DOUBLE MAP SUPPLEMENT: SOUTH AMERICA

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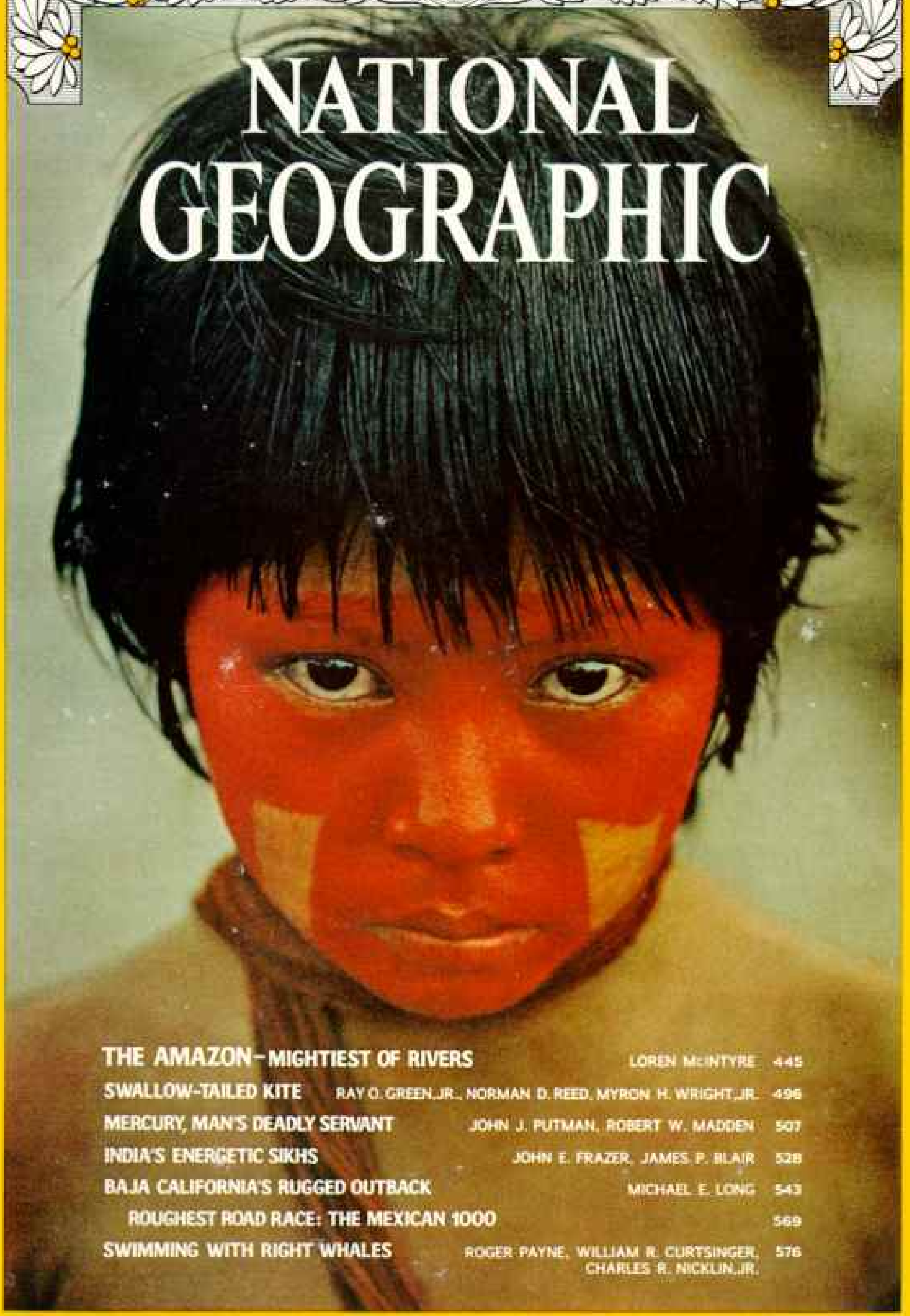

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

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WASHINGTON, D. C.

Organized "for the increase and diffusion of geographic knowledge"

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The 1973 Oldsmobile Ninety-Eight Regency.

Walter Hoving, Chairman of Tiffany's, says it's a car for people with good design judgment.

Maybe you'll agree. Maybe you won't.

But if you're going to invest $5,000 or more in a luxury car, shouldn't you at least come in and see?

"The Ninety-Eight Regency is a car that people with good design judgment will appreciate."

Mr. Hoving may be somewhat prejudiced—his company designed the timepiece facing on the dash, and it bears the Tiffany name. And that fact itself suggests the kind of quality and elegance you may expect in the Ninety-Eight Regency.

The Regency interior is extraordinary. Seat cushions and backs are tailored to create a soft, pillowed effect, like that of fine furniture. Zippered storage pouches are sewn into the front seat-backs. And a distinctive limousine-quality velour is included among your upholstery choices.

At Oldsmobile, we feel a car priced $5000 or more should be superior to an ordinary car. Not merely in room, ride, comfort and luxury—but in handling, responsiveness and roadability as well. And we think you'll agree.

There are some other American cars that can be considered in Ninety-Eight's class. And most are more expensive. But we don't think they're any more car.

Oldsmobile.

Always a step ahead.

1973 Oldsmobile Ninety-Eight.
Drive it and draw your own conclusion.

The symbol of America is vanishing. You can help save him by creating the first National Children's Eagle Nesting Area.

Send Hunt-Wesson a label, and we'll buy protective nesting land in your child's name.

A lot of things are killing the bald eagle.

Illegal shootings. Noise that scares it away from its eggs and its young. Pesticides that pollute its food.

Now, outside of Alaska, fewer than 800 nesting pairs exist in the United States. Bald eagles have been declared one of America's endangered species.

Recognizing the danger is a victory of a sort.

But our goal is to help the bald eagle increase its numbers to keep it from disappearing.

We can help do that simply by giving the eagle what he needs most to survive. Peace and privacy.

Here's how you can help, and also do something special for a child you care about.

For every Big John's or Snack Pack label you send us, we'll buy approximately 15 square feet of private land in a child's name next to the Chippewa National Forest in Minnesota. This land, where two pairs of nesting bald eagles have been found, will be turned over to the U.S. Forest Service, and will be known as the first National Children's Eagle Nesting Area. A small start in saving the eagle but a vital one. And, as we acquire more nesting land, we'll create more safe nesting areas.

Money that's left over after all available land is purchased will go to what the Forest Service considers a critical project: eagle study, so more can be learned about how eagles live and how to help them survive.

If you can get a group involved, you can do even more. Last year, more than 1½-million trees were purchased for planting in burned-out forest land through our National Children's Forests program. Unlike the Forests, this nesting land is not a place to visit; the risk of disturbing the eagles is too great.

There are a great many other things you and your children can do to save this magnificent bird and other endangered wildlife. You'll find them listed on our eagle conservation wall poster which we've prepared in cooperation with leading conservation organizations.

We'll send each child the poster plus a decal for bikes, books, etc., saying "Help Save The American Eagle." And we'll place his name in a vault near a marker at the Chippewa National Forest headquarters.

The bald eagle was chosen as our national symbol in 1782.

Help keep him alive, so your child's generation can have a symbol. Of survival.

Photo: Frederick Lent Truslow

HERE'S HOW YOU CAN HELP SAVE THE AMERICAN BALD EAGLE

Send proofs of purchase from the following products. Each proof received will purchase approximately 15 square feet of land. A poster and decal will also be sent. No limit on the number of proofs that will be accepted.

_____Hunt's Big John's Beans 'n Fixin's® or Chili 'n Fixin's™ bottom can label (any size).

_____Hunt's Snack Pack® 4-pack ingredient line panels from cardboard jacket of any flavor puddings or fruits (ingredient lines from individual can labels not acceptable).

You can reproduce this coupon and involve your friends, club, church or other organizations if you like.

HELP SAVE THE EAGLE
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FULLERTON, CALIFORNIA 92635

Name _____

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City _____

State _____ Zip Code _____

THIS OFFER EXPIRES FEBRUARY 28, 1978

Please allow 4-6 weeks for delivery. Offer void where taxed, prohibited or otherwise restricted.

