At our approach females rise from their nests, mere indentations in the hot sand that cradle four or five speckled eggs. Some birds lope away, feigning broken wings; others face us directly, a squawking

(Continued on page 239)

*James Cerruti described the "Sea Islands: Adventuring Along the South's Surprising Coast," in the March 1971 NATIONAL GEOGRAPHIC.

Shouting for attention, 6,000 Georgia farmers drove tractors to the state capitol last December in an unusual show of solidarity. Devastated by drought in 1977, they strongly supported the nationwide American Agricultural Movement, demanding federal action. This spring many cut back planting of corn, soybeans, and wheat, hoping scarcities would drive up prices.





“They are old mountains,” artist and author John Kollock has written about his northeast Georgia homeland, “and being old they contain much of the stored-up wisdom of an evolving nature over the centuries. A person cannot rush up on them and expect to gain anything.”

For the patient seeker, beauty shines in a maple leaf on dew-dappled grass (above) and the vista of Wolf Fork Valley rolling eastward through the Blue Ridge (left). For city youngsters, summer camps nest in the forests, here at the headwaters of the Little Tennessee. For the gourmet, family-style dinners spread out as many as forty homegrown, home-cooked delights. For the collector, grandfathers still whittle nonsense toys, and women stitch cotton rag rugs and bright quilts. For all, there is the pleasure of meeting just good folk.



battalion. But the inhabitants of this marshy realm have little to fear these days. A citizens' campaign in 1970 led to the creation of a marshlands protection program.

Half of the fabulous islands themselves—once the estates of wealthy northern families—have come into the public domain.* Likewise, the coast's gateway city, Savannah, now enjoys a special guardianship.

Savannah! To residents of the first city this is the *real* Georgia, the ideal, first class. Gen. James Oglethorpe founded the 13th colony here in 1733 as a refuge where the deserving poor might practice agrarian equality. The fruits of their labor, wine and silk, were to enrich the British Empire. The colonists themselves would be a living buffer, protecting the Carolinas from the aggressive Spaniards in Florida.

Only this last goal was achieved—with the defeat of a Spanish invasion on St. Simons in 1742. Grapevines and mulberry trees perished, and much of Georgia was to be settled by disgruntled frontiersmen from Virginia and the Carolinas. Savannah became a mercantile city, a place apart.

Savannah Glories in the Past

Oglethorpe's genius survives in the town plan. On a bluff above the Savannah River, airy squares serve as focal points for neighborhoods. Around them, generations of Savannahians and wealthy northern and British merchants built their town houses in the changing fashions of the centuries.

Twenty squares survive—shaded parks of oak and magnolia that invited me to walk, as native son Conrad Aiken wrote, "through a constantly changing palimpsest of acts and scenes. . . tall windows and wrought-iron balconies, like an evanescent stencilling."

Yet 25 years ago Savannah was on the skids. Natives left for the suburbs; wrecking crews demolished once handsome old mansions for their prized handmade bricks, Savannah grays, to build suburban ramblers. The old produce market came down for a parking garage.

Finally, civic pride rebelled. A foundation called Historic Savannah came to the rescue in 1955 with surveys, planners, and funds to purchase threatened properties.

*See "Cumberland, My Island for a While," by John Pennington, *GEOGRAPHIC*, November 1977.

Farming's a handful of hard work, no matter what the crop. The Grover James family near Clayton gathers potatoes before frost (facing page). Near Tifton, corn falls victim to drought, rot, and armyworm (below), but a bumper harvest of peanuts (center) helps cushion the loss. Pecans (lower) are brown gold worth 30 million dollars to farmers around Albany.



Tomorrow's shrimp cocktail is part of the ten-million-dollar annual harvest (right) by 350 commercial trawlers working the Georgia coast.

Cold weather in January 1977 cut the take by a third, prompting the state's Department of Natural Resources and the Marine Extension Service of the University of Georgia to come to the rescue. They not only helped fishermen develop better gear, but also located a new fishing ground 60 miles offshore where four boats netted a \$50,000 catch of finfish in their first two days. Now the agencies search 100-foot depths for hard-shell rock shrimp, a lobsterlike delicacy.

A local waterman near Savannah (below) traps blue crabs, second only to shrimp as money earners along the coast.



Some 1,100 buildings of historical interest, renovated as offices or homes, have become a virtual textbook of two hundred years of American architecture.

"We've done what Oglethorpe tried to do—combine philanthropy with profit for the city," said Leopold Adler II, investment banker and president of Historic Savannah in the 1960's. We were sipping ice tea in the high-ceilinged, ivory-colored living room of the town house on Bull Street that Adler renovated. "People are moving back to town. Most of the inner city is a national historic landmark district, one of the largest of its kind in the nation, and it's attracting more than 150,000 visitors a year."

Another urban renovation, a project of Savannah Landmark Rehabilitation, extends to the adjoining Victorian district with its wooden homes fronted by marvelously ornate porches. Some have already been renovated by young couples, but most,

classified substandard, are owned by absentee landlords who rent to low-income blacks. These are to be rehabilitated for their present residents.

In the pilot project on Price Street, William H. Mobley was bossing a young crew rebuilding three small homes built long ago from Georgia pine. "You *know* they're old," he marveled. "Just look at the mortise-and-tenon joints. And those ceilings—they're ten and a half feet high!"

A young worker eased past, carrying a bag of cement. He told me he liked the pay and the chance to go to night school for a free apprenticeship program. "I've learned to tear out, but not how to rebuild yet. Right now, I'm the everything man, the general helper, till I learn a trade."

On the Savannah waterfront seven million dollars in federal grants has financed a brick esplanade, while private developers have transformed five-story cotton warehouses into boutiques, offices, restaurants, and the Ships of the Sea Museum. Even a humble locomotive that hauls freight to the port charms visitors with its gleaming bright paint, Dixieland tape recording, and the name *River Street Rambler*.

Out on the Savannah River, the excursion vessel *Waving Girl* gave me a panoramic view of the port and the great factories that fuel the local economy. Up in the wheelhouse Capt. Sam Stevens recalled, "I wondered way back yonder why the people were always going away to sightsee. We've got it all right here in Savannah!"

Frontier Spirit in the Blue Ridge

Like the coast, the mountainous north of Georgia shines with potential as a recreational resource. Here the rough-hewn fingers of the Blue Ridge bend and dig into the Piedmont. Here dancing streams are fed by one of the East's heaviest rainfalls, an average of 70 inches a year. And here the iridescent leaves of fall rival those of Vermont. Families in pine cabins, trailers, and ranch houses trace their roots to Carolina farmers who cleared valley niches before the Civil War. (Those highland settlers tallied almost enough votes to keep Georgia from leaving the Union.)

Much of the vigor of that early frontier lives on in the "can do" philosophy of north



Georgians like Frank Rickman of Clayton. Rickman's forebears include a Baptist minister, and a mechanic who in 1903 helped build the innovative Rabun Gap-Nacoochee School, an academy and working farm where the well-known student magazine *Foxfire* was born.

Mountain Man Builds Posh Resorts

A red-haired bear of a man, Frank is a legend in these parts, a man who for the fun of it captures wild boars alive. He is a self-taught architect, contractor, movie actor, prop-man, dog trainer, and developer. He prefers to think of himself as a "bulldozer operator with a dream."

Twirling his handlebar mustache, Frank unconsciously echoed Savannah's Captain Sam: "We have all the natural beauty in the world here. I want to draw visitors with high-class attractions, and keep our young people working at home."

So Frank has been designing resorts, from children's camps to golf courses. A few years back he drove down to study the Augusta National golf course, where the Masters Tournament draws 30,000 visitors each April, and came home to bulldoze pastures at the base of a mountain into an 18-hole course called Kingwood.

Recently he designed and built the state's first ski resort, 2,300-acre Sky Valley, where chalets and condominiums gracefully ring a small slope equipped with snowmaking machines. A golf course and a Swiss-chalet lodge complete the layout.

Frank's most ambitious project remains but a mountaintop dream at the end of a rutted road. Some 2,000 feet below us spread a forested valley that sheltered a few farms. Frank envisions damming a creek to create a three-mile-long lake. Hundreds of second homes for Atlantans could fit unobtrusively along the shores. On the cliff where we



Georgia's window on world trade, the port of Savannah unloads Indian jute for the state's carpet mills and Japanese steel for Atlanta's rapid transit system, while exporting kaolin clay, peanuts, and forest products. At the world's largest paper mill, Union Camp, trucks and freight cars unload logs and wood chips (right) from nearby pine forests. The company produces 2,800 tons of kraft paper a day.



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One crusader in Savannah's holy war against urban decay, Mayor John Rousakis lends official support to private efforts to renovate Georgia's first city. Parks and waterfront have been refurbished, a civic center built downtown, new lighting and brick sidewalks added, as here on Gaston Street, a row of ornate Victorian homes from the 1880's. "The real dividend," says the mayor, "lies in the new pride that residents have in Savannah." The same holds true for all of Georgia.

stood, he would build a restaurant—and a launchpad for hang gliders that would fly to the water below.

Frank has already moved some earth, but now waits for money. Convincing backers is sometimes hard because Frank works without blueprints, the old way. "I just see what I want in my head."

As Georgians face increasingly fast-paced change, they seem to look ever closer to old verities, especially to religion—often but not always to fundamentalist Protestant Christianity.

"The church is the center of everything in



a small town, even the entertainment," Mrs. Lillian Carter, the President's mother, has said. The churchgoing habit persists in cities as well. In Atlanta three large churches clustered on Peachtree Road cause a mile-long traffic jam each Sunday.

And in Macon I chance upon a family that has just moved from Florida, inspired by Georgia's religious climate. The family is Jewish. Simon and Renee Baruch have opened a bright delicatessen on the refurbished downtown mall of Cherry Street and joined both of the city's synagogues.

"I find here the atmosphere of the Bible,"

Mr. Baruch tells me. "Georgians deeply respect the part of the Bible I believe in.

"You know why I believe?" He points to a glass of ice tea. "Do you think that exists?"

Yes, I nod.

"So do the places in the Old Testament. You can touch them; I have, in Israel—the very paths that Abraham and Moses trod." He digresses to the days when he fought for the creation of the Jewish state beside now Prime Minister Menachem Begin. Then he shows off the specialties prepared early each morning by his wife—the bagels, Syrian bread, and baklava. "These are unfamiliar to many Georgians, but they will learn. We even invented a peanut baklava in honor of President Carter."

Fast Food, Southern Style

So Georgians, native and newcomer alike, link economic realities with humane virtues—religion, humor, good fellowship. To me, 74-year-old Frank Gordy epitomizes this combination. A lean and agile man, he founded and manages the world's largest, and one of its oldest, drive-in restaurants. The 50-year-old Varsity near Georgia Tech in Atlanta serves as many as 35,000 customers a day with such gracious hospitality that each feels welcome. Color television entertains sit-down diners who feast on 35-cent hamburgers and 25-cent fried peach pies. A sign reminds customers of the proprieties: "On these premises men must wear shirts with sleeves."

While I munch on a bag of fried onions—a few ounces of the ton consumed here daily—Gordy shares his philosophy. His eyes dart constantly, looking for problems before they arise. "Be good to your customers, whatever your business," Frank expounds, "and they'll make you a millionaire."

From an oval office in Washington another Georgian gazes out a window (by coincidence it faces south) and contemplates the progress of his home state.

"We have been freed from many of the burdens of the past," the former governor says today, "and Georgia has become a place of hope and opportunity again."

Perhaps, as Frank Gordy and Jimmy Carter have been saying, there *are* no limits. Now Georgians too can dream the American dream—and make it come true. □

Amid natural grandeur, the romance and the reality of a rugged life-style come together in

New Zealand's High Country

ARTICLE AND PHOTOGRAPHS BY
YVA MOMATIUK and JOHN EASTCOTT

Surefooted as the sheep they track, two shepherds and their dogs walk a high



THE COCKSCOMB of the Southern Alps grew indigo. Wind played on the lake below. We hiked along a dusty road, heads low into the wind, my husband, John, and I. Tired as we were, I could sense his joy at being back in his home country amid the mountains he loves best.

A long driveway, lined by Australian gum trees, led us to the garden of Lake Hawea Station, graceful and civilized. Flower beds surrounded small ponds, and red fish swam under a stone bridge. A 5,000-foot range shielded garden and sprawling white homestead against gales.

A silver-haired man broad in the shoulders came out, dark eyes squinting against

the harsh light. "John and Yva? I am Jim Rowley. You can leave your swags on the porch"—he nodded toward our backpacks. We followed him into a room full of people. "We have a bit of company," Jim observed. "Neighbors, family, and friends from town. What will you have to drink?"

A tall woman warmly took charge. "You must be hungry. We shall eat soon. Would you like to wash first? There's a spare bedroom if you want to spend the night." Then she added: "I am Fiona, Jim's wife. Let me introduce you to everybody."

It was also my introduction to the high country, as New Zealanders call their region of glaciers, furious rivers, and tussocky

ridge on the South Island, where outdoor living is a tonic prescribed by all.

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basins stretching along the lofty 500-mile backbone of the South Island.* Some 300 sheep stations, or runs, as the mountain ranches are called, are scattered through this awesomely beautiful grazing country.

Ranch Has Cosmopolitan Trimmings

Lake Hawea Station, 160 miles from Dunedin, the nearest city, takes in 28,000 acres. Its 6,000 sheep and 140 head of cattle support the six members of the Rowley family and their hired help.

I can't think of a meat more satisfying than the dark, juicy merino mutton we dined on that evening. Later, basking by the fireplace, I looked around at crystal glasses, paintings, shelves loaded with books. Jim was telling some guests about his recent trip to South America. How could I ever have imagined these high-country runs to be primitive? Was it New Zealand's remoteness—12,000 miles from London, 7,000 from Los Angeles? Was it because the high country is so steep and sparsely populated?

Once, back in Wyoming, I had met a man festooned with photographic gear who smiled seeing my cameras. "Another photographer? Where from?"

"Poland," I replied. "And you?"

"New Zealand." John beamed, as if offering a gift. Later, when we went to live among the Eskimos,† he would tell me about the people in his native mountains, their confidence in their land, and the life they had built from scratch. And now a phone call from John, a perfect stranger, was all it took to bring an invitation to visit this high-country family.

I walked to the window; Fiona joined me.

"There was nothing here when Jim's parents bought the station in 1913. They built a hut, and for years carried water a mile up the gully. Then they moved an old schoolhouse here, but it burned down. After they built

*Peter Benchley described "New Zealand's Bountiful South Island" in the January 1972 *GEOGRAPHIC*.

†The authors told of life with the Inuit of Umingmaktok in "Still Eskimo, Still Free," November 1977.



Between peak and plain rises the high country, wrinkling the length of New Zealand's South Island. Lofty terrain and fitful climate challenge and inspire settlers of this spectacular sheep country. Trekking through the southern part (left), the authors visited stations, or ranches, that sprawl from valley floor to glacier rim.



this house, Jim's mother had the garden designed. She was a great gardener, and I suppose she always regretted that I wasn't.

"Jim and I had six children—our son Tom lives on the station with his wife and sons. In the early days you had no electricity or phone. You had to chop wood, heat water over an open fire, and wash everything by hand. It was a hard life, but we loved it."

Fording a River . . . 86 Times

The Southern Alps, growing dark before us, were first sighted in 1642 by a Dutch explorer, Abel Tasman. But 127 years passed before James Cook finally charted New Zealand. Even then, England was slow to colonize this distant land with its sometimes hostile Maori tribes. Fiona told me Jim's ancestors arrived in the early years of settlement in the 1850's. Hardships and struggle were their lot. But stay they did.

The next morning we drove to the end of a road in Jim's Land-Rover, hoisted our packs, and started for Birchwood Station.

Those New Zealand rivers! For two days we followed the gorge of the Dingle Burn. Water rushing down from melting snowfields hit us cold and hard as we crossed and recrossed the river 86 times, holding on to each other and swaying under our loads. Toward the second evening the beech forest stepped back. We climbed over bluffs and scree 3,000 feet to the saddle, hurriedly. The darkness, following us silently up the slope, swallowed us with one soft leap. The snowy barricade of the Southern Alps caught the last glow. I remembered a verse written by a high-country woman, Frances Blunt:

*And high, and high
The sharpened hills
—Proud amethysts that no man tills—
Carve pieces from the sky.*

From our sleeping bag, spread on rocky ground, the antipodal stars looked huge.