PATRICIA CAULFIELD (ABOVE) AND THOMAS A. DAVIS

Tracking Florida's tiny deer

ROVING RADIO STATION—a Key deer wearing a transmitter in its collar—crosses a highway on Big Pine Key. The cattle egret tags along to dine on insects stirred up by the collie-size cousin of the common whitetail.

Signals from the collar relay the deer's movements to Dr. W. D. Klimstra (**right**), Director of the Cooperative Wildlife Research Laboratory of Southern Illinois University. In an on-the-spot study supported by the National Geographic Society, the scientist and his assistants eavesdrop on the Nation's only herd of Key deer to understand their habits and habitat needs. Once nearly extinct, the animals have increased under federal protection to about 600. Yet they face an uncertain future as land development encroaches on their island domain.

Your friends can help sponsor such meaningful and rewarding research. Nominate them for Society membership on the form below.

This TV commercial shows your head from bouncing off

Allstate believes in air bags. We think they're today's best answer to highway death and injury. Along with lap belts, we'd like to see air bags installed for front seat occupants on all cars as soon as possible.

What's in it for us? The same that's in it for you. We want to reduce the thousands of annual highway deaths and the millions of crippling.

1. ED REIMERS: "Allstate believes in air bags. So recently they bought 200 Mercurys

2. with air bags for Allstate people to drive. The air bag is right under here.

5. bag might inflate accidentally, when it shouldn't. But the 'sensor' is designed to prevent this.

6. The roughest roads don't inflate the air bag. Bumps don't. Panic stops don't.

9. in a frontal crash serious enough

10. to cause injury.

how today's air bag can keep a windshield.

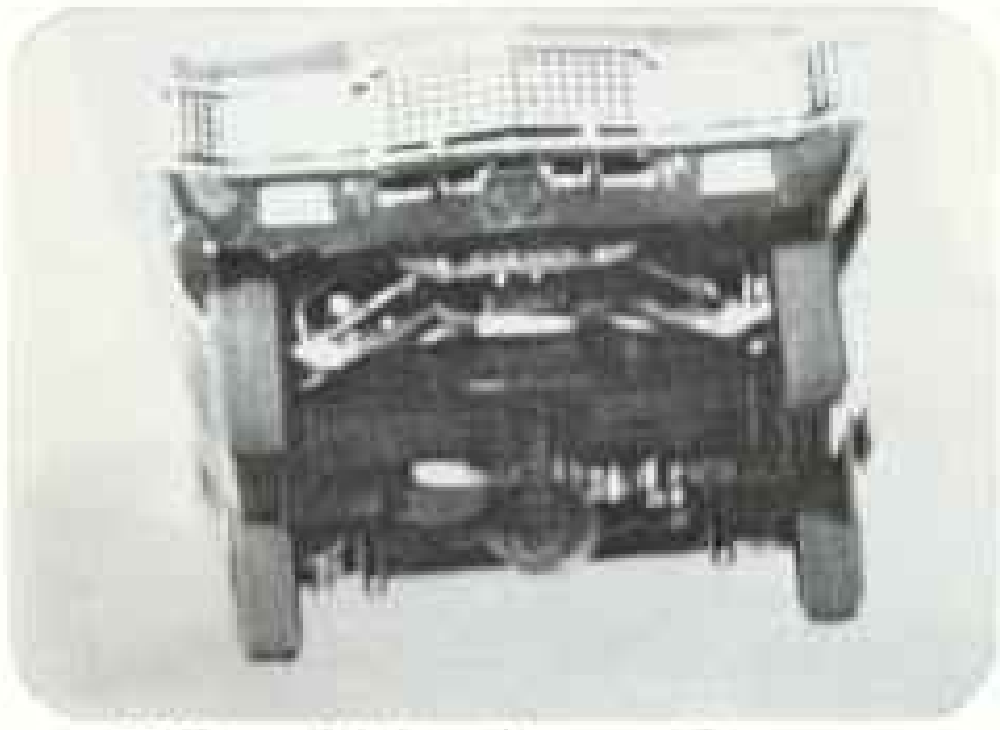
disfiguring injuries. Besides saving lives and preventing injuries, air bags in cars are expected to help hold down the cost of your auto insurance.

For a 30-minute film about air bags for your club or organization, write the Safety Director, Allstate Insurance Company, Northbrook, Illinois 60062.

Allstate®
Let's make driving a good thing.

3. This special sensing device, that uses technology from the space program, decides if a crash is serious enough

4. to inflate the air bag. Some people worry that the



7. Even driving the car off a ramp won't inflate the bag.

8. The bag only inflates

11. Allstate says let's use space age technology to reduce auto injuries

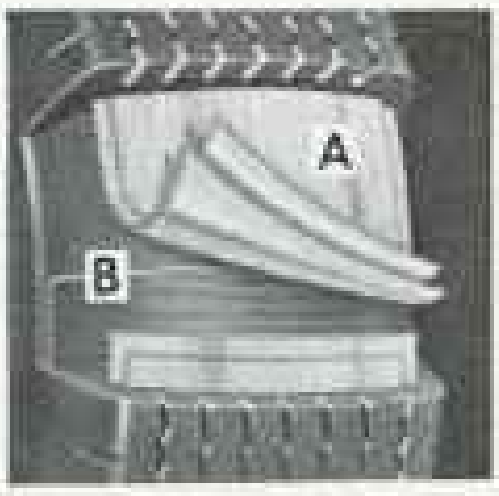
12. and save lives."

This commercial has not yet been shown on TV

General Tire radials can the protection of steel belts

surround your family with for 40,000 miles.

The new General Dual-Steel Radial™ tire.
The American radial built with steel belts under the tread. Guaranteed for 40,000 miles.



A. Dual belts of steel cord to protect in the tread area.
B. Flexible body plies wrap radially around the tire.

Run over rough highway edges, it smothers them and keeps rolling.

Go into a curve, the treads hold firm.

When you're apt to be carrying family-sized responsibilities in your car, those are the things that count.

We built the General Dual-Steel Radial to be a lot of tire. A Calibrated® tire to give you a smooth ride. A tire with Duragen® tread rubber to deliver a lot of miles. It's a tire that, more than anything, was built with you and your family in mind.

Mile after mile. Season after season.

Maybe for as long as it takes a 9-year-old to grow up to be a teen-ager.

GUARANTEED FOR 40,000 MILES

Our Dual-Steel Radial will give you 40,000 miles of tread wear in normal passenger usage on your car. If it doesn't, bring your Guarantee Certificate to an authorized General Tire retailer. We'll give you replacement tire credit or cash refund at our option equal to the percent of mileage not received, based on your purchase price if available or the current selling price, whichever is to your advantage. Excluded are repairable punctures; tires used on trucks, commercial or racing vehicles; and tires evidencing improper care or vehicle maintenance.

GENERAL TIRE

The safe-driver tire company.

If you're a 16-21 year old driver... or know one... ask about our 16-21 Safe-Driver Discount Program.

Beauty treatment for 87 acres of trash.

In this age of affluence, we have more of everything. Including more trash. 182,000,000 tons a year. And what to do with it is a real problem.

Burning it produces smoke and fly ash. Open dumps breed insects and disease.

Many cities bury their problem. It's cheaper, cleaner, more efficient and healthier.

And waste burial, or sanitary landfill, is a good way to turn low value land into a community asset. Los Angeles County reclaimed an abandoned strip mine with sanitary landfill.

The result is the lush, 87-acre South Coast Botanical Garden.

Find out what you can do in your community. Write for the free booklet, "What can you do with refuse?" to: Caterpillar Tractor Co., Dept. 718G, 100 N.E. Adams St., Peoria, Illinois 61602.

Or ask your local Caterpillar Dealer to show you the film, "The trouble with trash."

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We can make the world a better place to grow up in. Caterpillar machines will help.

CATERPILLAR

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The $29.95 blue chip investment.

The Honeywell Strobonar 100: an investment. Instead of an expense.

It costs you $29.95*. Once. And at about 200 flash pictures a year, it should last 12 years or more.

Flashbulbs for the same number of flash pictures cost about $30.* Each and every year.

So with the Strobonar 100, you should save about $350 over the next 12 years. And $350 saved is $350 earned. Which makes the Strobonar 100 one of the bluest blue chip investments.

The Strobonar 100 pays a dividend every time you click the shutter.