We woke uneasy. The air had changed. The wind rose and blew in isolated puffs, as if the mountain's great lungs were at work.



We rolled out and wrestled with boots and parkas. "A northwester!" yelled John.

A crimson arch spanning the stormy sky heralded dawn. It started to snow. Down in the valley a family of horses ran for cover. We descended, pushed by the wind. Suddenly we saw a lean, slightly limping man with dogs behind a mob of sheep. Ron Williamson welcomed us to Birchwood Station. His sprawling 11-room homestead, dwarfed by a great U-shaped glacial valley, nestles behind a windbreak of larch trees. In the warm oasis of its sun-room, I told Ron that we had seen few sheep in the mountains.

"You won't see many," he answered, chewing his cigar. "Forty-five hundred sheep and some cattle and horses don't crowd 100,000 acres."

Schooling Presents an Added Challenge

Isolation was never an excuse for ignorance in the high country, and Ron and Jennifer Williamson were determined to give their children the best education possible. Ten-year-old Simon (page 255) had just been sent to an excellent boarding school near Timaru. Younger Henry, like his brother before him, and other New Zealand children who live too far from town, still took correspondence courses under the supervision of his mother. Once, when restless Henry exclaimed, "Why do I have to learn all this?" I thought about how lucky he was to be able to express his frustration and get Jennifer's patient explanation. Later she told me: "I like to teach the children, to share in their early education. I'd miss out on this if they went to a regular school."

Before marrying Ron, she had spent two years in Europe, traveling and studying art and history. Her Birchwood scrapbooks reflect intellectual interests: reproductions of Matisse paintings, programs of chamber-music concerts. It was nothing for her to feed her family, horses, dog, and pig, then drive three hours to town to hear Sir Michael Redgrave read Shakespeare.

When Jennifer and Ron met each other, they were both deeply involved in show jumping. He was one of New Zealand's best horsemen. Then, he had an accident. It is one thing to survive a severe spinal injury, and quite another then to run a 100,000-acre high-country sheep station. The horse that



Taken into the human fold, an orphaned lamb rides in the arms of Janet Innes (left); daughter Kirsty totes the lamb's next meal of milk. The Innes family lives on Black Forest Station, a ranch of 38,000 acres. Pete, the father, avoids the twisting roads by flying a light plane (above) to the next valley to help his brother. The isolation of the high country breeds interdependence. When fire broke out on Black Forest Station, people from 80 miles around came to help fight the flames. Busiest time on the station is spring shearing. Inside the woolshed (below) the thick winter coats of the flock fall to the electric blades of Maori shearers.





First week's batch of sheep—5,000 to be exact—loiter on a hillside while autumn muster continues at Godley Peaks Station. For 18 days musterers, itinerant shepherds, comb 58,000 acres of gullies and peaks, looking for 10,000 merinos to move to



lower ground as the harsh winter nears. One station owner, caught in a northwester strong enough to blow shingle off the mountain he was climbing, jokingly said, "If I have any sheep up there, they must be mad, and I may as well leave them."

fell with Ron that day still grazes in front of his window.

"It wasn't his fault. I told him what to do, and he did it. Good, brave horse," said Ron, flashing one of his rare smiles.

The end of March found us at Glen Lyon Station, where the autumn roundup of Hereford cattle was under way. Calves would be driven on the hoof 130 miles to auction yards in Temuka.

We joined the men for a hearty 4 a.m. breakfast—cereal, fruit, mutton chops, eggs, and toast, washed down with steaming mugs of tea. Then we caught horses, thundering in the corral. I followed the red glow of cigarettes as we rode into the dark.

Splash! Dogs whimpered. We crossed the Dobson River with its tricky currents and quicksand bottom. I blessed station owners for breeding tall mounts. Riding experience told me to let my river-wise horse have his way. After all, he had as much to lose.

Calves Cornered in Madcap Roundup

Day broke golden. In the valley center, 2,000 pairs of horns moved restlessly between frost-covered fences. Larry Murdoch, the station's manager, worked the drafting gate, separating calves from the cows and bulls, while other men, ankle-deep in mud, moved the cattle. At noon Larry untied lunch from his saddle: a cold leg of mutton, bread, and Scotch.

"Larry, how many sheep do your family and shepherds eat a year?" asked John.

"Us and the dogs? About 300."

Then, with everybody mounted, Larry opened the gate. "Now the fun begins!" someone shouted. Calves rushed out. Riders and dogs followed madly through the swamp, over the rocky flats, and across the river, finally bringing them into holding pens. Larry rode up, his big frame easy in the saddle, red face sprinkled with mud, happy.

"That was lucky. Sometimes half the calves go up the valley." He pointed toward the main divide of the Alps, Glen Lyon's boundary 30 miles away. At dawn tomorrow the 16-day trek to the coast would begin. Now we rode back to the homestead.

There, Larry scooped up his 3-year-old daughter and went to milk the cow. Squirt-ing milk into the child's mouth, he said: "It's great bringing up kids here. It's a good life."

Holding her on one knee at dinner, Larry cradled his newborn son, Kane.

"Why 'Kane'?" asked one of the men.

Larry smiled a bit shyly. "I had a good dog by that name once. . . ."

Dogs! Originally brought from Scottish-English borderlands, the hardworking border collies "made this country," say farmers. They erected a statue of a collie on the shore of Lake Tekapo, with a plaque in Gaelic: "*Beannachdan air na Cu Caorach*—Blessings on the Sheep Dog."

Each station breeds, trains, and worries about its dogs. Shepherds endlessly analyze family trees and personalities. The dogs run behind horses, ride in trailers, fly in small planes, compete in trials. Most of all, they walk. The harsh climate, steep terrain, and icy rivers shorten their days, but they seem to love their work. They are taught to respond to voice and whistle commands, often from a great distance.

Ian Anderson, sound and agile at 70, is a "top dog" himself; he still climbs the peaks of his run and competes in dog trials. One night at the Andersons', I asked, "Ian, how do you start a young huntaway [barking] dog?"

"First I take this keen young pup and call my other dogs," Ian explained. "We all jump in the pen with the sheep, and I tell the dogs to bark. So they bark their heads off, chase the sheep, and the pup begins to get the idea of team spirit!"

Next morning I spotted Ian working with sheep near the woolshed. Suddenly, unbid, his dogs leaped the rail and created havoc. Ian shouted to no avail. He saw me and laughed, "You asked how I started them, but not how I stop them."

His wife, Betsy, used to represent New Zealand as a downhill ski racer. Both agree that "when you compete, you learn to lose—because you get a lot of practice at it."

Room to roam delights high-country youngsters like 10-year-old Simon Williamson, riding at Birchwood Station during a holiday from his first year in boarding school near Timaru. As do most children on remote stations, Simon took government-run correspondence courses for his early education. A teacher visited several times a year.

About twenty miles from Ian's place, Twizel, a construction town of 6,000, unpretentious in its prefab uniformity, houses workers on New Zealand's largest hydroelectric project. When completed in 1984, the canals feeding power stations from glacier-fed lakes and rivers of the Mackenzie Basin alone will hold 17 million cubic meters of water—34 times the nation's annual consumption of beer, as locals compute it.

"God" Has Plans for High Country

Maori legend credits Rakaihautu, a giant of a man, with digging this chain of mountain lakes. In Twizel we went to see his modern equivalent: Max Smith, project engineer, known locally as "God" (page 263).

We talked about New Zealand's fast-growing appetite for electricity, creation of new recreational lakes for increasing numbers of tourists, compensation for people's properties that would be flooded out. And

Max Smith's concept of the high country:

"The runholders lease more than 90 percent of their land from the government. Runs are big and generally underdeveloped. I believe the state should use water from this project to irrigate the land, subdivide it into economic units, and sell it to farmers willing to make it productive—whether for intensive grazing or for crops."

We later mentioned this idea to Professor Kevin O'Connor of the Tussock Grasslands and Mountain Lands Institute.

"Max has part of the story," commented Kevin. "You cannot plan a farming system the way you plan a hydro system. The runholders are cautious innovators. If they were reckless, they'd go bust in that environment, being at the mercy of weather and market. High-country farming can't be regulated like water behind a dam. A farmer must be free to accept his own risks. Ask Bruce Scott of Godley Peaks Station what pays his bills."





All in the family

FAMILIAR BEDFELLOWS on a Sunday morning, Tom and Adrienne Rowley with their youngsters (left) enjoy a break in the work at Lake Hawea Station. From the time they can walk, high-country children pitch in on station chores. The family would be incomplete, however, without its dogs—both hardworking border collies that attend to the sheep, and high-spirited hunting dogs like Labradors, one of which receives an obedience lesson (right).

Checking the competition, Tom's parents, Jim and Fiona (below), inspect the fleece from a neighbor's station prior to a wool auction in Dunedin. Thriving in the high, dry environment, merino sheep produce some of the finest wool in the world. It goes into apparel such as worsted suits and knit dresses.



We did ask, at the High Country Field Day, where runholders and government agents discussed farming issues. A microphone stuck in the tussock amplified questions and grievances, revealing to us the complexity of this pastoral existence.

Bruce Scott told us about his new gravity-fed irrigation system, a major improvement, providing Godley Peaks stock with feed for the winter.

"My father always said, 'Remember that those merino sheep in the hills pay for what you do down below.' And he's jolly well right. My profits hardly warrant the cost of irrigation. New Zealand has got where it is mainly on the initiative and the drive of a small number of farmers down the generations. We do try to introduce improvements. But, heaven help us, no farmer could survive wasting money the way they do on that hydroelectric project."

I summoned my courage. "Bruce, could we join your autumn muster?"

He hesitated, then asked: "Can you walk?" Godley Peaks has the toughest foot muster in New Zealand, 18 grinding days of climbing 8,000-foot mountains and combing sheep out of country so steep that its shingle faces seem almost vertical. The young shepherds who muster with Bruce gain a reputation for skill and endurance.

A fortnight later in a mountain hut I watched Bruce Scott from my sleeping bag at 4 a.m. "Don't get up till I cook breakfast," he had ordered. "I need room. Coffee or

tea?" I preferred coffee; other sleeping bags chose their brew. Bruce delivered it hot and returned to sizzling mutton chops.

A natural leader, Bruce was also a mother hen, preoccupied with safety. Before we plunged into the cold darkness outside, he tuned in the weather forecast. "My hardest decision when the weather is uncertain is if we should muster that day. They"—he looked at his young shepherds—"are other people's sons. I honestly believe if I lost a man on this place, I'd give up."

At Godley the snow risk was always there. In the late spring of 1967, 51 inches fell in two days, killing a third of the freshly shorn Godley flock. Avalanches, foul weather, and bluffs claim another 2 percent every year. Before winter tightens its grip, 9,500 sheep, scattered over 58,000 acres of mountains and valleys, have to be found and brought down to relative safety.

The muster went on. Each day we brought more sheep off the dangerous slopes. Each night we spent in a different hut, pushing on relentlessly.

Shepherds Fleeced by Sheep Thief

From Godley Peaks, John and I recrossed the Mackenzie Basin. It was named for a Scottish shepherd who stole a thousand sheep and hid them here in 1855. Shepherds gave chase, caught him, and took him to jail, from which he escaped several times before he was eventually pardoned. Instead of damnation, he and his dog met instant fame,



and the unexplored basin was quickly settled. Newspapers advertised: "Wanted, a shepherd. Must be a Highlander with dogs. . . ." The Scots came to stay.

John and I headed for a Mackenzie stronghold, Black Forest Station, at the end of a 35-mile dusty track. Once a week a mail truck brings news and supplies. All meat, vegetables, eggs, and honey come from the station itself. Jessica Innes, a striking beauty, may change from work clothes into an elegant gown to serve dinner, but if stock work requires, she drives like a commando over perilous mountain trails. Her husband, Allan, chairman of the Waitaki Catchment Commission, deals with water- and soil-conservation problems. Only now is the high country recovering from an infestation of rabbits, which destroyed the grazing.

"We were desperate," Allan told us. "Either the rabbit had to go, or we had to go. We applied for permission to import '1080,' a tasteless, odorless poison, but the government at first said no. Finally we managed to get it in from Tasmania." The poison, now used officially on chipped carrots scattered by small planes, saved Black Forest as well as other runs.

Seeking desert grasses that would prosper in the dry Mackenzie Basin, Allan and Jessica have traveled to the mountains of Thailand, Iran, and the U. S. Their daughter, Sara, 22, with a degree in horticulture and landscape architecture, looks after trial plots of seeds that were brought back. She

also breaks, trains, and shoes the family horses. We glimpsed her on her favorite mount, Bulldozer, 17 hands tall, soaring like a chestnut bird over high fences. Sara's brother, Pete, manages Black Forest. After one typical day, I read Pete's diary entry:

"Raining at last! Mustered young cattle. In cottage, getting stove and telephone working. Dismantled diesel motor. Killed cow for dog food. Stripped deck on tip trailer, built bee boxes. . . ."

Penknife and Twine, Just in Case

Pete's petite wife, Janet, chops wood, spins wool, and unloads winter feed with her children in tow. Three-year-old Ben climbs under cars to "fix them," feeds newborn lambs, and asks, "Mummy, did you also lick me when I was born?"

Janet does remember the long drive to town the night Ben's sister was born, Pete calmly collecting penknife and twine, ready to deliver their baby if necessary. The Inneses work hard and play hard. They've been building their own life in a new land ever since Pete's grandfather came to the Mackenzie in 1912, equipped with a master's degree in Greek philosophy and math from Aberdeen—and determination.

In the busy woolshed, Pete's father, Allan, mused: "Farming is one of the few things people can still do as a family. It looks like separate operations, but we really run it together and help each other." Just as neighbors help
(Continued on page 264)

Never mind the parlor, Jim and Fiona Rowley prefer to take tea on the garden floor (left). Highlanders are addicted to the outdoors—synonymous with hard, satisfying work and easy relaxation. Fierce snowstorms and fast rivers do take some lives, however.

Indoors at Irishman Creek Station, Lady Peggy Hamilton (right) finishes a book about her experiences in World War I. Her late husband, Sir William, invented the jet boat to explore the high-country waters.