The dividends it pays are the better pictures you take. Simple settings determine just the right amount of light needed for a perfect exposure.

A built-in Ready Light glows each time the unit's ready to use. And with fresh batteries, that's a flash picture every 10 seconds! Without the hassle of flashbulb storage, changing, and disposal. When you're not using it, just slip it in your pocket.

The Strobonar 100 also synchronizes with your camera through a hot shoe contact or its detachable shutter cord and has a guide number of 25.

You can start clipping coupons now by clipping the one on this page and sending for your FREE electronic flash brochure, facts on the complete Honeywell Strobonar line and the name of your nearest Honeywell dealers.

*Not including batteries.

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BUICK. The solid

ELECTRA 225 LIMITED

For 1973, Buick offers an extra-ordinary system of innovations you can actually feel.

With your hands. With your ears. With all your senses.

For example, there is a built-in emission control system so advanced you may actually sense a new degree of engine smoothness. It's subtle, but it's there.

1. For 1973, there's a rugged braking system that automatically balances front and rear braking forces for smooth, confident stops.

2. Deep, roomy full-foam seats. For solid comfort and support.

3. AccuDrive. For stable

feeling for'73.

handling, even on bumpy roads.

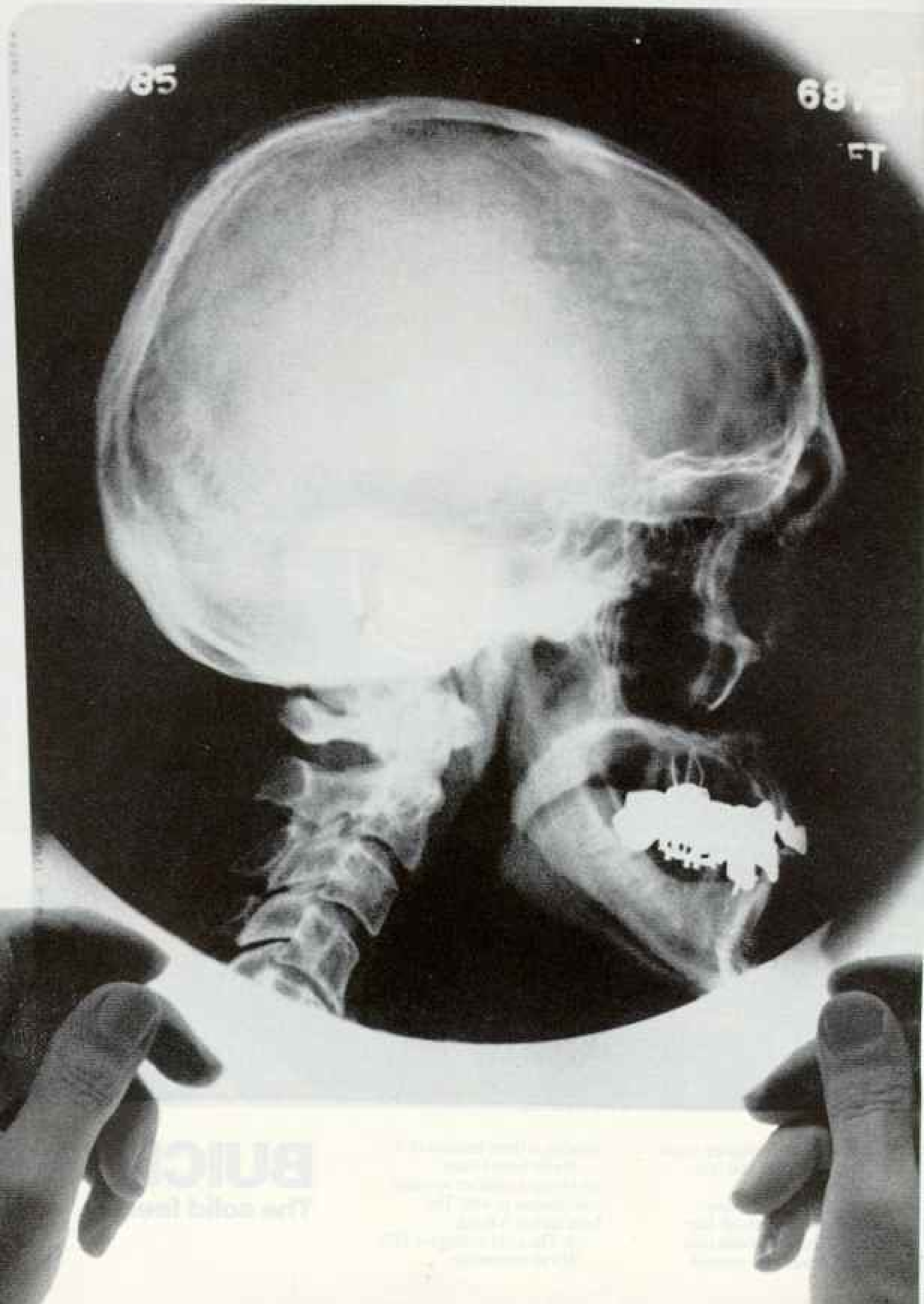
4. A new front and rear bumper system.

Many things you may never become aware of: like Buick's double-paneled roof. But the silence, the sense of solidity, is there because of it.

Never before have we brought together so many innovations so well. The total feeling is Buick.

5. The solid feeling for 1973. It's an experience.

BUICK.
The solid feeling.



General Telephone & Electronics, 730 Third Ave., New York, N.Y. 10017

This man will never die.

Headache, dizziness, and double vision; it could be a brain tumor. Fever, and an elevated white blood cell count, with a shift to the left; it could be meningitis. Blood pressure, 240/150; it could be malignant hypertension.

The symptoms are real, but the patient isn't.

Connected to terminals in classrooms at the University of Illinois Medical School, a Tempo Communications processor, provided by GTE Information Systems, acts as a super-efficient secretary to the main computer, accepting information and firing out answers.

A medical student considers the information provided by the computer, diagnoses the condition, and proposes a course of treatment. If his diagnosis and treatment are correct, the computer gives him an "A" grade.

If he's wrong, the computer puts the pressure on.

The hypothetical patient returns with additional complaints. This time, the student doctor has less theoretical help at hand. Instead of seeing the patient in the hospital emergency room, as he did the first time, the computer tells him that it's 3 a.m. at his doorstep. The symptoms appear far more serious, and the correct diagnosis is that much more critical.

If he's wrong again, nobody dies.

Teaching medical students to be right can't, and shouldn't, be achieved by computers. That's the work of experienced, dedicated professors of medicine. But as a training aid, the computer has a lot to offer, and we're proud of the contribution to this program that General Telephone & Electronics has been able to make.

Before he begins his practice, we'd like every new doctor to practice on us.

GTE

GENERAL TELEPHONE & ELECTRONICS

The late, late Summer in Bermuda looks just like these postcards. Enjoy it now.

When Summer leaves you, it is alive and well and waiting for you in Bermuda. Everything you could do in Summer can still be done on our island during September, October and November. Catch up with the Summer vacation you missed. Or enjoy another. Your travel agent can send you to the late, late Summer in Bermuda. Or simply write to Bermuda: 610 Fifth Ave., New York, N.Y. 10020— 6 N. Michigan Ave., Chicago, Illinois 60602.

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Ridiculous prices to make you fly Qantas.

Prices as low as $760 for a whole tour to Australia. (And that's really a new low, even for Qantas.)

But then Qantas will stop at nothing to get people to fly with them. To Australia. To make my life unbearable.

Qantas. You won't ever find me playing post office with them.

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As low as $760 including economy class round-trip and 14 nights twin occupancy hotel. Price from West Coast based on 14/35 day Group Inclusive Tour fare. Mail to: Qantas, 555 California Street, San Francisco, CA 94104.

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Travel Agent_____

QANTAS

Australia's round-the-world airline.

NQ

The sterling silver Parker 75 Classic Ball Pen. Give it to someone who's economy-minded.

The Parker 75 Classic Ball Pen sometimes overwhelms people who get it as a gift. It looks a good deal more expensive than the $12 it costs. People tend to say "But you *shouldn't* have."

So, calmly point out the economy features of this obviously extravagant pen.

Tell the person who gets it that he'll never have to buy another ball pen ever. Because we guarantee this one against defects for the owner's lifetime, or we'll repair or replace it—free.