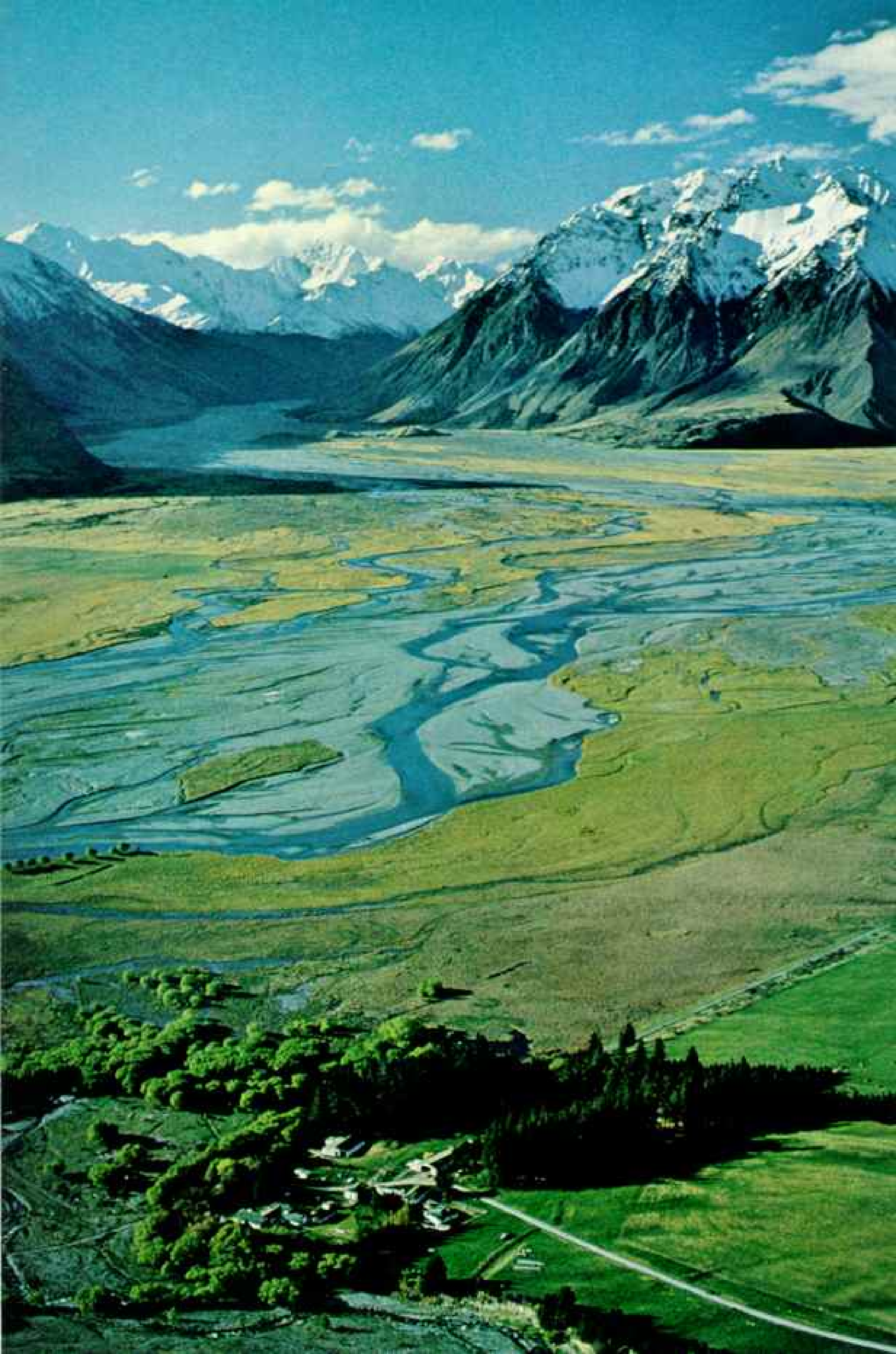




Winter at their heels, two musterers push a mob of sheep toward safer and sunnier



ground. The high-climbing, independent merinos will not be seen again till spring.





Trouble on the horizon?

AS FAR AS THE EYE CAN SEE is grazing country on Glen Lyon Station (left), 100,000 acres large.

Cattle wander the river flats, while sheep climb to the snow line on 8,000-foot peaks. The high country's spacious way of life may be threatened by the ideas of people such as Max Smith (above), the powerful head engineer of a massive hydroelectric project in the Mackenzie Basin. Smith believes that the government should irrigate and subdivide the stations in order to encourage high-intensity farming. He also wants to see the construction town of Twizel (below) eventually provide room for tourists. Station owners do not shy from development, but if progress means a crowd, the highlanders will pass.



(Continued from page 259) one another.

One spring day Pete, returning from town, spotted white smoke over the still-distant station. He hit the accelerator. The car careered off the road twice before it flew over the last bridge and skidded to a stop in the Black Forest compound. Beyond the range of hills a strong northwest wind played with its new toy. Fire!

Pete's call for help was radioed all over the Mackenzie country. People came from 80 miles around, more than a hundred of them. Driving to the top of a ridge, we saw the flames raging over grassy basins, then galloping uphill. A firebreak had to be burned across its path. I remember Pete's tense profile, like a young hawk's, his blond head touching his cousin's as both listened to Allan from across the basin on their citizens' band radio. Another cousin worked below us in a silent fury.

Allan's voice was calm. "The fire is fairly thick in the end of the basin. You might have to let it burn back through the rocks and get it round the next ridge. Over."

"There are men there, as thick as bloody bees," Pete answered. "Hang on! There's another fire down here. Send some men up this spur."

For seven hours the fight went on. The flames roared uphill, licked the firebreak, tried to jump across, then collapsed into ashes and thick smoke.

Back at the homestead, tired, blackened men filled the sunny rooms. Little Ben took beer around; Sara and Janet hurried with food. Jessica turned regally to her son: "Pete, you really will have to apologize to those two nice ladies in Kurow who monitored your radio calls. Your language was atrocious." But her eyes spoke relief and joy.

Drowning Dog Proves Golden Retriever

Not only pastoralists found their Utopia in the high country. One of the last Otago gold miners, Joe Scheib, still lives near Skippers overlooking the wild Shotover River. It was here, in 1862, that two Maoris, rescuing

their drowning dog, saw gold dust clinging to its coat. Before the day was over, they had collected 300 ounces of it.

Such days were rare. It took Joe 40 years of backbreaking work to find that much gold. And the once generous river now apparently carries only water. The gold-rush crowd left; there is no second crop.

"When we came, we were going to make our fortunes in a hurry. But it didn't happen that way," Joe reminisced, petting his dog, whose coat showed only ordinary dust.

His wife, Joy, added: "It's a dream, but a lovely life. Free. Never dull. There's usually something to eat. And always hope. Even if we didn't strike it rich, it doesn't matter. We never worried about having the biggest house or the brightest colors. They are not important. The quality of life is important."

Farewell to New Old Friends

Before leaving the high country, we went back to Lake Hawea Station, where we had started eight months earlier. There a mob of freshly shorn sheep spilled out of the woolshed. Jim and Tom Rowley came out to greet us, the bleating drowning their words.

"It's good to see the sheep after they've been out in the hills," Jim said. "Every year their condition and wool gets a bit better."

Fiona Rowley came from behind. "The kids! Welcome home. We are just about to go to town for the wool sale. Do come with us. Jim loves his wool and has to see it sold. You'll stay longer this time, won't you?"

We did. We cooked, mustered, talked, played, yet one day had to leave. Fiona agreed to let us slip out without farewells, but then ran after us, gray hair flying. She pressed a jar of shortbread into John's hand, whispered, "God bless," and fled.

John and I started downhill. It was softly raining. Ahead we saw Tom and his little boy, Angus, in red boots, with an umbrella. Dogs followed them. Going to look up young bulls, father and son walked hand in hand through the spring-green grass. □

Flush of beauty spreads across a snowfield at sunset in the Southern Alps. Ever since settlers entered the mountains in the 1850's, the high country has promised a special joy. A shepherd once expressed it for himself: "To be young and fit and keen, alone in a mountain world with only the skyline beyond: what a life for a man!"







Norway's Strategic Arctic Islands

By GORDON YOUNG

SENIOR EDITORIAL STAFF

Photographs by MARTIN ROGERS

MØRKETIDEN, the Norwegians call these days of winter blackness—the dark time. Although it was noon, the glowing sun lay far beneath the distant horizon, and the islands of Svalbard lay shrouded in frozen gloom. The temperature was holding at forty below zero—both Celsius and Fahrenheit, for the two scales meet at that low level—as I struggled toward the coal-mining headquarters of Store Norske Spitsbergen Kulkompani.

Willem Barents, the Dutch explorer who put these Arctic islands on the map in 1596, had named them Spitsbergen, Land of Pointed Mountains. Leaning into the icy wind, I thought that the archipelago's present Norwegian name fit it better: Svalbard, Land With Frozen Shores.

Frozen indeed! Most of the islands' 62,000

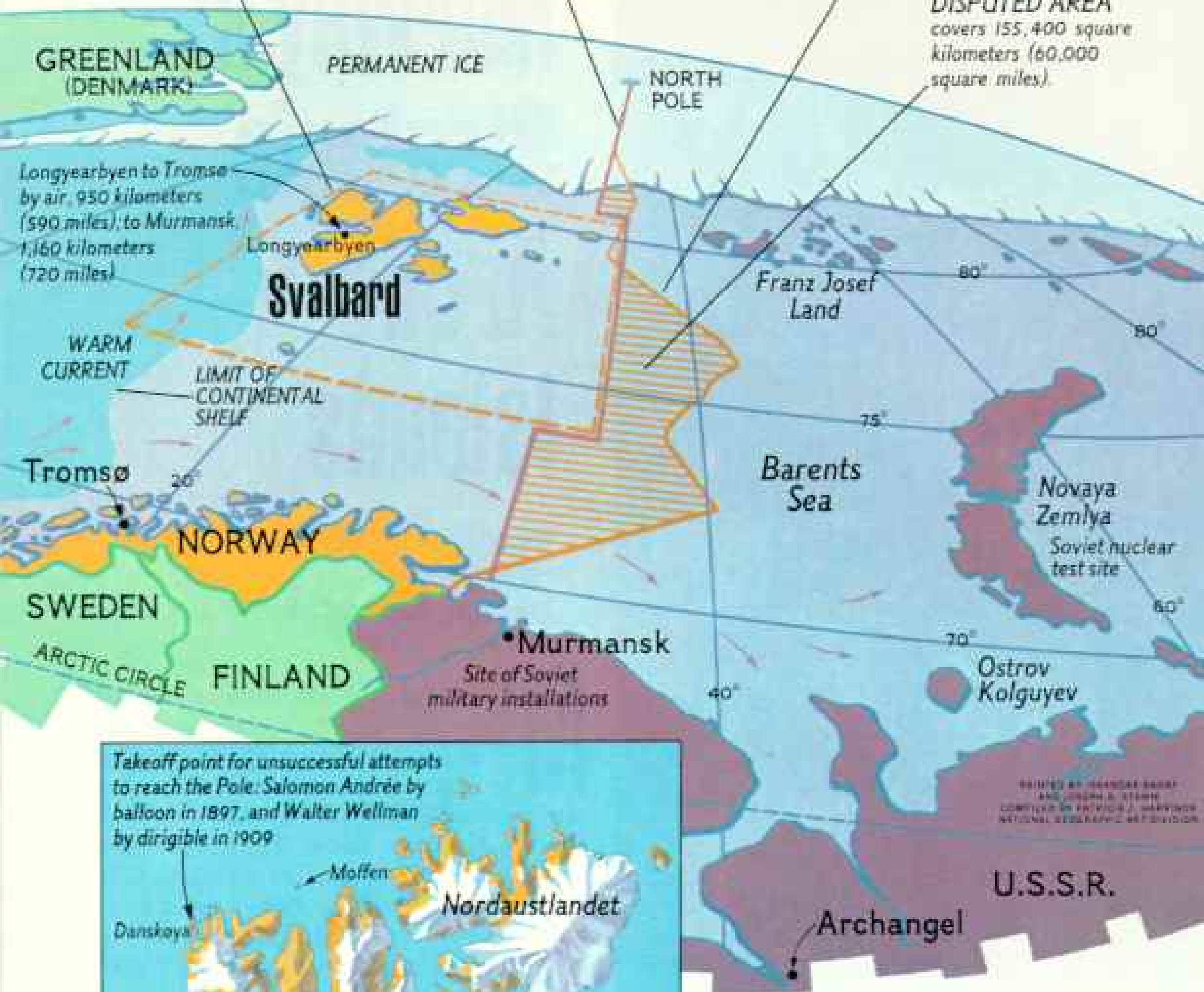
Winter's wrath buffets the mining town of Longyearbyen in Svalbard, Norwegian islands only 1,046 kilometers (650 miles) from the North Pole. Rich coal deposits, possible substantial oil reserves, and a strategic location near the top of the world are ending Svalbard's long isolation.

SVALBARD TREATY
entitles 41 nations to tap
the islands' resources, though
only Norway and the Soviet
Union do so.

SOVIET CLAIM
encompasses the sea
from the Norway-Russian
border to the North Pole,
observing the treaty line.

NORWEGIAN CLAIM
includes the waters west
of a line running midway
between Norway and the
U.S.S.R. to the Pole.

DISPUTED AREA
covers 155,400 square
kilometers (60,000
square miles).



EDITED BY HENRIK BAKER
AND JOHN A. STONE
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North of nearly everything, Svalbard holds importance far greater than its West Virginia size might indicate. In 1925 the Treaty of Svalbard gave Norway sovereignty over the archipelago, formerly called Spitsbergen after its largest island. The treaty bars military activity on the islands, but it permits exploitation of resources. The U.S.S.R., which mines coal there as extensively as Norway, has 2,000 citizens on Spitsbergen, compared with Norway's 1,000. The Soviets are also concerned with Svalbard's strategic location; Soviet submarines based at Murmansk need the ice-free waterway between Svalbard and Norway's mainland to reach the Atlantic.

square kilometers (24,000 square miles) is covered by glaciers or frozen as deep as 300 meters. Stretching to within 1,046 kilometers (650 miles) of the North Pole, Svalbard is so far north that the northern lights reach into its southern sky.

Yet these remote islands—for centuries too unimportant for any nation to claim—now receive international attention. To the Soviet Union, they pose a potential security problem. To the rest of the oil-hungry world, they hold promise of easing the prospective world energy shortage.

Coal Mine Started by an American

Ice encrusted my beard by the time I completed the half-mile walk from my quarters to the Store Norske office, but warm Norwegian hospitality and scalding coffee were waiting.

Henrik Varming, assistant manager of the mining complex, briefed me as I sipped. "An American—John Munro Longyear—started a commercial coal mine here in Longyearbyen in 1906. The town, of course, is named for him."

Peering out the window, I grimaced. With four months of darkness out there, I thought of this isolated community as the City of the Long Year.

Varming continued. "Store Norske Spitsbergen Kulkompani—the Great Norwegian Coal Company of Spitsbergen, in your language—bought Longyear out in 1916. But now the government has become the owner. If a second mining area, Sveagruva, goes into production, Norwegian coal tonnage here will probably double."

Varming grinned when I asked if this was a typical day. "There is no typical weather on Svalbard. Tomorrow may be warm, or raining, or even colder. A low-pressure system usually hovers over Svalbard. When the system drifts to one side of the islands, north winds bring down polar air. When it moves to the other side, winds from the south send up warmer air."

"What attracts miners here?" I asked. "High wages?"

He shook his head. "The pay isn't much higher than on the mainland, but taxes are low. A miner can save enough in a few years to go back [coastal Tromsø lies 950 kilometers south] and buy the house or farm of his

The great white way of inland ice leads a dogsled toward Ny Ålesund, one of the world's most northerly towns. Overland travelers use sleds and snowmobiles; no roads exist between cities. Once a coal-mining town, Ny Ålesund is now a Norwegian base for Arctic research.





Sinking roots in frozen soil, the Soviets have built communities at Barentsburg (below) and Pyramiden. A stylized red star and hammer and sickle (right) proclaim the Soviet presence in the village named for Willem Barents, a Dutch explorer who visited the islands in 1596. The chill air provides a natural refrigerator for fish and fruit outside a Barentsburg apartment (left). Though Norway has sovereignty, enforcement of Norwegian law is generally left to the Soviets in their villages. The Soviets also have a contingent stationed at the three-year-old airport at Longyearbyen to service flights from the U.S.S.R. and helicopter hops from Barentsburg and Pyramiden.



dreams. Besides, we do our best to fill the miners' leisure hours."

Longyearbyen, I learned, has a movie theater, canteen, gymnasium, indoor swimming pool, a good school, church, store, clubrooms for hobby groups, and television.

Arctic Mélange: Reindeer and "Kojak"

A few hours later I sampled the television. Then, turning away from a suspenseful "Kojak" episode, I glanced out the window to see reindeer passing.

Reindeer, and virtually all species of wildlife here, are protected now by government edict. But there was a time when sealers, whalers, and walrus hunters harvested the Arctic waters surrounding Svalbard. Later came scientists interested in Svalbard's fragile environment. Polar explorers

used the islands as a jumping-off place.

Still, the archipelago remained an orphan, claimed by no nation, for it seemed to have little to offer the world.

In 1925 Norway assumed sovereignty through a treaty signed eventually by 41 nations. The treaty provided that each nation was entitled to exploit the islands' sparse resources. Only coal-short Norway and the Soviet Union are doing so. Both operate mines here, producing about the same amount—as much as 450,000 tons yearly.

At the canteen I chatted with white-haired Anker Carlsen. He had spent the last quarter of a century in Longyearbyen's mines. I asked what life had been like before regular air service was established with the mainland in 1975.

Anker stared off into the past. "Life was



Dark skies over a white land come not only from Svalbard's four months of sunless winter, but also from the dust spewing from a coal-processing plant at Longyearbyen. Svalbard's environment, especially vulnerable because pollutants are slower to break up in Arctic areas, may face increased threats if recoverable oil deposits are found

stable then. When the last coal boat left in the fall, we would look at each other and realize that we were cut off from the rest of the world. That brought a closeness, a reliance on each other, you understand? It was good, that isolation. But now airplanes land each week to remind us of the world outside. I prefer the old way."

He sighed. "A different kind of miner works here now. We old ones came because this was an orderly, unchanging life. Today young miners come to make a stake."

When Anker first arrived, he found the town in ruins; German warships had shelled it virtually to kindling during World War II. Norwegians occupied the islands through most of the war, although German radio operators in remote areas transmitted meteorological information.

Only a few scars of war remain. More than 40 percent of the land, in fact, has been turned into national parks and nature preserves by the Norwegians. Reindeer can be seen wandering along the broad gully that cuts through Longyearbyen. A few musk-oxen still survive—and occasionally a polar bear strolls through town in search of a garbage snack.

The U.S.S.R. takes special interest in Svalbard because it lies close to the ice-free route that Soviet Navy ships must use to reach the Atlantic when they leave the big military complex at Murmansk. The Soviet presence on Svalbard is prominent; Russians outnumber Norwegians two to one.

Svalbard's location is a hot topic of conversation. I listened one night at the canteen as prodigious amounts of beer turned one



offshore. For Longyearbyen's Norwegian residents (above) the gloom of the long winter's night is brightened each week by mail call. Though wages aren't materially different from those in Norway, rock-bottom taxes and the dearth of spending temptations can make a stint on the islands financially rewarding.

Norwegian miner into a military strategist.

"Svalbard's permafrost would make almost instant runways for the bombers of an unfriendly nation," he pronounced. "Oh, I know the treaty that gave us sovereignty bars military facilities here. But Norway is too small to defend these islands against the big powers—there are more Russians in Moscow, for instance, than there are Norwegians in all Norway." Actually Svalbard would have many defenders if attacked, since Norway is a member of NATO.

Airborne Super-scramble?

The miner paused to drain his beer mug, then squinted at me as he refilled it. "Suppose your country and the U.S.S.R. came to blows. I think your planes would race for Svalbard. Soviet planes, too."

Another tilting of the glass. Then: "As for me, I would head for the deepest mine I could find and cover my ears."

The Soviet Union also turns a concerned eye on the Barents Sea, which borders Svalbard on the east. Those treaty-signing nations that have exploitation rights on Svalbard—do they also have the right to exploit parts of the Barents Sea?

The question is more than academic. Geologists believe that oil awaits tapping in this part of the world. Already oil companies of many nations have sunk wells on Svalbard's islands, with disappointing results. If oil exists, it lies offshore.

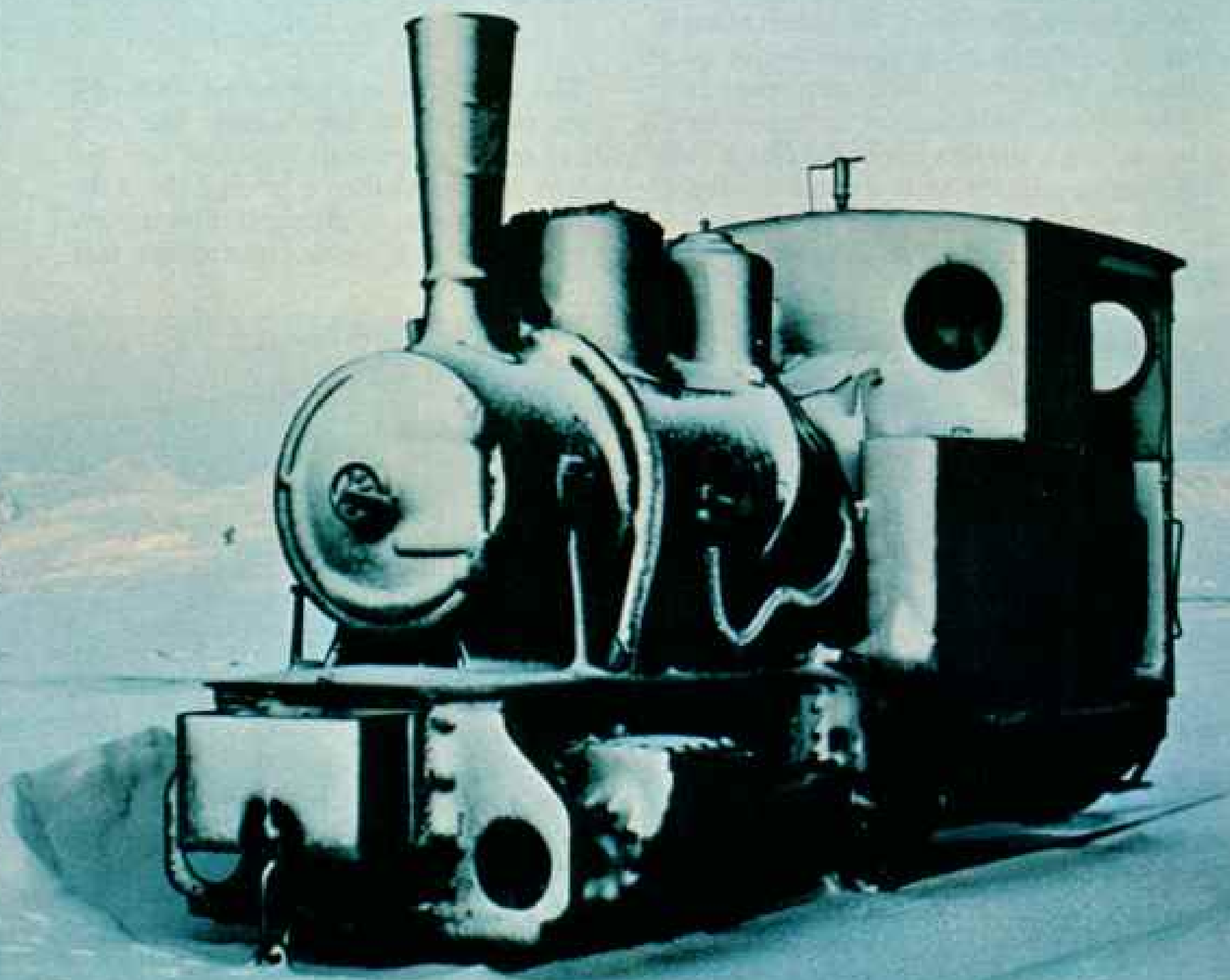
The difficulties of tapping it, though, may dwarf the drilling problems that have been encountered in the rugged North Sea.* There is moving pack ice to contend with in the frigid waters surrounding Svalbard, so probably operations could take place only during the brief summer.

More than just these technological problems must be solved before drillers probe the Barents Sea. A basic difficulty revolves around the question of ownership.

*See "Striking It Rich in the North Sea," by Rick Gore, NATIONAL GEOGRAPHIC, April 1977.

The little engine that could—and did—carry coal from a mine at Ny Ålesund has stood frozen in its tracks, carrying only gossamer veils of snow, since the railway was abandoned and the mine closed following explosions more than 15 years ago.





Norway maintains that the waters around Svalbard, outside the four-mile limit specified by the treaty, are an extension of Norway's continental shelf. Thus Norwegians can say who drills—or fishes—there. Yet if the shelf were declared part of Svalbard, would not all the treaty nations have a right to exploit it?

Another troubling question: Though Norway and the U.S.S.R. both abut the Barents Sea, where is the dividing line between them? Norway claims it meanders midway between the Norwegian and Soviet landmasses, to the North Pole (map, page 268). The Soviets hold out for a "sector line," essentially a straight line to the North Pole, deviating slightly as it detours Svalbard. This would give the U.S.S.R. a considerably larger portion of the seabed—and

eliminate the possibility of foreign presence uncomfortably close to Murmansk.

Environmental problems also must be solved. An oil spill in the fragile Arctic could be much more damaging than one in temperate climates, because the cold would slow breakdown of the oil.

Though many nations are watching developments in Svalbard with interest, most—including the United States—remain discreetly silent.

Longyearbyen: Color It Gray

The midnight sun shines on Svalbard from mid-April to late-August, and only then, on a return visit, did I at last get a look at Longyearbyen in daylight. Like many coal towns, its principal color is gray. Still, the rugged, soaring mountains that



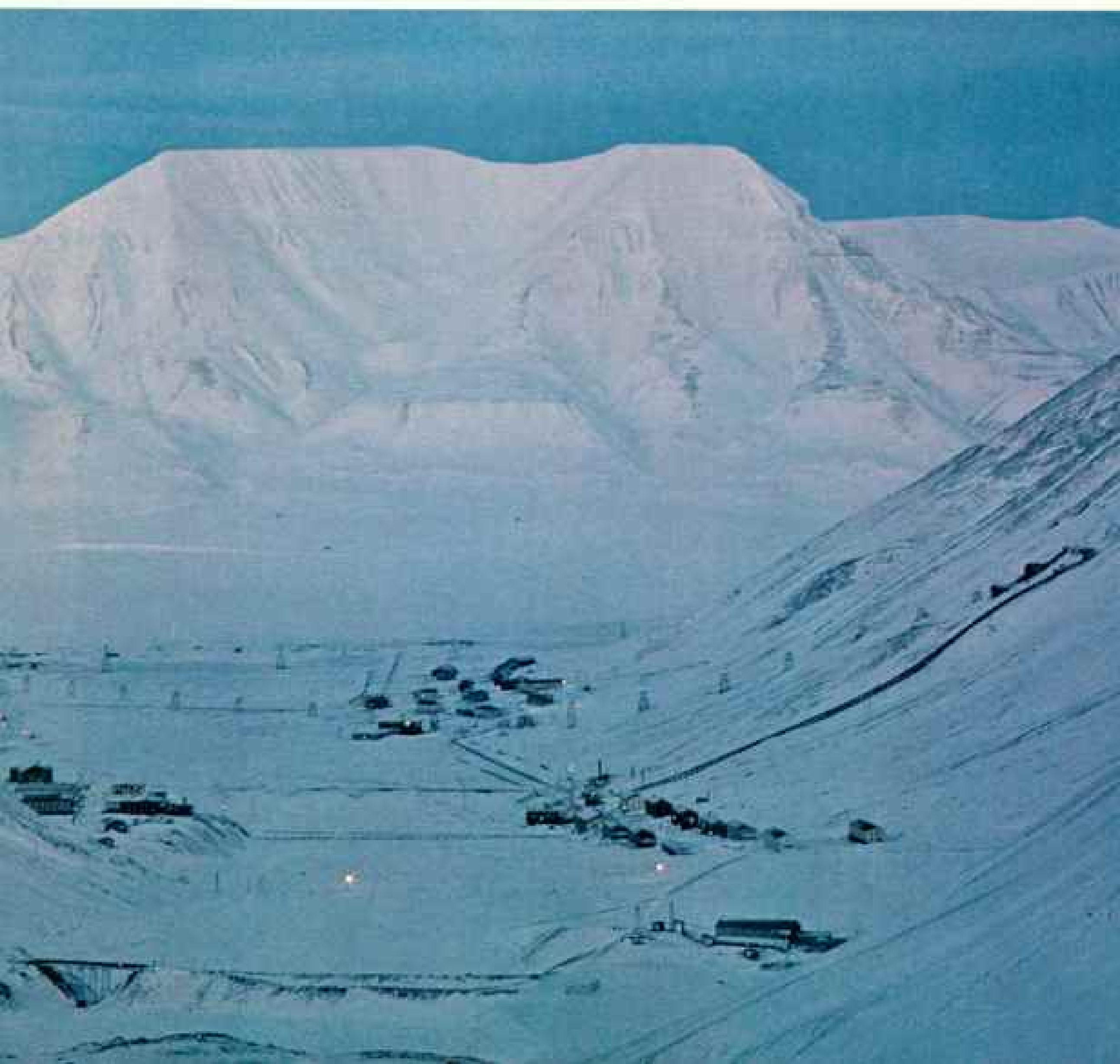
surround it imparted a grandeur that I had not envisioned in winter darkness (below).

Now the town was even more isolated from the other settlements. The constant sun had thawed the top few feet of tundra, turning the island into an impassable combination of creviced glaciers and bogs. No longer could off-duty miners roam about on their snowmobiles. Ships and helicopters offered the only transportation, for there are no roads outside the settlements.

By special arrangement, Leif Eldring, the Norwegian *sysselemand*, or governor, had offered me his helicopter for a trip to the main Soviet settlement of Barentsburg, 35 kilometers away. Next morning photographer Martin Rogers and I landed in the solidly built Soviet community (pages 270-71).

Miners here, too, could attend movies,

Winter's blue-white icing coats the land, as well as the harbor that stretches between craggy mountains and huddled buildings of Longyearbyen. The light, though faint, heralds the coming of summer; then the pack ice melts, allowing ships to enter and carry away coal mined and stockpiled during the dark months. The return of the sun also brings exultant Svalbard residents outdoors. Longyearbyen policeman Alf Kolbu and his wife, Bjørg (facing page), beam after his victory in a cross-country ski race between the Norwegians and Soviets.



visit the library, or work out in the gym. It was a more orderly place than Longyearbyen and one with more amenities. Cattle grazed near the town square, and a large greenhouse produced tomatoes, cucumbers, green onions, and flowers.

"Most of our miners come from the Ukraine," said Nikolai Nechaev, the consul. "We have 1,200 people here, including 300 women and 96 children. Pyramiden, north of here, contains another 850 people."

To enliven Arctic life, the Soviets and Norwegians exchange folk-dance groups and face each other in the Svalbard "Olympics"—chess matches, table-tennis tournaments, and ski races.

It was a brief visit but filled with hospitality. At the end of it, our helicopter waited patiently while Martin and I exchanged the last of many vodka toasts with the consul.

Back in Longyearbyen I visited Sysselmann Eldring again to thank him for his help. The talk turned to tourism.

Tourists Must Rough It

"Since we have no hotels or restaurants, cruise ships provide the best way to visit Svalbard. Some campers arrive each summer, but they must bring their own food as well as tents. It is for the best; the ecology here is too fragile to withstand anything but controlled tourism."

Martin and I were anxious to see more of Svalbard, particularly the island of Moffen, gathering place of the walrus. So we looked up Per Johnson, captain and co-owner of *Sandsvalen*—the Sand Martin.

His vessel was a 22-meter coastal freighter; the iron plates in her rust-covered hull had been welded together the year World



A friendly face-off eases sometimes-strained relations when Soviets and Norwegians put down their coal picks and pick up Ping-Pong paddles, ski poles, and chessmen for Svalbard's annual "Olympics." Four shoeless employees of the Soviet airline, Aeroflot, offer a study in mixed expressions as they watch a table tennis match (above). An

War I began. Martin and I spent the best week of our lives aboard her.

Per Johnson, I discovered, is becoming a Svalbard legend. He had been a coal miner, oil worker, member of a North Pole dogsled expedition, trapper, sawmill owner. This was his second ship; the first had gone down in the fury of an Arctic storm.

And yet he was only 32 years old.

"We'll go where you want to go," he told us with his infectious grin. "And maybe some other places I think you'd like to see. By hell, this is going to be some trip!"

For many years walrus were not seen on Moffen. They began to return only a few years ago. "Walrus are peaceable creatures," Per told me, "but they are extremely curious. Maybe one will come up to our outboard skiff to look at us, and hook his tusks over the gunwale. It has happened."

What then? I believe there was a twinkle in his eyes as he answered. "An old trapper told me that you must put on your mittens, grab his tusks, and gently lift his head up to unhook him. But be sure to wear your mittens when you do it. Otherwise, the warmth of your hands on his tusks will panic him."

A likely story! Still, I was careful to take my mittens when we boarded the little skiff off Moffen.

As we landed, four of the comic giants swam toward us, then veered six meters offshore to keep pace with us as we strolled the beach. Ahead on the shore, a huge male snored, accompanied by two females. He raised his head as we neared, gave us a solemn stare, then yawned cavernously and humped his way into the sea, followed by his two companions.