Tell him that the 75 Classic writes better months longer than the ordinary ballpoint—three times longer—and then refills with a cartridge for months more writing.

Most important, ask him what price he puts on exasperation. In this area, the 75 Classic costs nothing. It starts writing instantly, and puts down a crisp track at less than four ounces of pressure. That's because the ball in the tip is microscopically textured to glide effortlessly.

What price does he put on pleasure? Here's where this pen really delivers. That slim, solid sterling silver case isn't just for show. It gives the pen the proper heft and balance in the hand. He'll write comfortably with it for hours.

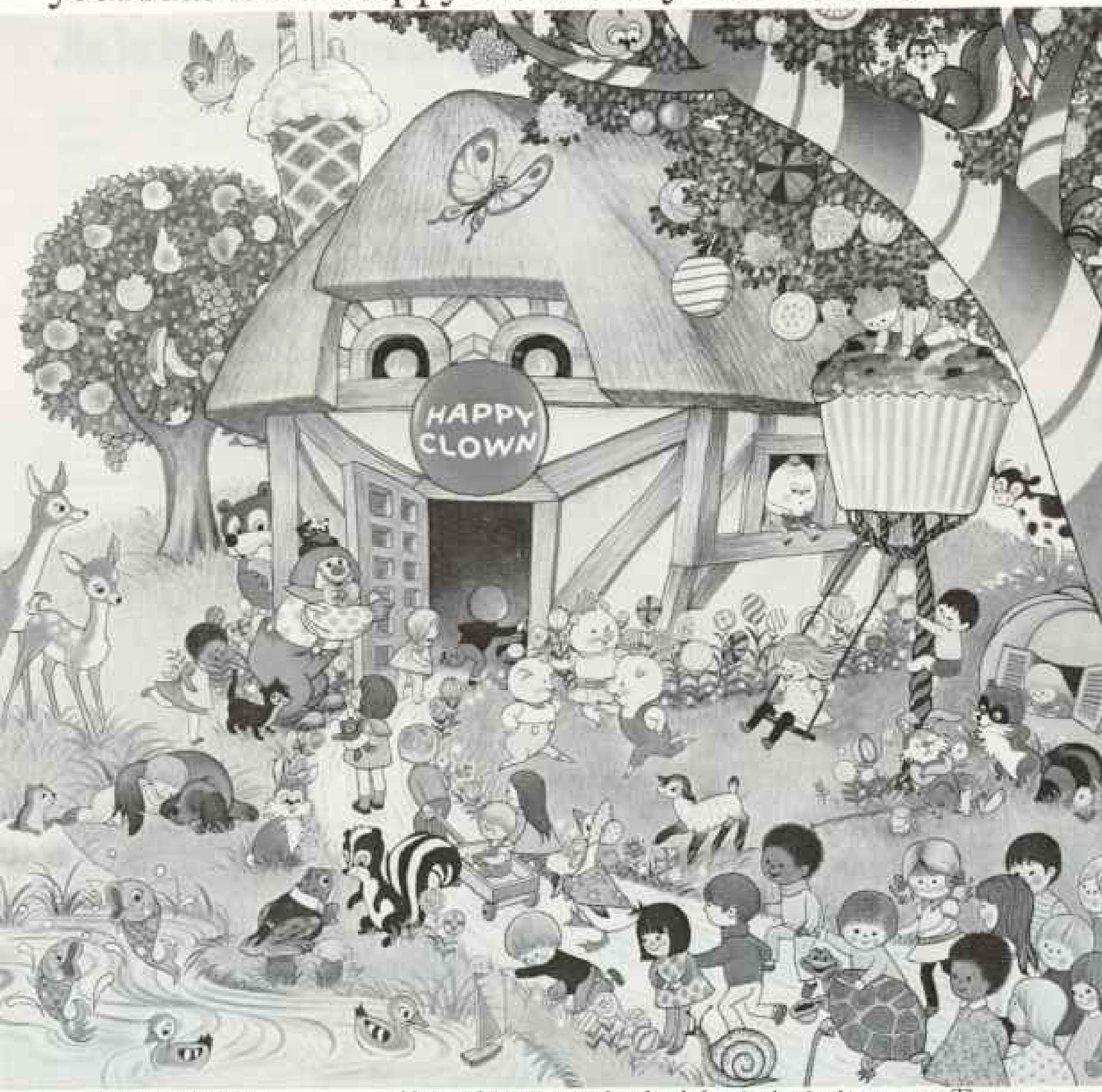
After you've convinced him what an economical gift you've given him, why not go back to the store and buy another 75 Classic for yourself? After all, you're economy-minded too.

PARKER

Maker of the world's most wanted pens

The sterling silver Parker 75 Classic Ball Pen or matching Cartridge Pencil, $12. A memorable gift for personal or business friends.
Other fine Parker pens to own or give from the $1.98 Jotter Ball Pen to the $150 Parker 75 Presidential Pen.

If nobody bothered to warn you, you'd be proud to send your kids to the Happy Clown Day Care Center.



Forget what you see.

The most important part of a day care center is the one part that can't be faked and glossed over with bright paint and papier-mache.

That part is what's inside.

If it's a good day care center, inside it'll have qualified teachers. An adult volunteer staff, and a program for parent involvement.

It might have someone who knows what to feed kids to keep them healthy. And someone to care for them when they're not.

Inside it'll have affection, too. Kids seem to thrive on that.

Without at least a few of these things, a day care center is only a hollow shell. Something that can do a kid more harm than good.

That's Metropolitan Life's concern. The children. So we've prepared a booklet for parents called "Day Care: What and Why."

Right now in this country there are 5 million kids under age six whose mothers hold jobs. Quality day care would be good for all kinds of kids, including many of these 5 million. Yet only 700,000 spaces in licensed group care centers are currently available.

A word of caution, however.

Even worse than no day care centers at all would be lots of well meaning but inadequate ones. Those years a child spends in a day care center are few but vitally important to his future. More than half of everyone's learning ability is developed before school age.

If you're as concerned as we about day care centers being good ones, send for our free booklet. Write: Day Care, Metropolitan Life, One Madison Avenue, New York, N.Y. 10010. Or call your local Metropolitan office.

Don't put it off. It's something we think a lot of kids can't do without.

Metropolitan Life

We sell life insurance.
But our business is life.

New Caprice. The most distinguished Chevrolet of all.

The new Caprice is the finest Chevrolet we make. The most comfortable, the most elegant. The finest.

It feels luxurious. Coupe, sport sedan, 4-door pillared sedan and convertible.

You sit down on big foam seats covered with expensive fabric, look out over a distinguished instrument panel.

Caprice is smooth, easy to handle. It's very quiet.

We gave Caprice our biggest standard V8, power steering, power disc brakes, one of the best automatic transmissions made.

And there's a twin cushion front seat you can add so your passenger can recline in comfort.

'73 Caprice. You might not want to look any higher.

Caprice Coupe at Good Harbor Beach near Gloucester, Massachusetts.

GM

1973 Chevrolet. Building a better way to see the U.S.A. Chevrolet

NATIONAL GEOGRAPHIC

October 1972

RICHARD HARRISON

Perched on the continental divide at 18,200 feet in the Peruvian Andes, writer-photographer Loren McIntyre climaxes a year-long survey of the Amazon. To pinpoint scientifically the river's most distant source, he has teamed with an Inter American Geodetic Survey expedition supported by the National Geographic Society. Here, at the farthest point in his quest, meltwater from the snow at his feet trickles down to a tiny lake to start the Amazon on its majestic course.

Ranging the River Sea's six-nation system of tributaries, McIntyre recorded the swiftly changing face of the entire Amazon region. His report begins below. Completing a portrait of the great river and the continent whose heart it threads, this issue also brings to members a richly detailed, double-sided map of South America.

The Amazon, untamed titan of the world's rivers, flows rich in mystery and legend across 4,000 miles of South America.

Countless tributaries
of many colors
and unfamiliar names
swell the River Sea
on its way
to the Atlantic.

PHOTOGRAPHS, PAGES 444-445, BY LOREN MCINTYRE

Upstream from a gleaming sandbar, leaf-stained waters give a sherry hue to Rio Negro shallows. Above, a piranha shows its teeth.