"Trappers once used walrus hide as



international "confrontation," complete with national flags, occurred when a Norwegian chess player (above, left) squared off against a Soviet opponent. Although Norway and the Soviet Union occasionally bump heads over the Soviet's failure to abide by Norwegian laws and regulations, relations remain, on the whole, polite.





rope," Per commented. No other animal hide is as strong, he believes. But hunters, sad to say, killed the gentle walrus for those big ivory tusks, as well as for the oil in their blubber. I stared along Moffen's low-lying beach and mourned; it was littered with bones of the marine mammals.

"A few years ago," Per reminisced, "I wintered over on one of the small islands near Svalbard. Suddenly I heard what I thought was the sound of an airplane. I grabbed my lantern and rushed outside—it turned out to be a big bull walrus, sleeping on a passing ice floe. By hell, that walrus sure could snore."

No Trees, Yet Sawmill Thrives

Before heading for my bunk that night, I cleared up a puzzle. "Per, why did you build a sawmill on Svalbard when the tallest tree on the islands is only eight inches high?"

He puffed on his pipe. "There are plenty of logs in the Barents Sea. They drift across from logging rivers in the U.S.S.R."

Next morning I awoke with thoughts of the *Titanic* running through my head, for ice scraped along the iron hull near my bunk. I scrambled up on deck to see Per casually guiding *Sandsvalen* between drifting floes. Ahead lay an immense mass of blue-green ice: Monaco Glacier. At its base, half a dozen seals floated, each riding a small floe.

Pointed mountains and frozen shores—I meditated on how well named these islands were as we cruised along the coast.

And how lonely. "I've heard that three centuries ago," Per said, "the British sent condemned prisoners to Svalbard, promising them eventual pardon if they'd winter over. All refused; they believed that even hanging was kinder than this."

Once, we beached *Sandsvalen's* skiff near a long-abandoned whaling site and clambered over the shore back to its old graveyard. It was a macabre sight, for weathered coffins lay exposed amid the rocks. Year by

Ripples of sequined snow and matching fur coats reflect two shades of white as a polar bear mother leads her cubs on a springtime stroll on Nordaustlandet. Under Norwegian law a polar bear may be shot only if deemed a menace.



Borne on air and water, a sea of gulls bobs and flutters beneath the cloudy blue face of a glacier. Although chilled by sub-zero temperatures and a thick ice cover, Svalbard supports a thriving animal population, some species of which were near extinction before enactment of protective measures. National parks and preserves embrace 43 percent of the islands.

Light from a low-lying sun sets the jagged peaks of mountains north of Ny Ålesund aglow as they zigzag toward the sea (right). Svalbard's terrain and climate may be forbidding, but its resources and location promise to keep international attention focused on the once isolated land.

year, the permafrost heaves the coffins up, until they surface.

But gentle nature still protected her dead. Earth had seeped in to fill each coffin and conceal what lay there.

The whaling station was bird land now. We walked carefully across the spongy tundra, avoiding the many nests that lay on the surface. Arctic terns screamed their anger from aloft, swooping down to within inches of our heads. Puffins dived around us like tiny, fat warplanes.

Ny Ålesund—one of the most northerly settlements on earth—was our final stop (page 269). I found researchers working there year round, probing the environment. Some check electromagnetic waves in the upper atmosphere; others investigate fish



populations in inland lakes or range far from the settlement to study whether reindeer are overgrazing the tundra. Biologists have created a tiny "oil spill" not far from Ny Ålesund to study its effect on the tundra.

Falling Barometer Led to Explosions

A few decades ago Ny Ålesund was an active coal-mining town. But in 1952 Svalbard's unpredictable weather system produced a sudden drop in barometric pressure. Mine ventilating systems became overloaded, methane gas built up, and an explosion resulted, causing many deaths. The mine reopened, but ten years later another fatal explosion closed it for good.

From our comfortable quarters we could see Kongsfjorden, dotted with ice floes. At

its edge stood an iron tower—the mooring mast that had been built to tether explorer Roald Amundsen's dirigible *Norge*. In 1926 he had lifted off on a successful flight that took him over the North Pole. In the same year Richard E. Byrd and Floyd Bennett set their sights on the Pole, taking off from Ny Ålesund in an airplane.

My cruise and my work were ending. I returned to Longyearbyen in time to catch the Friday flight to the mainland. As my airliner headed toward Tromsø, the islands shrank behind me until I could see them as most of the world must imagine them: Lonely, frozen bits of land, lost in an inhospitable sea.

But the world is finding them—for there is no place on earth too remote, too hostile, to escape a rush toward riches. □

MOUNTAIN GOATS

Daring Guardians of the Heights

ARTICLE AND PHOTOGRAPHS BY
DOUGLAS H. CHADWICK

In bold defiance of gravity, mountain goats reign with eagles across a no-man's-land of rock and ice stretching from the northwestern United States through Canada to Alaska. Questing endlessly for forage, they balance on one scant foothold after another, relying on remarkable nonskid hooves that can splay wide for a steady grip. But the landscape and climate extract heavy tribute from *Oreamnos americanus*. To observe the harsh existence of these rugged climbers, the author, a wildlife biologist, and his wife, Karen, spent several years, including long grueling winters, on windswept cliffs in and around Montana's Glacier National Park.

SARAH REEVES CHADWICK

MINUS 30 DEGREES F. The winds were white and sharp with snow crystals. Huddled in an icy cave on the steep cliff wall near the crown of the continent in Montana, I rubbed the chilling frost from my cheeks.

I had been looking for some time at a mound of drifting snow when it suddenly trembled and rose in front of me. Long strands of white wool emerged as if from the ledge-hanging icicles. Flurries of snow seemed to twist into a beard and massive, shaggy shoulders. Finally I could make out large black eyes and black sharp horns curving above them.

There was a flurry of white as the creature shook itself to remove the last of the snow that had fallen on its back while it lay bedded, and then it was still. I don't know how long I watched as it stood like a sentinel on the sudden edge of earth and sky and surveyed the cloud-swept world below.

In the mid-19th century the mountain goat seemed little more than a myth. Confusing descriptions of the animal sent back by early trappers and explorers of the American West had led many people to consider it a mixture of frost, altitude, and imagination rather than a real being.

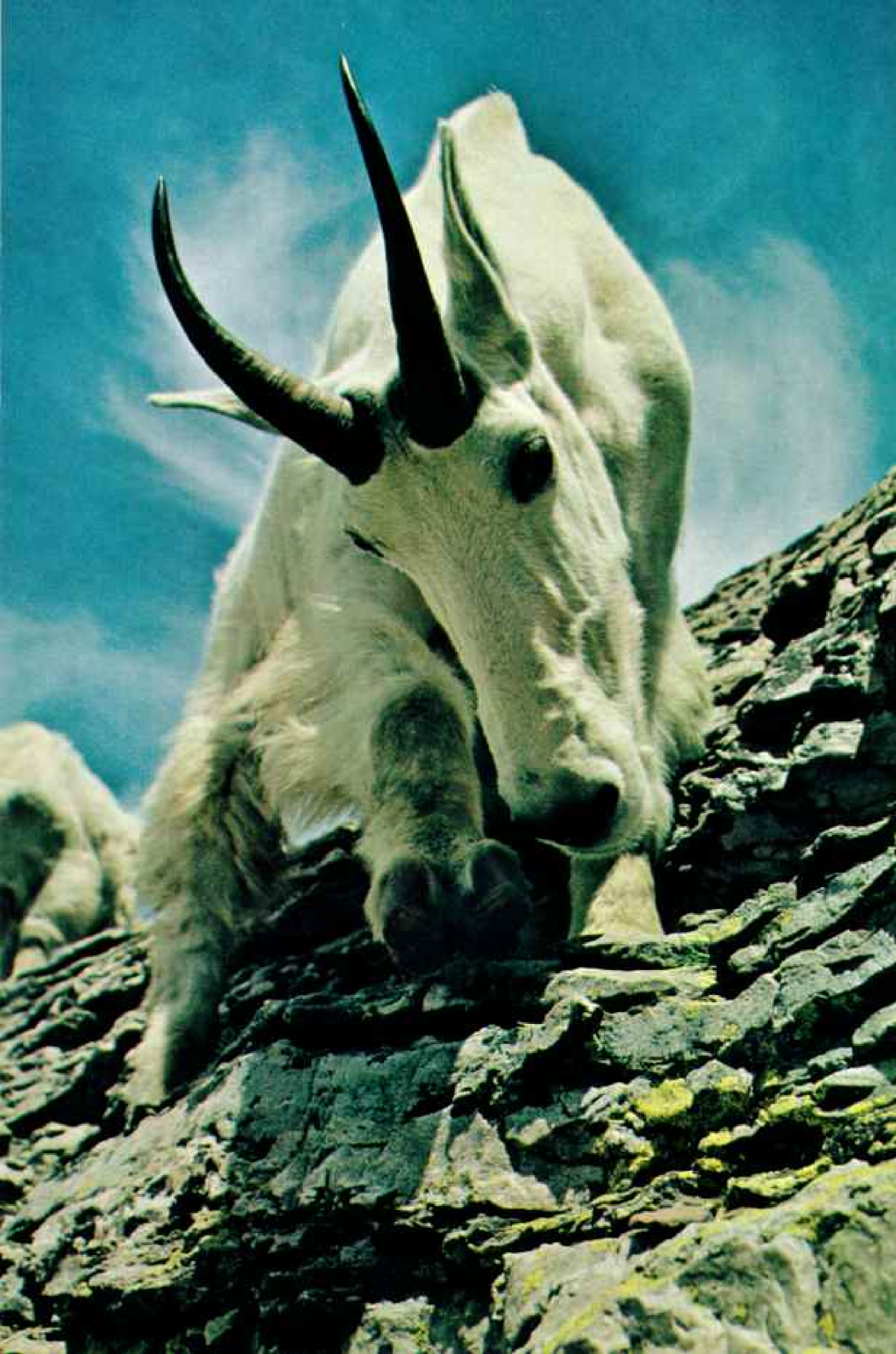
They were wrong. I have wrestled with mountain goats in traps, taken their measurements, and placed radio collars around their necks. And once on a mountain pass, I was gored in the leg and knocked backward by a large billy, as the male is called.

Scientists now know this crag dweller as *Oreamnos americanus*, a member of the Rupicaprid tribe of hoofed animals. Unlike true goats and sheep of the closely related Caprid tribe, the horns of Rupicaprid females are virtually the same as the males'.

The mountain goat's ancestor crossed from Asia to North America to become the only Rupicaprid—and the best mountaineer—in the New World.

Today mountain goat populations occupy the heart of high country from southern Alaska south through the Yukon, Alberta, and British Columbia to Washington, Idaho, and Montana. A few small populations have been transplanted into other mountainous western states in recent years.

When you visit mountain goat range in the Rockies, you enter a huge tilted world of







sharp peaks and knife-edge ridges, plunging basins that hold turquoise lakes, and wide U-shaped valleys. Small glaciers still scour mountaintops in northwestern Montana's Flathead National Forest, where I began my studies of the white goats in 1971. Glacier National Park, where I have continued my work since 1974, is named for its ice-carved topography and the more than fifty active glaciers within its rugged domain.

Weather Hampers Field Studies

It was not long after I moved up onto the mountainside to join the goats that I began to understand why so much about their lives, especially during the long winter period, was still a mystery. To reach my Flathead study area, I had to travel 80 miles of backcountry logging roads, mostly by snowmobile, then climb up a steep hillside across from still-steeper goat cliffs. Blizzards would make it impossible to see beyond the tent flaps for days or even weeks at a time. When I could see across the valley, there remained the task of picking out a handful of white goats from thousands of acres of fresh snow. In this high country, snows can drift 60 feet deep along ridges, 30 feet deep around the goat cliffs, and come above a goat's shoulder on the cliffs themselves.

Winter, I learned, is the most critical time for the cliff dwellers. It is then that the goats must call upon all the qualities they have evolved to survive.

To help retain precious body heat, the mountain goat wears a double coat. Hollow guard hairs as long as eight inches lie like a coarse mat over a thick fluffy layer of cashmere-quality wool. Thus insulated against all but the most bitter mountaintop weather, the goat can concentrate on its next most vital need: to reach a sparse, scattered, and half-buried winter food supply.

Washed with gold by the westering sun, a high mountain slope is a poetic setting for mating goats. Distinguishable from females chiefly by their greater size, the 200-pound males, or billies, forsake their solitary ways during autumn courtship, when they subordinate themselves to more dominant, group-oriented nannies. Offspring arrive in late spring.



ELIZABETH FULLER CHADWICK (BELOW)



Any scrap of rock or ledge suffices for the maternal affairs of mountain goats. While one nanny keeps vigil near her ledge-resting kid (left), another nurses her youngster above a mountain stream (above). Bristling with energy, the precocious kids attempt to leap and climb within an hour or two of birth. Before long, other obstacles lacking, they tackle their mothers (below). "The big eyes of young goats," notes the author, "give them the appearance of being perpetually astonished at the world that wheels beneath them."



Footgear becomes all-important here, because in the straight-up-and-down world of *Oreamnos americanus* the balance of nature is much more than a scholarly concept. Unusually flexible, the two toes of the goat's hoof can spread apart wider than the hoof is long to distribute the animal's grip over a large area. Or they can draw together to grasp a knob of rock.

The goat has a rough, pliable traction pad on the bottom of each toe. On wet and icy surfaces these skid-resistant pads can make the difference between a full life of 12 to 13 years or something that would fall—quite literally—short of that. Dewclaws projecting from the rear of the ankles provide additional traction on steep downhill routes.

A Heels-Over-Head Solution

With its special hooves, short legs, and powerful forequarters, the goat's mountaineering prowess is almost unbelievable. I've seen them blithely descend a two-sided rock chute by bouncing back and forth off the sides in a sort of controlled fall.

Once I watched as a goat became trapped on a ledge that had grown too narrow for the animal to turn around on. After a glance at the next ledge some 400 feet below, the goat planted its front feet and slowly walked its rear end over its head along the rock face as though it were performing a cartwheel. As I held my breath, the goat continued until its hind feet came down so that it faced the direction from which it had come.

Most goats appear to be born with a gravity-defying confidence. But one poor female, whom I called Nanny-Not-Me, showed every sign of being afraid of heights. She would balk at crossing gaps in the narrow trails. Where other goats ran and played across these deep ravines, she would paw the ground in what looked like nervous frustration for 15 minutes or more before working up courage to go on. I often wondered what had made her so timid, but I never laughed: I knew only too well how she felt.

The goat's climbing skills and warm coat combine with a third important adaptation to help it get through the lean winter months: a varied, highly flexible diet.

A study by botanist Elizabeth Chadwick revealed that the goats dined on some 170 plant species during the year. In winter, dried grasses and sedges were the staple foods. Goats usually pawed craters through the snow to reach these plants. At other times they leaned out over the sky to graze on them from ledges where snow had dropped off or been wind-whisked away.

When long blizzards temporarily buried winter-range ledges beneath layers of snow or icy crusts, goats readily took to the sheer rock walls between ledges. There they found tiny ferns, mosses, and lichens growing in cracks and half-hidden crevices. Where bushes poked up above the snowpack, goats snipped their limber stems, and they would also stretch up on their hind legs to reach the needled branches of gnarled and twisted subalpine-fir trees.

Their winter diet choices were followed by a succession of colorful summer flowers: spring beauties, strawberry blossoms, yellow bells, daisies, mountain gentians, and miniature alpine forget-me-nots, to name just part of this edible bouquet.

Goats Make Formidable Foes

What do mountain goats die from under natural conditions? Predators came first to my mind as a possible answer. In the first few months of my study I had lost food to coyotes, a sleeping bag to a curious wolverine, and an expensive tent to black bears. I was dive-bombed by golden eagles while climbing near their nest. And twice I was charged by grizzly bear families.

In the warmer months grizzlies and cougars sometimes tried to waylay a goat that had strayed from its cliffs into a meadow or forest below. But it was not often that a goat ventured far from steep terrain, and when it did, it was never (Continued on page 293)

On a vertical takeoff, a young goat bounds down the mountainside (following pages) as others in the typically small, matriarchal band look on. A breathtaking aptitude for controlling falls comes into play early, as the aggressive butting between young goats sends many hurtling. Ample evidence of death and injury from such flights, however, testifies that even these gifted mountaineers cannot work miracles. ▶







easy prey. An older goat's horns are rapier-sharp and extremely quick. Though defenseless on their own, young of the year, known as kids, quickly took refuge beneath their mothers' legs when danger came prowling. I watched lynx, coyotes, and Wolverines back away from the lowered horns of a snorting, stamping mother goat.

Once the goat is within its rock fortress, only the eagle can harry it. The big, sharp-taloned birds tried to swoop off with young kids, and I also saw them try to knock larger goats off precarious footholds.

Cliffs Offer Safety—and Mortality

Though predators make for exciting stories, their toll on mountain goats is probably minimal in most ranges. It would be more accurate to say that the mountain itself preys most heavily upon the goats.

During late winter and spring, about the time the geese and swans come winging north through the passes, entire mountainsides are in motion, booming, sliding, and washing downward, as the awakening giants shrug off their thick mantles of ice and snow. Frosts cleave new facets on rock escarpments and send huge boulders tumbling down toward the forested valleys. Like the white goats, you hear a great *craaaack!* somewhere above and feel the mountain tremble, and then run to find shelter—ferently hoping there is still time—beneath some overhanging ledge.

You can observe the signs of fear in the mountain goat then: an upraised tail, ears laid flat against the head, a crouched stance. Sometimes the tongue flicks in and out.

Of the adult mountain goats that I found dead, 60 percent had been carried down in avalanches. Another 15 percent had been killed in falls. And nearly every herd included survivors whose lame legs and broken or deformed horns gave further evidence of the risks a goat takes every day of its life. The heaviest toll of all falls upon the young.

In early winter the immature animals were often floundering through powdery snow as high as their heads. Then toward late winter I would see them toiling with their small hooves to paw through sodden or crusty snow to find something to eat.

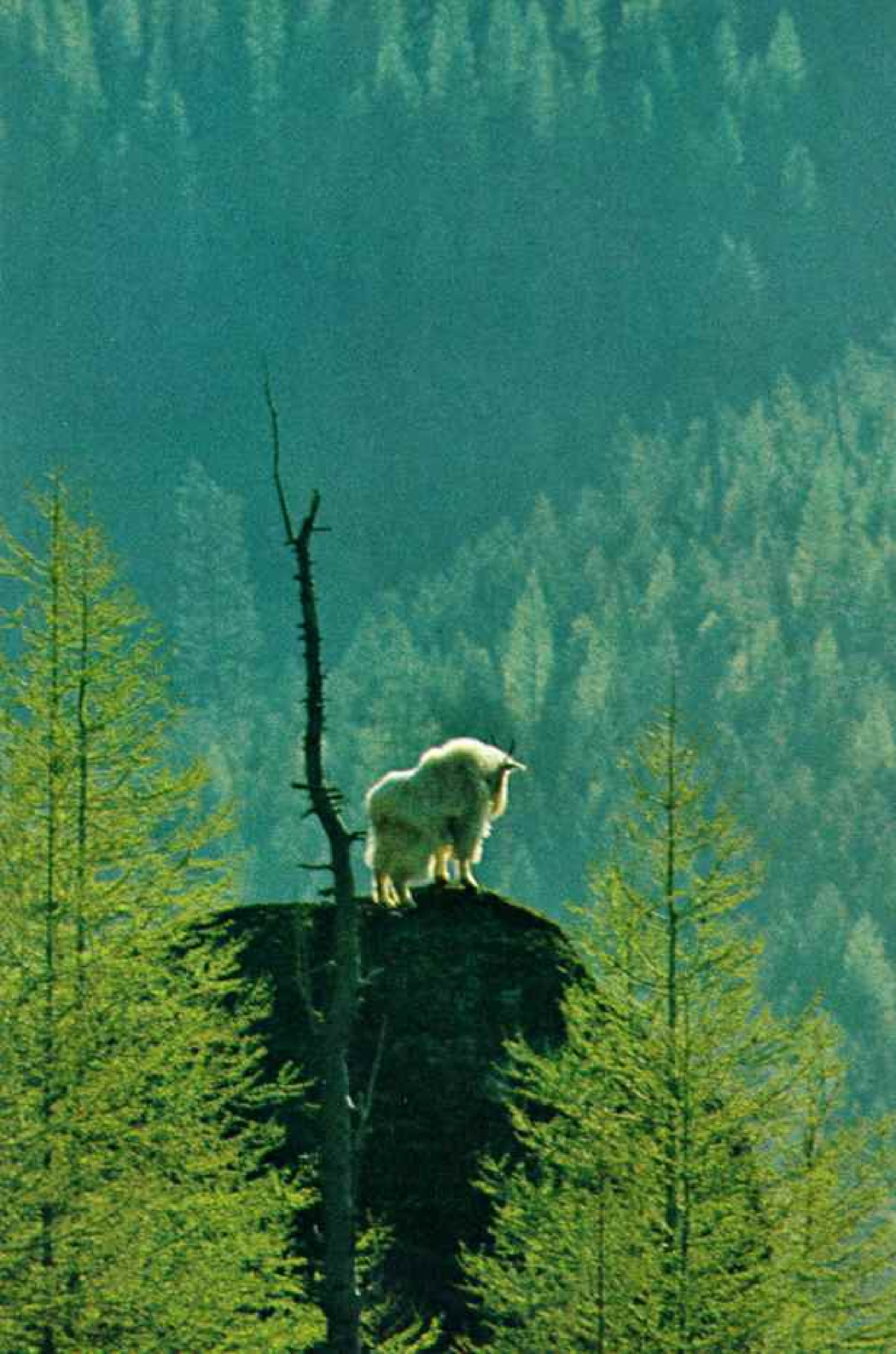
It is not unusual for more than half the kids and nearly as high a percentage of the



Double-suited for survival, mountain goats can endure winter temperatures as low as minus 50°F and winds as high as 100 miles an hour in rich winter coats that boast more than three inches of cashmere-quality wool overlaid with long hollow hairs (above). With the onset of summer, when the goats begin to molt, birds and squirrels in the valleys compete for the tufts of downy nest liner (below) that float down from the limestone-and-shale cliffs. But regardless of season, the goats rarely leave the dizzy heights (facing page) that keep them safe from most predators. Here, a small band feeds near a rock overhang, a shelter from avalanches that are the animals' greatest natural enemy.



KAREN REEVES CHADWICK



yearlings in any goat herd to disappear over a tough winter.

Mother and infant form the primary social bond of mountain goats. Toward the end of May the pregnant nanny leaves the herd and seeks an isolated cliff. There she will give birth, usually to a single kid, much less often to twins.

Kids Use Mom as Launching Pad

I remember one kid, scarcely 30 minutes old, not yet able to stand without toppling over. Every so often it would wobble away from its mother and try to climb straight up the nearest rock wall. This inborn approach to the world also sends kids tottering up onto boulders whence they spring willy-nilly—only to crash-land because their legs are not yet strong enough to support them.

The nanny's basic strategy is to keep nudging her daredevil offspring toward her uphill side and then rush after it the moment it wanders off. Kids usually sleep touching the nanny's uphill side too. But they may not sleep as long as she does. So a nanny is likely to awaken with her kid clambering up on her back and neck as it prepares to leap into space once again.

Kids and yearlings spend much of their time playing. Even a sedate old nanny may give in to their taunts and join them as they spin and buck and toss their horns while sliding down a cool summer snowbank. And of course any crag or boulder will serve for a game of king of the mountain. It is good practice. As adults, the same goats may battle in earnest to determine who is on top in the social hierarchy that plays a major role in nearly every part of their lives.

I was surprised at how often aggression occurred between mountain goats. Any one animal might be involved in as many as six or seven battles and chases in an hour, most of them ritualized—that is, limited to formal threats and posturing. But any such contest could quickly become more serious.

Butting heads as sheep do would be next to suicidal for the sharp-horned adult goats.

Instead, rivals arch their backs and whirl head to tail, each trying to hook the opponent's flank. I saw some goats gored and others butted over as much as a twenty-foot drop. Once a yearling caught between two aggressive older goats slipped off a sheer cliff and fell, uninjured, to a lower ledge.

What, I wondered, could possibly be the purpose of such combativeness?

A still more puzzling aspect of this society was the way huge, powerful billies behaved as subordinates to the smaller nannies. I even saw them sidle stiffly away from kids a tenth their size.

After thousands of hours of gathering data, I began to see some patterns emerge. It helped to be able to draw upon the histories of the animals I had marked with collars or could identify by scars or unusual horns. For example, to examine changes in the role of billies, I could scan my notes on Number 104, also known as William Goat, a billy that I collared as a yearling.

Little Billy Grows Up

At first I would almost always find him tagging after an adult nanny, often in the company of one or two other young goats. As he grew in size and strength, he intimidated his subadult companions and was soon confronting older nannies. Toward 2½ years of age, however, a growing sexual interest began to compete with William's aggressive inclinations. Torn now between making love and making war, this maturing billy seemed to find life in typical female-subadult bands increasingly frustrating. Where before he had gone out of his way to challenge other goats, he began to back away from the stress of social encounters and yielded the right-of-way even to smaller goats.

William Goat eventually took up the wide-ranging, mostly solitary life of an adult billy. This development in William's career, which I also observed in other billies, yielded important social results. The mature male with his sharp horns ceased to pose a physical danger in the daily battles of mixed

Down from its loftier precincts in search of a salt lick, a mountain goat surveys the deceptive serenity of a spring-mantled valley in Montana's Flathead National Forest. Mining and timber access roads, here and elsewhere where the animal is still fair game, increasingly bring hunters directly to its front door. ELIZABETH FULLER CHADWICK

groups. And he no longer competed directly with females and young goats for critical forage on their winter ranges.

The many battles I was seeing among other goats seemed to serve two purposes. First, fighting kept bands of goats spread apart over their range, and this reduced competition over food and shelter. Second, with big billies avoiding mixed groups, the highest positions in the social hierarchy were won by nannies. It became clear to me then that no matter how long or harsh a winter might be, at least some adult females would survive it because they had had first rights to whatever food and shelter were available.

Is Man's Encroachment a Threat?

Using new information that other goat researchers and I had assembled, I decided to take a look at the most pressing question about the species: Why have mountain goat populations been declining in different parts of their range in recent years? What could cause this hardy species to disappear entirely from some mountain strongholds in the United States and Canada as well?

Could the goat's decline be linked to changes in human use of the backcountry? In western North America, the past 30 years have seen a vast network of logging and mining roads cut through previously remote valleys and up to the higher ridges.

"Our mountain goat herds were being decimated in accessible areas," Canadian wildlife biologist Ray Demarchi told me when I visited his office in Cranbrook, British Columbia. His colleague, Ken Sumanik, pointed to a map and said: "In one area our goat count dropped from 163 to 3 in five years after the country was opened up by logging and coal and oil development. The very nature of the animal, living on the open cliff face as it does, exposes it to heavy hunting losses when it becomes easy to reach."

In my own Flathead study area, more than half the goat ranges I surveyed had U. S. Forest Service roads and clear-cutting nearly to their tops. Old-time residents told me of seeing 30 or 40 goats on cliffs where, after road building and logging, I counted three or four.

I had also watched closely as a new road was bulldozed into a wild valley. I spoke with the hunters who came into the goat

range that fall. Most said they were seeking trophy heads of billies, but they ended up killing more nannies than billies, largely because the sexes are hard to tell apart.

Kids normally remain with their nannies for nearly the entire first year of life, receiving attentive maternal protection against the elements, predators, and—importantly—older, aggressive herd members. Kids also share scarce winter food in the craters dug by their mothers. Youngsters whose mothers had been shot, however, lost that care. I watched as those kids were butted away by other females and forced to fend for themselves through the winter.

Shooting billies can also have side effects, especially if it disrupts fall mating activities. And because most males winter on different and generally less desirable ranges than those used by other goats, the food a billy would have eaten had he lived does not necessarily become available to other members of the herd.

"Without much biological information to go on," Lonk Kuck, an Idaho game biologist, told me, "we assumed the goats' reproduction rate would compensate for hunting losses, as with other game animals. Instead, I found hunted herds leaving their cliffs and moving to steeper ranges, where they found less food and produced fewer young. We now plan to take a much more conservative approach to goat hunting in this state."

In marginal ranges or in heavily roaded and disturbed habitats, this species may not be able to support any hunting at all—not on top of normal losses.

Good News for the White Mountaineers

The emphasis is shifting from harvesting herds to protecting and restoring them. Nearly all the biologists I talked with agree that the simplest and most effective way to protect mountain goat herds is to close off the roads that make them easy to get at.

Having lived for so long among them, I admit that if I were to manage these frost-white crag leapers, it would be mostly for their scenic and educational values.

We should take special care to see that the white goat remains, for it is a symbol of the mountain stronghold. Its decline marks the extent to which we have invaded and exploited the high wilderness. □

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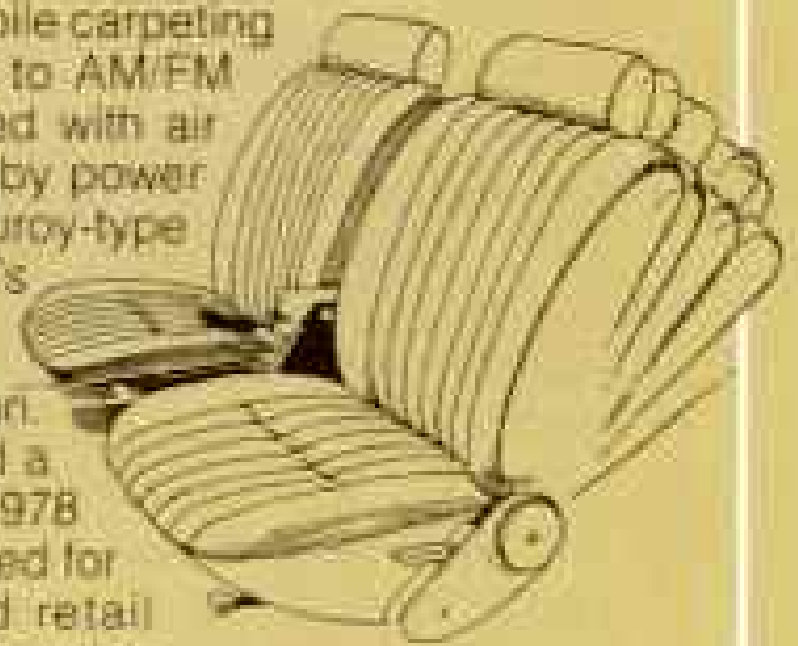


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The great quest for new dinosaurs

MAKING NEWS after 65 million years of extinction, dinosaurs now seem to some scientists quite different from the old stereotype of sluggish, cold-blooded, pea-brained creatures. Recent excavations have turned up new dinosaurs and led to new theories about them.

In Colorado, Dr. James Jensen (right, above) of Brigham Young University unloads fossilized bones protected by plaster casts. His excavations, supported in part by the National Geographic Society, have yielded evidence of what may prove to be the largest of all dinosaurs — already nicknamed "Supersaurus."

A world away in the Gobi Desert, a joint Polish-Mongolian expedition unearthed a small plant-eating dinosaur locked in death with an agile carnivorous dinosaur (right) that may have been warm-blooded.

Beginning on page 152, Dr. John H. Ostrom of Yale University explores the changing views about these animals. Such exciting scholarship may be shared with friends by completing the form below.