Ash and steam erupt from 17,159-foot Sangay, towerin

Born in the cloud-piercing Andes, the river's western bastions of wilderness. Despite four centuries of exploration,

ove the Ecuadorean rain forest.

A plane swoops close to an 877-foot waterfall pouring into a tributary of Peru's Apurimac.

headwaters plummet and churn through one of earth's last huge tracts of primeval beauty remain unknown.

Braiding a verdant floodplain,
the river carves a maze of
meandering channels, constantly
changing and often uncharted.

The Rio Negro above Manaus, Brazil.

The Huallaga, a Peruvian tributary of the Amazon, cuts a new channel across its own loop.

Where waters merge,
the silt of Andean
highlands dapples and
roils into a slow-moving
flood of coffee brown.

The black-water Rio Negro and the brown Amazon join at Manaus (above). A muddy, silt-banked offshoot of the Amazon's main channel projects into the blue-water Rio Tapajós (right) near Santarém, Brazil.

Oases of civilization, cities and towns
the world's largest rain forest. Yet the Amazon
by nature, its vastness dwarfing

Afternoon sunlight breaks through storm clouds to gild Belém, ocean gateway to the Amazon.

pulse with light just beyond the shadows of
remains a region dominated
the most ambitious works of man.

AMAZON

The River Sea

ARTICLE AND
PHOTOGRAPHS BY
LOREN McINTYRE

FOR SHEER IMMENSITY, the Amazon is incomparable. Its volume exceeds the combined flow of the next eight largest rivers on earth. Rivaling the Nile in length, it is sixty times greater in discharge at the mouth. At maximum flood, it pours eight trillion gallons into the ocean every day—enough to furnish two hundred times the municipal water requirements of the United States, or twenty times its total industrial, farming, and power needs.

Seeking a name to evoke the oceanic size of the Amazon's vast complex of waterways, Portuguese explorers called it O Rio Mar, The River Sea.

Whereas the Nile has no tributaries for its final 1,450 miles, the Amazon gathers waters along its whole length from hundreds of feeder streams, some larger than the Mississippi. Curiously, the tributary rivers, with few exceptions, run brown

Market-bound Colombians fight Devils Cataract on the Vaupés, a Rio Negro tributary. Attuned

from the west, black from the north, and blue from the south. They merge into a main stream milk chocolate in hue, yet purer chemically than most tap water in the United States.

Almost 14,000 miles of Amazon waterways are navigable, and several million miles of *igarapés* (passages through swamps and woods, often concealed by overgrowth) are penetrable by canoe. "It's a *marañón*—a maze—that only God could figure out!" Francisco de Orellana is supposed to have complained. The one-eyed conquistador became the Amazon's first explorer when he crossed the continent downriver in 1542.

For a while Marañón was the river's preferred name. But Friar Carvajal, Orellana's chronicler and first but not least of the river's tellers of tales, originated the name that endured when he reported attacks by women warriors like the Amazons of Greek myth.

Today Marañón denotes a magnificent Peruvian tributary laden with the Andean silt that gives all the brown-water rivers their muddy color. Collecting runoff from a spectacular array of snow peaks, the broad Marañón narrows to 100 feet to squeeze out of the Andes through a gap called Pongo de Manseriche—Gateway of Fear. It spills onto the flatlands and then snakes eastward to the Ucayali River. Where the two join—not cleanly but tangling like embattled boa constrictors—the two-mile-wide main stream takes the name Amazon for its final 2,400 miles to the Atlantic.

From this confluence last year I traced the farthermost source of the Amazon yet discovered. It lies up the Ucayali's chief headwater, the Río Apurímac, and beyond—4,000 miles from the River Sea's mouth. (See map, pages 460-61, and the supplement map **South America**, distributed with this issue.)

Previous expeditions to Amazon sources sooner or later went astray by turning up a *larger* fork of the river instead of pursuing the

to the river's moods, this family eke out an existence on a farm beside the swift watercourse.

longest branch. In my quest I would disregard relative volume, which varies with the seasons. National Geographic cartographer Russell Fritz and I had located the most remote rivulets, with the help of excellent Peruvian Government maps prepared from aerial photographs and ground data gathered by the Inter American Geodetic Survey.

In Peru the IAGS was organizing an expedition to the Amazon source region in the southern highlands. I joined the party as National Geographic Society representative; the trip would be a rare chance to explore where no man had set foot.

Victor Tupa, who directs IAGS field parties in pinpointing locations and verifying placenames, outlined the expedition's plans: "We will drive to Cailloma, 85 miles north of Arequipa. About 20 miles south of the town lies a semicircular rampart of the continental divide. All that trickles from the inner rim joins to form the Apurimac."

"Victor, I hope you'll climb with me to the origin of the most distant stream," I urged.

"With my waistline? Whoa, that's over 17,000 feet, well above the call of duty."

But Victor did reach the source, at the end of a rope led by Richard Bradshaw, with me safely in the middle.

My friend Richard, a British metallurgist, is also a skilled mountaineer. On the long hike from Cailloma to the southern end of the plateau, Richard and Victor backpacked tent, stove, ice axes, crampons, ropes, pots, and food, while my shoulders sagged under mere cameras, compasses, and altimeters.

Thin Air Adds to Climbers' Toil

We camped on a spongy meadow where five brooks converge to form the little Lloqueta River, farthest tributary of the Apurimac. Next day we climbed to the crumbling crest of the continent, where atmospheric pressure measures only half that of sea level. During coming months deep snow would cover these heights, but now, at the end of the dry season, some were forested with wind-carved spires of ice; other ridges were bare.

Aerial photographs taken 17 years earlier showed numerous glaciers here. Almost all had evaporated. At one point I was wondering whether so barren and lofty a moonscape existed anywhere else on earth, when suddenly a herd of vicuñas fled before us over the divide, kicking up dust where a glacier had lain a few years ago.

On October 15, 1971, we reached an ice-edged ridge above Carhuasanta, longest of the five headwater brooks. The Indians call that 18,200-foot summit Choquecorao. There Victor staked a Peruvian flag and the IAGS plaque (page 445). I planted miniature National Geographic Society and United States flags. Richard hoisted a tiny Union Jack.

A thousand feet below the ridge we sighted a lake, its crust of ice thawed by the midday sun. We clambered down to quench our thirst with its transparent meltwaters. Here at 17,220 feet was the farthest source of the mighty Amazon—more a pond than a lake, just a hundred feet across.

Victor named the little lake after me, more or less in fun, knowing it may not always be the most distant water of the River Sea. It could disappear in a single season. The Andes are new mountains; they still buckle and break, and cataclysmic landslides often shatter the stillness of the peaks.

Tunnels Will Divert Water to Desert

Man's brusque hand also alters the land. Before Columbus, the Incas diverted rivers to irrigate Andean terraces. By 1985 a massive dam will silence the voice of the "Great Speaker"—the Inca meaning of Apurimac—at the defile from the Cailloma highlands where its torrent begins to cut a canyon toward the jungle. Tunnels will tap the headwaters and send a flow 43 miles under Andean crests to provide electricity and to irrigate nearly 150,000 acres of Peru's rainless coast. If all the upper Apurimac should thus be diverted, the quest for the source of the Amazon might have to begin all over again.

But not long after our expedition, flying with Peruvian Air Force Maj. Mario Sánchez Moreno, I verified that Laguna McIntyre was still there. We were spending a week on aerial photography of the Apurimac.

(Continued on page 464)

Midway between two cultures, a Machiguenga tribesman somberly examines insect damage to his corn crop. Permanent farms were urged by missionaries as the first step in the transition of these Peruvian Indians from wandering hunters and gatherers to settled tillers of the soil. Less fortunate Amazon aborigines have failed to survive change and aggression; in Brazil alone, more than a third of 230 known jungle tribes have become extinct in this century.

COLOR KEYS THE AMAZON'S WEB OF TRIBUTARIES by geography — and sometimes by season and time of day. From the north the streams tend to flow black, darkened by the stain of rain-forest vegetation, like tea steeped too long. From the south they gain clarity from the filtering of white sandy country and pick up the sky's deep blue. From the west they churn with the brown silt of Andean highlands, which imparts a light chocolate tone to the mighty main channel as it rolls to the sea. Rise and fall of the waters — the clock and calendar of riverine life — produces constantly changing hues.