OTIS IMMIGER, NATIONAL GEOGRAPHIC PHOTOGRAPHER



ZOFIA KIELAN-JAWDROWSKA, INSTITUTE OF PALEONTOLOGY, POLISH ACADEMY OF SCIENCES, WARSAW

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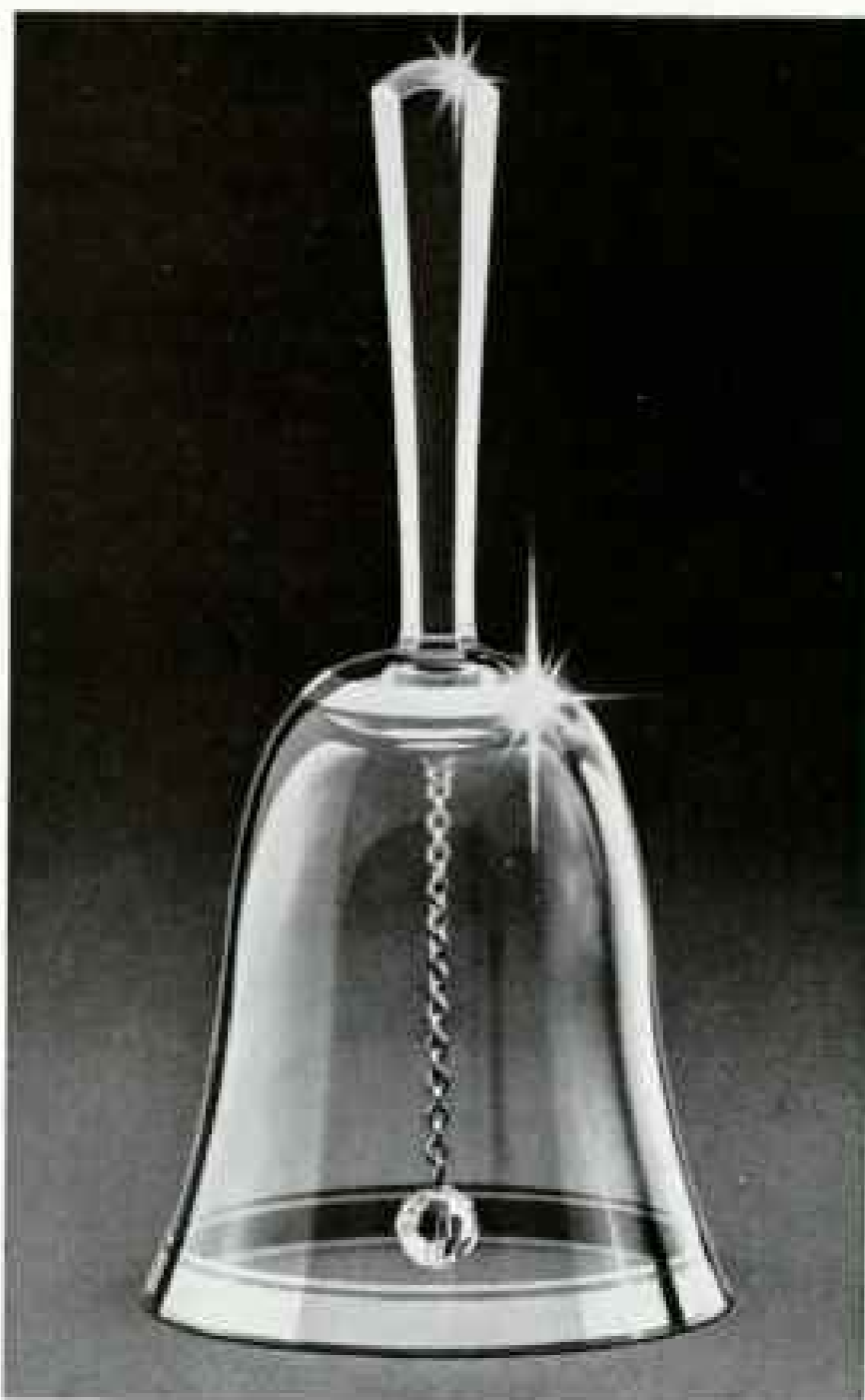
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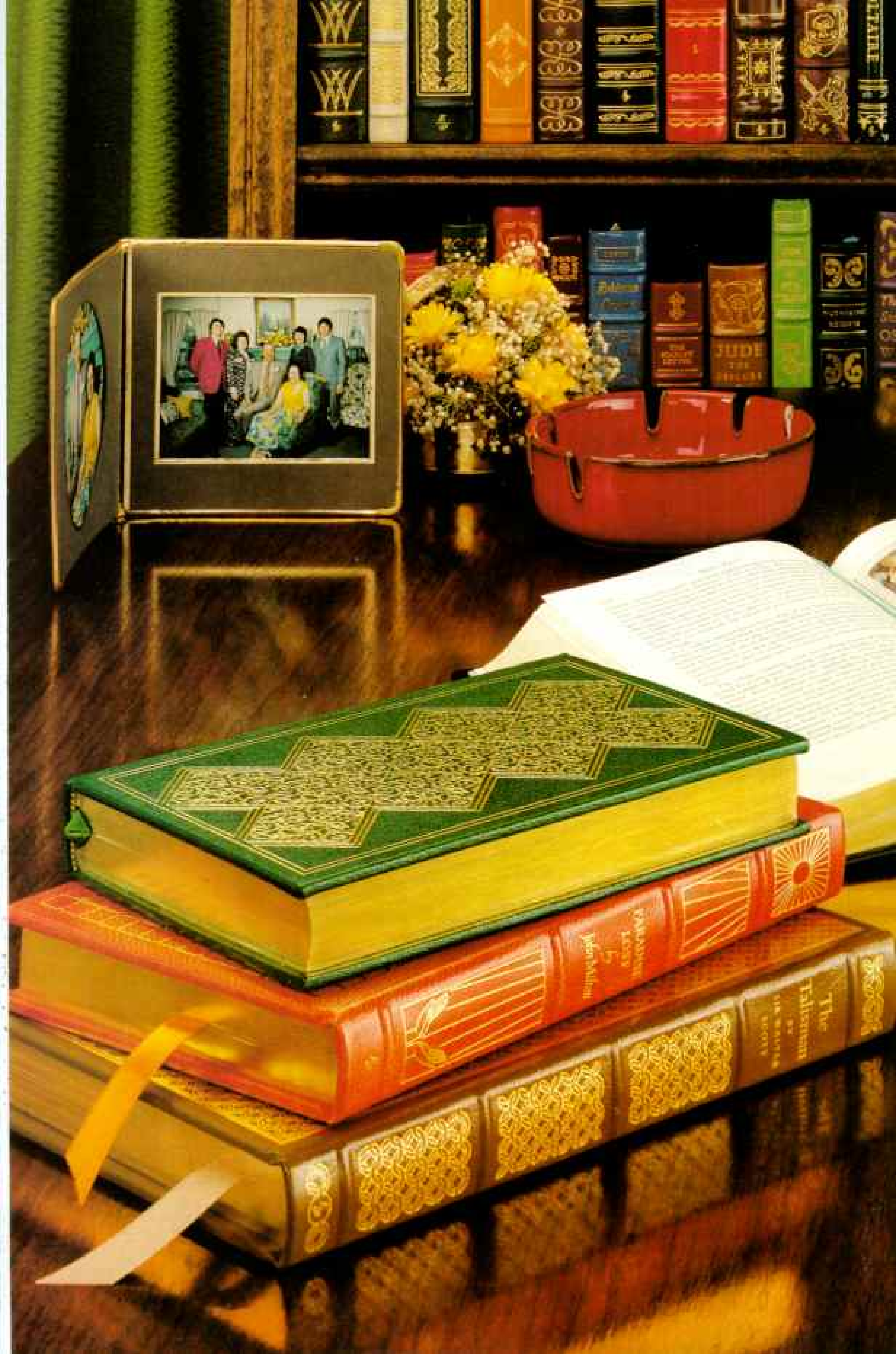
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(Continued on next page)



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(continued from previous page)



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Please pass along my thanks for your negative steering axis (or whatever it is called) to your engineers back in Germany. It helped keep me out of big, big trouble.

Many West Virginia roads, particularly those in the southern part of the state are bad. Unfortunately, I have to travel these roads during the course of my business.

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Traveling home recently on these bad roads, the sidewall of my left front tire blew out while I was driving at about 50 miles an hour. Faced with on-coming traffic

on the left and a steep drop off the pavement on the right (40 feet down through the trees to the river), I braced for the worst. It never came. In fact I had little trouble maintaining control as I slowed to about 10 miles an hour and drove for about a quarter mile to a tiny spot where I could get most of the car off the road.

Finally, I was back on the road, thanking God that He was with me during the emergency, and thanking Volkswagen for designing a front end that helped me stay on the road.

With warm thanks,

Brian Regut

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Left, the Sheraton-Maui. Above, the Sheraton-Kauai. The Neighbor Island experience in Hawaii: sea, sand, scenery, Sheraton comfort.

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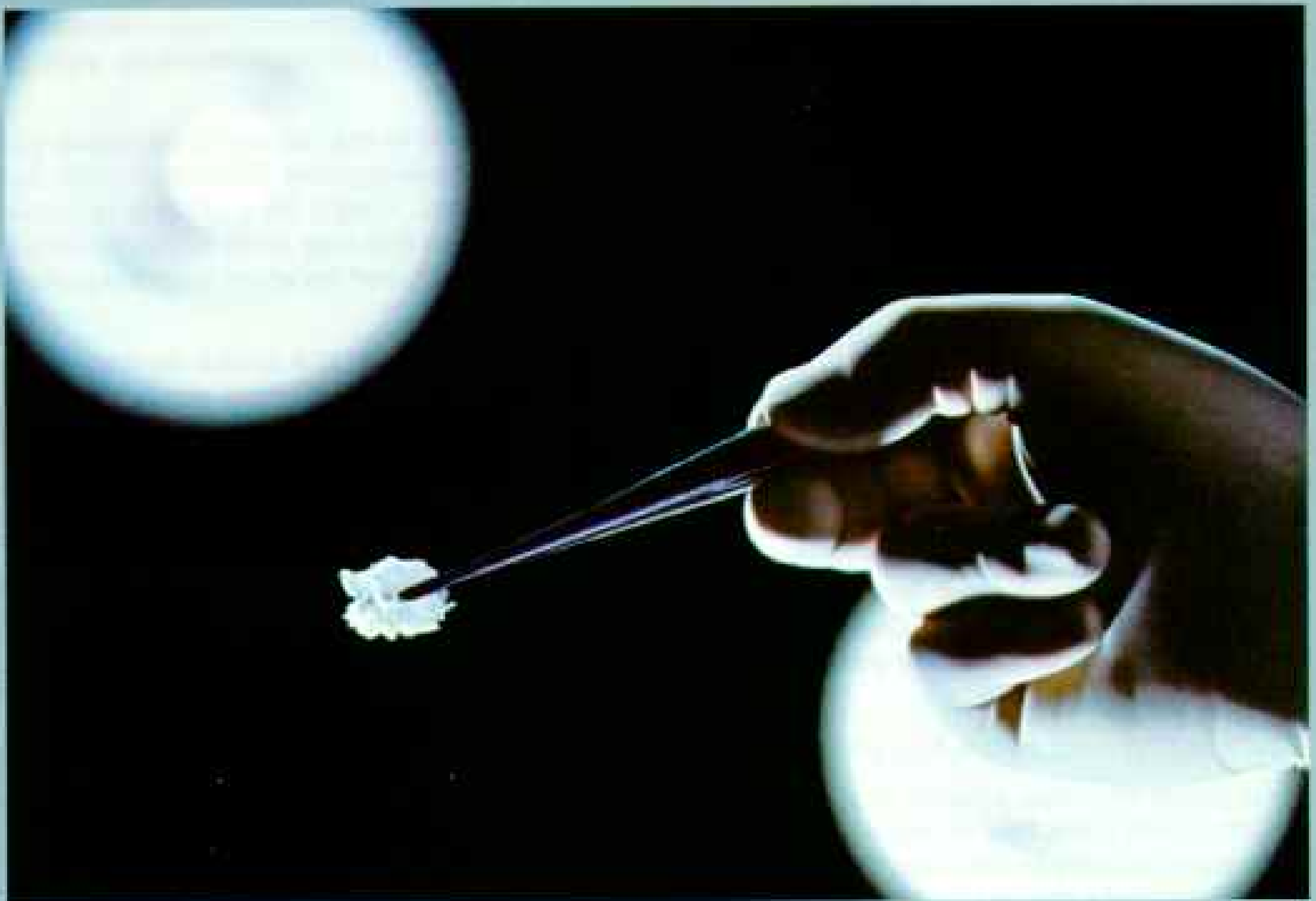
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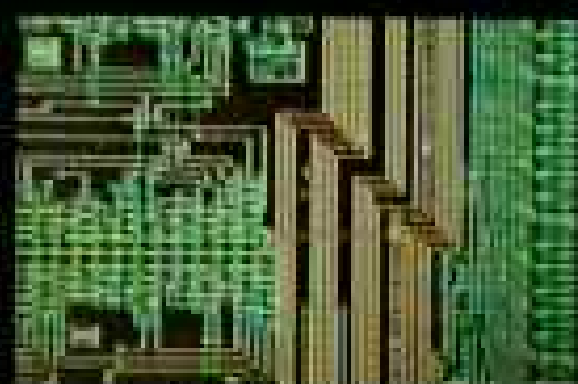
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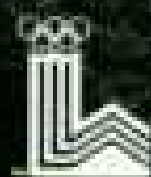
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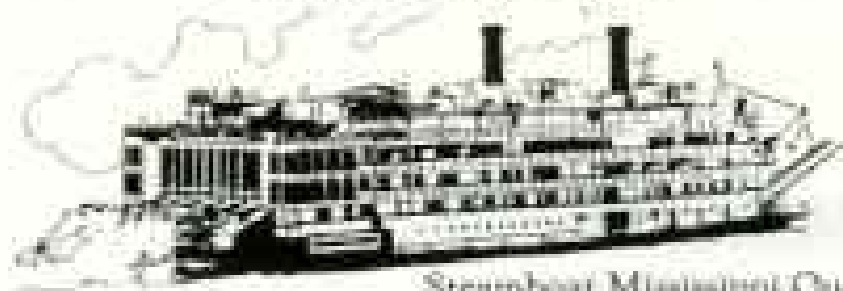


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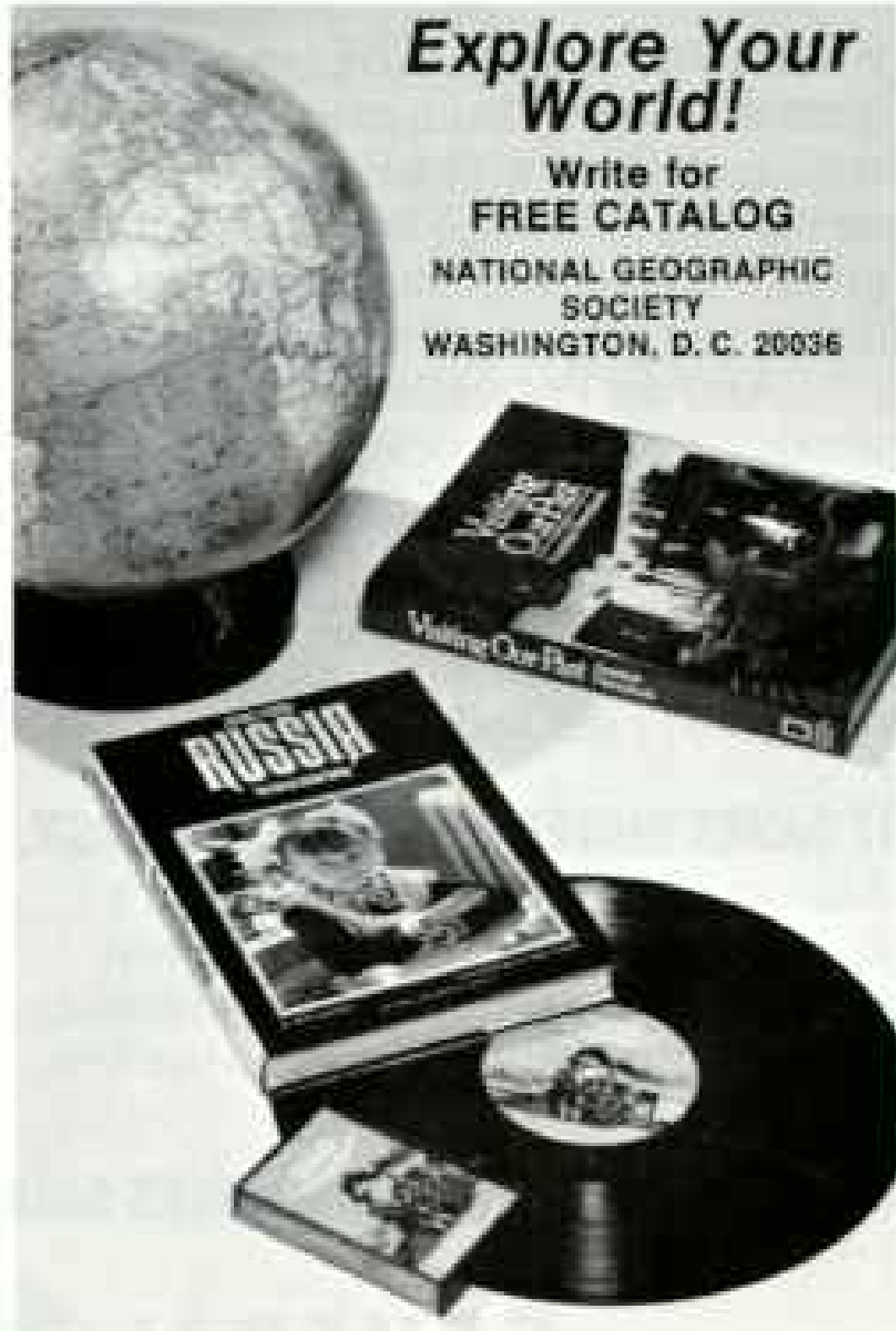
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And you know, it was one of the best buys anyone could make.