PANAMA

VENEZUELA

COLOMBIA

ECUADOR

PERU

BRAZIL

BOLIVIA

Unique natural link between two major river systems, the Casiquiare Canal permits rivercraft to navigate from the Amazon to the Orinoco.

Unlike most blue-water streams, the Rio Branco flows milky white with sand washed from far northern Brazil's treeless plains.

An international waterway, the Amazon was opened to world traffic by Brazil's Emperor Dom Pedro II in 1866. Vessels of any nation may, without restriction, ascend to the countries of the Amazon's headwaters.

Farthest source of the Amazon, an ice-fed pond in Peru's Andes gives birth to a trickle that 4,000 miles later becomes a flow sixty times greater than the Nile. The author accompanied an Inter American Geodetic Survey expedition to help pinpoint the source, named Laguna McIntyre in his honor. The National Geographic Society supported the project.

Pacific Ocean

BOGOTÁ

QUITO

LIMA

Orinoco
Ventuari
Casiquiare
Guainia
Maroa
San Carlos
Vaupes
Cucui
DEVILS CATARACT
EQUATOR
Negro
Uraricoera
Boa Vista
Rio Branco
Curaray
Napo
Putumayo
Iquitos
San Pablo de Loreto
Leticia
AMAZON
Solimões
Parque Nacional Manu
Manu
Chinaco
Ucayali
Juruá
Purus
Jurua
Tefé
Coari
Madeira
Marañon
Huallaga
Aguaytia
Pucallpa
MARANON CURVE
TRANS-ANDEAN HIGHWAY
Abujao
Cuzco
Urubamba
Callama
Lake Titicaca
Arequipa
Callao
Porto Velho
Theodore Roosevelt River
Guajara-Mirim
Mamoré
Madeira
Beni
Mamoré
Trinidad
Iténez
Grande
Ilampu 20,873
LA PAZ
Illimani 21,201
Colquiri
Cochabamba
Santa Cruz

460

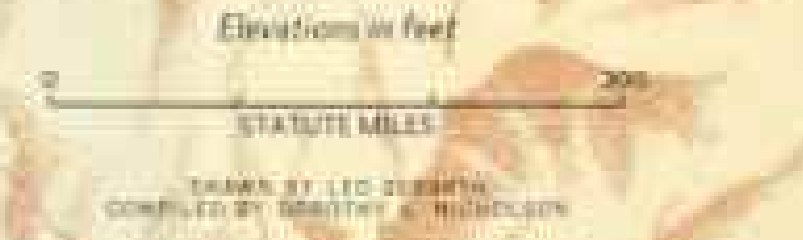
Realm of the rainbow rivers

Veins of the River Sea face a basin three-fourths the size of the contiguous United States. A huge freshwater lake may have covered the area millions of years ago.

VERTICAL SCALE EXAGGERATED 20 TIMES

The Amazon at Óbidos—1 1/2 miles wide and 200 feet deep—handles ten times the Mississippi's volume at Vicksburg, where that river is a third of a mile wide and 70 feet deep.

Rampaging down Andean mountainsides, Amazon waters drop an average of 27.3 feet every mile in the first 600 miles, then only three inches a mile on the remaining journey to the sea.



As a hotbed of competing life forms, the Amazon region yields to no other. English naturalist Henry Walter Bates a century ago discovered an amazing 14,712 species in the area, of which 8,000 were new to science. Today the known total exceeds 100,000. Plant species by the thousands intermingle so exuberantly that no solid stands of marketable timber exist in two million square miles of rain forest. Waters teem with countless species of fish, some armored, some fanged, some stunningly colorful—stars of the world's home aquariums. But insects—biting, stinging, disease-carrying—are the rulers of the realm. Voracious hordes denude fields and forests and torment new settlers and aborigines alike.

In pursuit of friendship, Machiguenga boys scamper after a landing airplane that earlier had brought author McIntyre to their village on the Urubamba headwaters in Peru. Forest Indians traditionally shy from contact with outsiders, but missionaries have won the trust of these villagers with patience and understanding.

Aboriginal "engineers" wind-test homemade pinwheels in an airplane's prop wash at another Machiguenga village. The blast that spins the balsa toys also fans the grateful lads—a rare treat in the Amazon's steamy climate.

Solemn chief Kokush wears feathers and face paint, part of a legacy handed down from headshrinking ancestors. The Achual chief exchanged his headband for the author's spare reading glasses. "Now I can see again," the delighted Indian said. He let each of his four wives try them on.

After resighting the Amazon's source, we skimmed far down into the awesome Apurimac gorge, over a mile deep, where no vessel could survive the river's turbulence. I wondered whether we might see remains of the Inca suspension bridge that had spanned the lower gorge for centuries. We did not, but when we landed near a swift mountain stream east of the Apurimac, we discovered a bridge that cannot fall down. Machiguenga Indians had bent tall saplings from opposite banks, joined the treetops above the torrent, and woven a fiber footpath over the trunks. Recently an 80-foot bridge there had broken in the middle and fallen *up!*

In the clearing of the Machiguenga village, children came running as we climbed out of our plane (preceding pages). We had to keep our hands free so that ten boys and girls could attach themselves affectionately to each of us, one to a finger, to escort us to the chief's house. The primitive Machiguengas have no proper names, not even secret ones, so we lent each youngster a Spanish name, like María and Rodolfo. In its isolation, this village has so far escaped the complexities of onrushing civilization that beset most jungle tribes.

Mountain Indians Struggle in the Jungle

Although the Incas and their descendants abhorred the jungle, overpopulation is crowding Andean Indians off their rocky highland farms into the brown-water valleys. Still clad in thick woolens and hindered by age-old farming practices, they compete for jungled hillsides with more sophisticated part-Indian settlers from downriver (page 466).

Because the upper river courses are steep and flanked by the thickest of the Amazon's rain forests, most migration into the brown-water valleys follows "penetration roads," which open new lands. The first and now greatest of these is Peru's 526-mile Trans-Andean Highway from Lima to Pucallpa on the navigable Ucayali River.

I first traveled it in 1947, shortly after it opened. The trip took 11 days. My prewar Packard boiled over the 16,000-foot summit, rattled perilously down the eastern escarpments, and mired in jungle ruts. Then, after 200 miles of pushing and slithering, the car emerged from the muck into the cratered streets of Pucallpa, a thatch-roof lumber and trading town. Painted Shipibo Indians, silver ornaments piercing their lower lips, sold pots and monkeys on street corners.

I stayed at the jungle base of the Summer Institute of Linguistics, six miles outside Pucallpa, overlooking hook-shaped Lake Yarinacocha. The institute, then a small missionary group dedicated to translating the Scriptures into Indian tongues, shared the lake with Shipibo fisherfolk, friendly porpoises, and Joe Hocking, an old-time missionary settler. Joe harvested the lake for what he called "pure protein," to raise giant grapefruit and chickens: the meat and bones of caimans—which look like alligators—cooked, chopped up, and raked over a seven-foot skillet until dry.

In 1953, with both a better car and an improved highway, I again drove from Lima to Pucallpa—this time in only six days. I stopped at the village of Aguaytia on the river of the same name to look for a young Cashivo chieftain who had been bitten by a deadly fer-de-lance and cured at a clinic in Lima. We had become friends while he was being treated for the snakebite, and he asked that I someday photograph his family.

I found the chief camped on a sandbar with his two teen-age wives, and I snapped the family pictures. But he wanted copies *mailed* to him! How? Emptying his basket of manioc bread, armadillo roasted in its shell, and a Dick Tracy comic book, the chief took out a cellophane-wrapped package. I still treasure the calling card he handed me:

Washington Bolivar
Jefe de la Tribu de los Cashivos

Aguaytia – Via Chanbillo

By 1969 the Trans-Andean Highway was mostly paved, but not Pucallpa's streets. With 60,000 inhabitants, the city had little running water except the afternoon rains. The Ucayali had left town for a new channel a mile away. The caimans had vanished from Lake Yarinacocha, and the porpoises were leaving, seeking surcease from swarms of *peke-pekes:* improvised outboards with lawn-mower type motors on dugouts. The linguists now worked in 36 Peruvian villages and had more than 2,500 missionaries in 23 countries.

In 1971 I found linguist Jeanne Grover working with civilized Aguarunas near the Peru-Ecuador border. I told her I planned to visit "my" Aguarunas—a group at Chiriaco on the upper Marañón. Fifteen years back, these onetime headshrinkers had stripped, painted, and initiated me, then sent me to hunt with blowgun and darts. Jeanne at that time had lived among them for three years.

"Don't go," she now warned me. "You'll be disappointed. A penetration road cut through the area and a wave of settlers swept up your friends, who then put on pants, cut their hair, and melted into the scene. Sad—I had hoped they wouldn't abandon their culture. But they adjusted quickly. Why, my Aguarunas here are letting their hair grow long again, to 'get with it!'"

Later I stopped by Aguaytia and found no one who remembered Washington Bolivar.

River Navy Makes Life Brighter

I journeyed on, 600 miles down the Ucayali to Iquitos. Situated just below the point where the Ucayali and Marañón join to become the Amazon, Iquitos was, a century ago, a garrison village. Today it is a metropolis of 76,000 inhabitants. Ocean liners steam 2,300 miles up the Amazon to dock regularly at Peru's "Atlantic seaport."

I stayed there at the fine new quarters of Adm. Guillermo Faura, commandant of Peru's river gunboat fleet. Admiral Faura and I had been shipmates in the late 1940's, when I served on detachment from the U. S. Navy as gunnery advisor to the Peruvian Navy.

The amiable admiral recalled how Peru's Pacific Fleet personnel used to dread Iquitos. "Officers in disfavor were banished to the river fleet to scratch their chigger bites and broil in the heat. Then, thanks to that surplus LST your navy sold us in 1951, Iquitos began to pave her streets."

Lack of rock in the upper Amazon region long hindered Iquitos's growth. The LST loaded 2,800 tons of gravel in Callao, on the Pacific, and sailed through the Panama Canal and up the Amazon to Iquitos—a 7,000-mile voyage between cities 650 miles apart.

"Many Iquitos families still treasure keepsake stones pilfered from the shipment before paving began. That trip from one side of Peru to the other initiated our navy's civic-action policies," the admiral said. "Now 80 percent of our river fleet operations aim at civic betterment. Warships deliver construction equipment and school supplies. We converted the gunboat *Napo* to a hospital ship. We even fix civilian radios and generators."

The city exploded with excitement while I was there. Last November 16, Peruvian drillers struck oil on their first try, west of Iquitos. City fathers declared a two-day holiday. Parades filled the streets; a gunboat fired a

21-gun salute, to the delight of the children lining the shore.

Just below Iquitos, the Rio Napo joins the Amazon, bringing the waters of Ecuador's Curaray as well. The Curaray's forests conceal hundreds of fierce Auca Indians, who exalt the art of slaying with spears. There, in 1969, I reached the outpost of Miss Rachel Saint, an almost legendary linguist missionary who was then alone in Auca territory. My stalwart, tough-minded friend looked older than her 55 years; she was dead tired from combating a polio epidemic.

"Don't make any abrupt moves," Rachel warned. "Remember you're an alien presence among these frightened people. They react violently when disturbed. The polio epidemic has upset a group of forest Aucas who just arrived. They blame the witch doctor for the deaths from the disease and speared two members of his family to death."

Rachel appointed two Auca ex-warriors as my bodyguards. "Kimo and Dyuwi were two of the Indians who killed my brother and four other Americans. But they're Christians now. Auca custom demands you visit every hut in the village. Kimo will go inside with you and Dyuwi will watch outside."

Missionaries Die Rather Than Kill

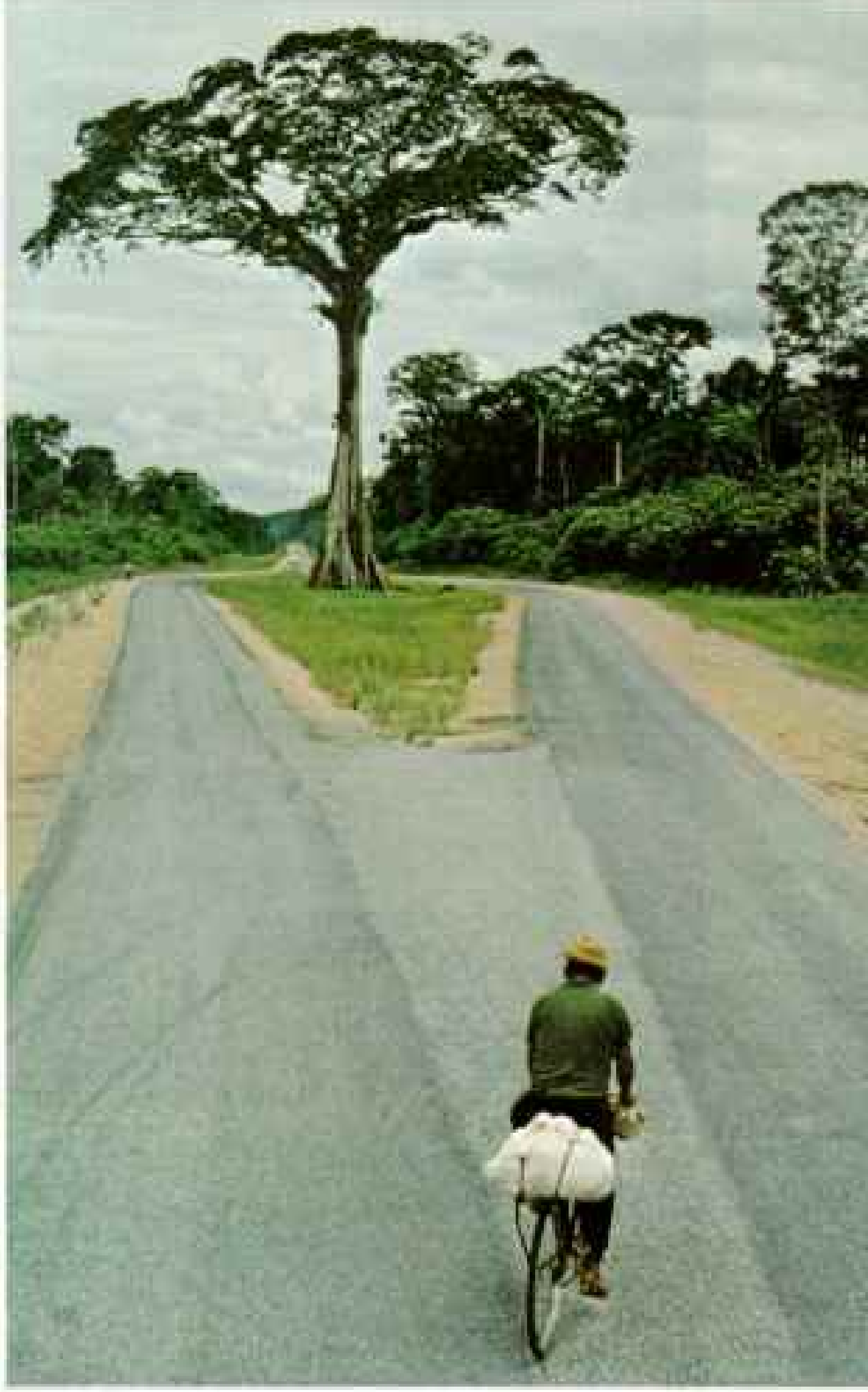
In 1956 Rachel's brother, pilot Nate Saint, and his fellow missionaries landed on a beach in Auca country, expecting a peaceful reception after months of cautious approach and air-dropping of gifts. But five Aucas attacked. Though Nate and the others were armed, they just kept firing into the air. The Aucas speared them one after another. Then they bashed in the "wood bee," as they called Nate's little yellow airplane.

Rachel and the widow of one of the missionaries began converting Aucas to Christianity. Later, working alone, Rachel won over many more, including the killers, partly because of the example of nonviolence set by the five Americans who died on the Curaray beach. Then the 1969 polio epidemic took 16 lives and frightened 28 of Rachel's hard-won friends back into the forest.