It’s the only electric refrigerator I’ve ever owned, and it’s sitting in my kitchen this very day, working away like it’s always done. Still keeps the milk nice and cold, and the lettuce crisp.

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My family teases me about it, but I simply can’t replace this faithful friend.

The salesman who sold it to me still lives here in Tyler. I saw him the other day and I shook his hand.

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Elouise Prater, Temple, Texas

My mother-in-law’s old ‘Monitor’ really influenced our choice. And I grew up with my own mother’s GE refrigerator. She had it 30 years.

We’ve had so many GE appliances that have lasted and given great service, well, to me, the name General Electric means dependability.

So even though I looked at some others, I knew this beautiful GE side-by-side was the only refrigerator I wanted.

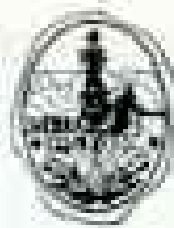
I like getting ice cubes and crushed ice and chilled water without opening the door.

Inside, there’s lots of room. And adjustable glass shelves that are easy to clean. Automatic defrosting, of course. Even a separate temperature control for my meat bin.

I expect it will last and last, like that ‘Monitor’ of Jane’s. I can’t imagine a better value.

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Flowers of the American Wilderness

*Twelve collector's plates by the world-famous artist Jeanne Holgate.
Crafted of fine porcelain and individually bordered in pure 24 karat gold.*



Alaskan Wildflowers

Plate shown smaller than actual 7 1/4" size.

*This is the first collection of its kind
ever issued by the Sierra Club.
It is available in exceptionally limited
edition—by subscription only.*

*The subscription deadline is
August 31, 1978.*

The flowers of the American wilderness are among the most beautiful of our natural treasures. Delicate, graceful and vibrant, they have the power to stir the heart as well as the senses. Yet so elusive is their beauty that it is a rare artist indeed who can capture it with accuracy and realism.

But now, the Sierra Club, America's foremost conservation organization, has commissioned one of the most gifted floral artists of our time—Jeanne Holgate—to do exactly that. In its very first collection of porcelain plates.

An acclaimed artist whose style combines uncompromising accuracy with a mastery of form and color, Jeanne Holgate works directly from the living flower. Thus, she is able to depict each wildflower exactly as it is in nature. So completely true to life that the tiny creatures she so joyfully portrays approaching her flowers are never a surprise to the viewer. For this is where the bumblebee, the grasshopper and the butterfly truly belong.

The result is a collection of beautiful works on porcelain—so lifelike that each is aglow with the inner beauty of the flowers themselves. A collection that will bring the beauty of our country's wildflowers into the home, where it can be enjoyed—year after year—by every member of the family.

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There will be twelve porcelain plates in this historic Sierra Club collection. Each will measure 7 $\frac{1}{4}$ " in diameter, a size chosen especially to enhance the delicate beauty of its subject. And every design will delight the eye with its clear and uncomplicated beauty.

Each of the twelve plate designs will portray the loveliest wildflowers of a different region of our country, from the enchanting *Lady's Slipper Orchid* of the New England woods to the *California Poppy* that grows in profusion along Pacific shores . . . and from the charming *Forget-me-not* that brightens the Alaskan plains to the graceful *Water Lily*, glory of the Florida Everglades.

Thus, together, the complete collection will por-

tray America's most distinctive and beautiful wildflowers—in a form destined to remain forever fresh and fascinating.

Crafted of the finest porcelain

Each plate in the Sierra Club collection will be individually crafted of fine Bavarian porcelain, prized throughout the world for its whiteness, its translucence and its enduring strength. And every plate in the collection will be individually decorated with a rich border of pure 24 karat gold.

The Sierra Club has appointed Franklin Porcelain, a division of The Franklin Mint, as the sole issuing authority for this, its first collection of porcelain plates. And only those plates which meet the most demanding quality standards will be accepted for issuance to subscribers.

Limiting the edition of fine porcelain plates

By order of the Sierra Club, *Flowers of the American Wilderness* will be produced and issued only by direct subscription. The total number of plates to be issued will be sharply and permanently restricted in the manner long ago established to assure the rarity of the finest porcelain plates. Thus, there is an absolute limit of just one subscription per person, and the total edition of the collection will be forever limited to the exact number of subscriptions entered by the official deadline date, plus one set for the permanent archives of the Sierra Club and one for the artist.

As a subscriber, you will receive your plates at the convenient and systematic rate of one each month for a year. The issue price for each fine porcelain plate is just \$39, and a display stand will be provided with each of your plates.

A legacy of beauty

As fine porcelain to display in your home . . . as a collection of original works by a world-renowned floral artist . . . and as the first collection of porcelain plates ever issued by the Sierra Club, this will be a most rewarding acquisition.

And, because a truly worthwhile possession retains its appeal forever, this collection will also be far, far more. A legacy from you, to be passed along from parent to child, down the generations. A legacy that will—again and again—inspire a love of beauty and an appreciation of America's proud natural heritage in all who come to possess it.

But please keep in mind that the Sierra Club's *Flowers of the American Wilderness* plate collection is available for only a limited time. To subscribe, simply complete the application at right and mail it by August 31, 1978. After that date, this beautiful collection will never be made available again.

There is no need to send any payment now. But please be sure your Subscription Application is postmarked no later than August 31st.

JEANNE HOLGATE's work is a permanent part of the great floral art collections of the world—including those of Carnegie-Mellon University's Hunt Botanical Library, the British Museum, and the personal collection of Her Majesty Queen Elizabeth, the Queen Mother of Great Britain. She is the only artist ever to have been awarded successive gold medals by the Royal Horticultural Society, and is listed in "Who's Who in American Art."

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PORCELAIN PLATE COLLECTION

Valid only if postmarked by August 31, 1978.

Limit: One subscription per person.

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Please enter my subscription for *Flowers of the American Wilderness*, consisting of twelve collector's plates crafted of fine Bavarian porcelain, each bearing an original work of art by Jeanne Holgate. The plates are to be shipped to me at the rate of one every month.

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Wildflowers of the Southwest



New England Wildflowers



Wildflowers of the Florida Everglades

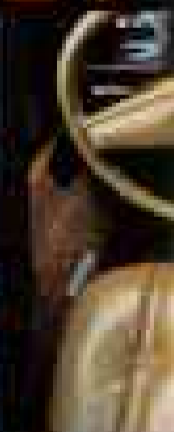


1978 Chrysler Cordoba

"The picture of style and taste."

Anthony Edgeworth, contributing photographer, Esquire Magazine

We asked New York fashion photographer, Anthony Edgeworth to show you a new Cordoba the way he sees it. "To me . . . Cordoba is classic. Look at the proportions . . . the unbroken reflective surfaces . . . an absence of chrome. It has a strong look. I like that. I like the interior too. It's uncluttered. The car looks like it would fit a very special way of life. Cordoba? It's the picture of taste."



That's the way one of the nation's leading photographers sees Cordoba. Now put yourself in the picture when you buy or lease a new Cordoba at your Chrysler-Plymouth dealer.



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CHRYSLER CREDIT CORPORATION

No breakfast is nutritious until somebody eats it.



When you're Kellogg's, it's pretty easy to put good nutrition into a cereal. After all, we've been doing it for a long time. What's not so easy is getting good nutrition into a child.

A one-ounce serving of Kellogg's Sugar Frosted Flakes® cereal contains 25% of the U.S. Recommended Daily Allowance of 7 essential vitamins. Plus 10% of the U.S. RDA of vitamin D and iron.

But that's not why kids like them. It's that sparkle of sugar frosting we add that gets the cereal out of the bowl and into the youngster. That means they can get a very smart start on the day.

Kellogg's
A very smart start.

PPG Solarcool® Bronze glass tames the blazing summer sun. And air conditioning costs.



With all of its windows and sliding glass doors glazed with PPG Solarcool Bronze reflective glass, this Florida home looks perfectly beautiful.

But it's on the inside that Solarcool pays off. By reducing glare and heat gain from the burning southern sun, this newest PPG residential glass can save up to 17 percent on air conditioning costs. That's compared to clear glass and is based on a PPG computer energy analysis. Comparable savings can be obtained in other locations.

In the daytime the glass reflects the lovely Florida sky and water. Even more important, it sharply reduces visibility from the outside, so people inside enjoy comparative privacy. And ultraviolet light, a major cause of interior fading, is cut way down.

If Solarcool can tame air conditioning costs in Florida, think what it can do for the home you're going to build or buy. Why not write for a free copy of our Solarcool idea book: "Best Glass Under the Sun." PPG Industries, Inc., Dept. NG-388, One Gateway Center, Pittsburgh, Pa. 15222.

Bent Tree Development by
The Babcock Company, Coral Gables, Fla.

PPG: a Concern for the Future

PPG
INDUSTRIES

Gasoline made simple.

A lot of the new cars tend to be choosy when it comes to fuel. Most of them have catalytic converters, which means they are designed to accept nothing but unleaded gas.

Hondas are different. All our new cars—the Civic® 1200, the Civic CVCC®, and the Honda Accord®—operate without a catalytic converter. So you can take your pick of regular or unleaded gasoline. As for premium, there is no benefit and it's a waste of money.

Of course, whichever gas you use, you can go a long way on it in a Honda. Our best mileage car, the Civic CVCC 5-Speed, was rated at 47 mpg for highway driving, 37 mpg city, according to EPA estimates.



HONDA
CIVIC CVCC
HATCHBACK

Our lowest EPA mileage estimate was received by the Civic 1200 with 2-speed manually-selected Hondamatic transmission: 30 mpg highway, 23 mpg city. All estimates are lower for California and high altitude areas. Also, the Civic 1200 is not available in California or in high altitude areas.

Although we're happy to tell you about our 1978 EPA mileage figures, we want to be realistic about them. So please keep in mind that EPA estimates are the result of laboratory tests and are offered only as a means of comparison.

When you drive in actual traffic on real streets and highways, your mileage might not be as high. Of course, in addition to how and where you drive, your mileage is affected by such things as your car's condition and optional equipment.

Still and all, a Honda makes the neighborhood service station a nice place to visit. You get your choice of gas pumps when you drive in. And very good mileage after you drive out. Now, how could we make gasoline any simpler than that?

HONDA
We make it simple.



Andersen® Perma-Shield®

What more could you want in a window?

Fuel-saving design.

It comes from a vinyl-clad wood core, optional double-pane insulating glass and a snug-fitting design that's two times more weathertight than recognized air-infiltration standards.

Warmth, charm and character.

The natural beauty of interior wood trim that can be stained or painted to complement any decor.

Easy open, easy close.

Perma-Shield Casement Windows crank open smoothly to scoop in passing breezes. And just as easily, they close up tightly.

Insulating glass.

Double-pane insulating glass provides a major part of the fuel-saving benefits of single-pane glass with storm windows. And only half the glass cleaning chores.

Inside comfort.

Andersen close-fitting tolerances and rigid vinyl weatherstripping help seal out drafts and dust, help save on heating and cooling bills.

Low upkeep.

Thanks to an exterior sheath of long-life, rigid vinyl that doesn't rust, pit or corrode. Doesn't chip, flake, peel or blister. In white or our earth-tone color, Terrastone.

Send this coupon for more details about Andersen Perma-Shield Casement Windows (for both home and office) and our other window and gliding door styles. See your lumber dealer, too. He's in the Yellow Pages under "Windows." Or consult your architect or builder.

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You see, with us you have a choice. To be alone on one of our endless islands, pampered by nature. Or be with others, pampered by us.

For reservations and information, call your travel agent or 800-327-0787.

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It's Better In The Bahamas

BAHAMAS



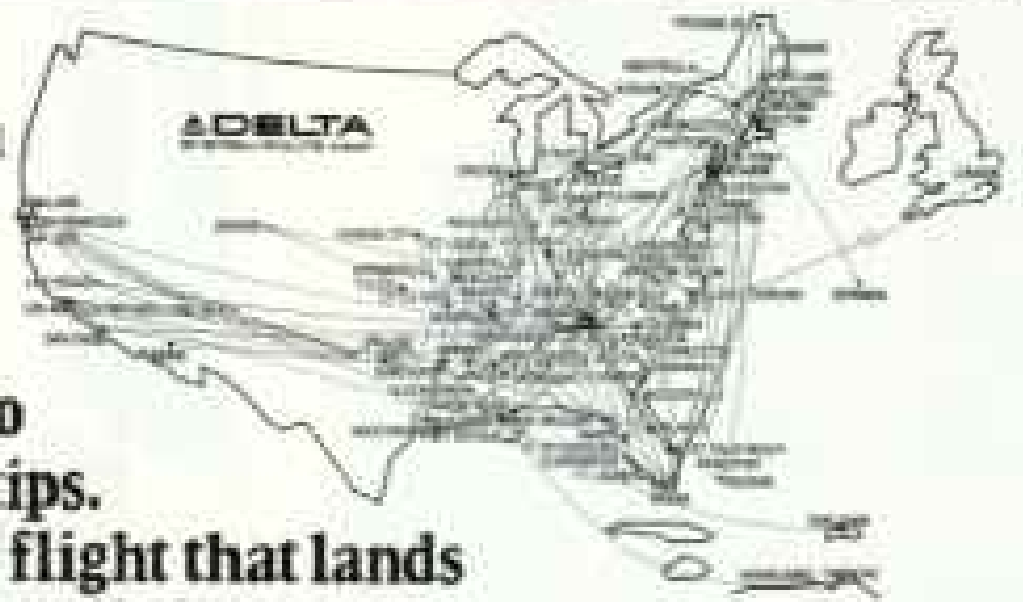
Delta is an air line run by professionals. Like Captain Frank Moynahan, a 28-year Delta veteran who pilots a Wide-Ride L-1011 TriStar.

The man and the jet are well matched. Frank has over 26,000 hours and 7,800,000 air miles under his seat belt. And the giant jet is so responsive that he could fly it with his fingertips.

So Frank's passengers enjoy a smooth, easy flight that lands them smiling. And that, Frank says, is what it's all about.

When it comes to people, Captain Frank Moynahan couldn't care more. In fact, that goes for all 31,000 Delta professionals.

Delta is ready when you are.®



This is Delta's Wide-Ride L-1011 TriStar, a \$25 million superjet. The "living room" cabins are 8 feet high, almost 19 feet wide.



“My new bifocals
have no lines...”

And who needs
more lines?”

Why in the world should anyone know that you're wearing bifocals, except you?

American Optical has designed a new kind of bifocal lens, with no telltale line across the middle. **ULTRAVUE™** Lenses. The invisible bifocals.

Unlike ordinary bifocals, the different magnifications merge together smoothly, so you can see clearly close up, far off, and everywhere

in between. Ask your eye care professional about **ULTRAVUE** Lenses from American Optical.

The bifocals with no lines. They're feather-weight and tintable. Absolutely perfect for today's fashion frames.

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