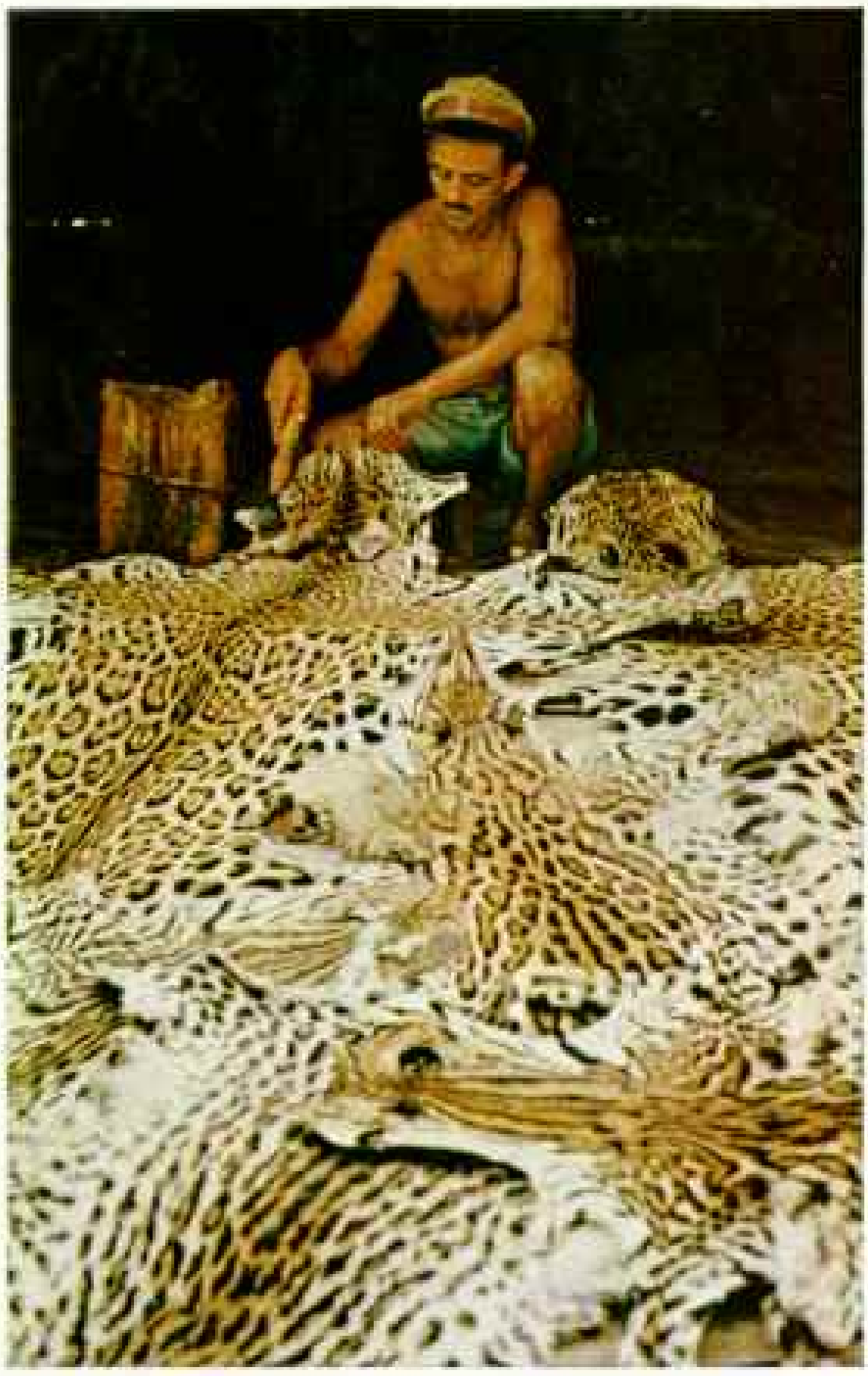
Polio is rare along the Amazon, but measles has wiped out entire tribes, and malaria is widespread. Though leprosy is dreaded, thousands of afflicted people circulate freely in riverine communities, but seriously afflicted patients prefer to live in leprosariums.

I couldn't find a boatman willing to land

Bolivian pioneers carve a homestead alongside new Highway 1 near the Mamoré River (**facing page**). Their government, eager to develop underpopulated lowlands, offers free land to those who will work it. In Brazil a spreading network of highways has attracted several million settlers to the Amazon region in the past decade.



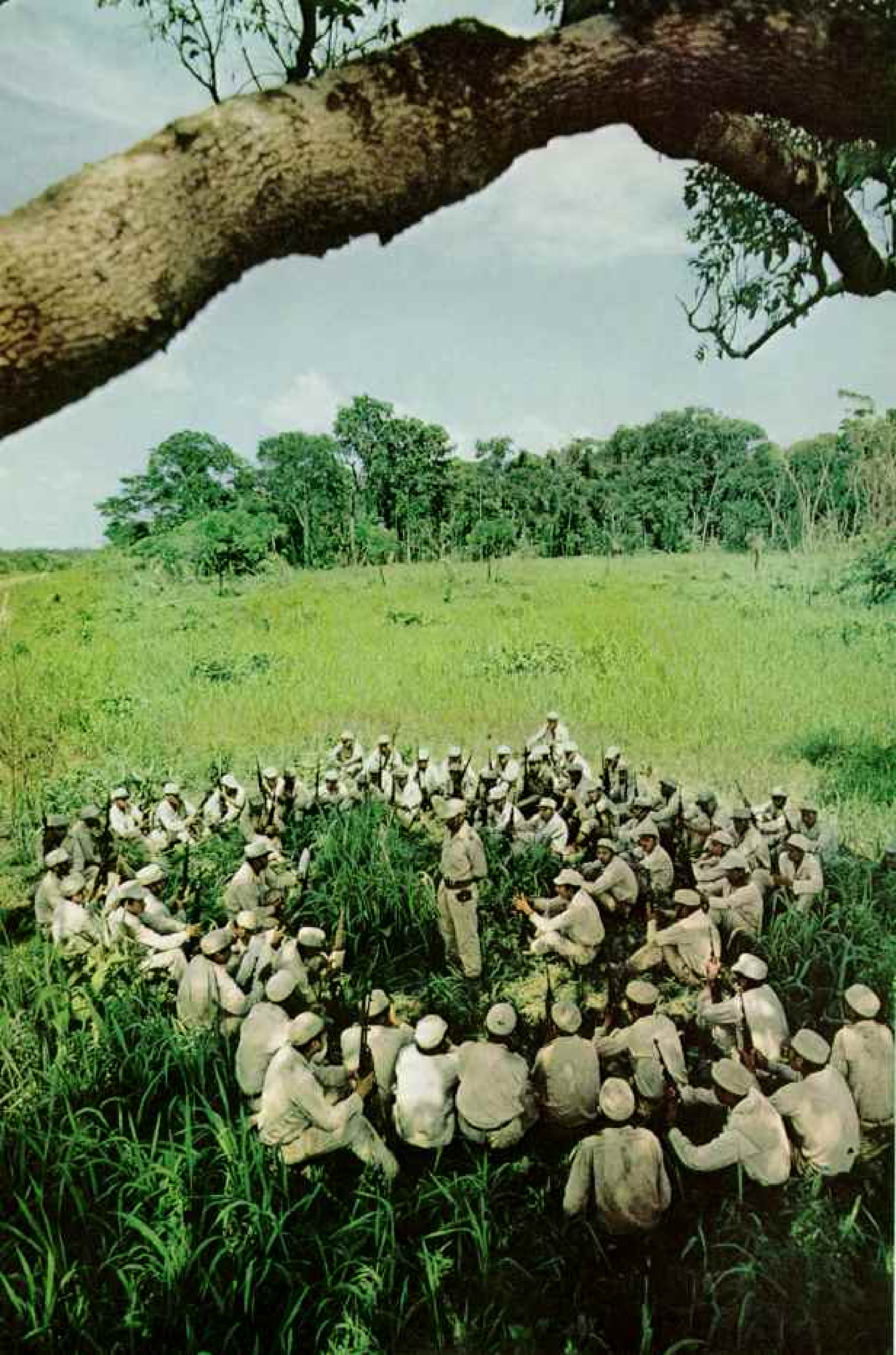
Roadman, spare that tree! A construction supervisor's admiration for this 150-foot *mapaca* resulted in this brief but scenic split in Bolivia's Highway 1.



HELEN AND FRANK SCHREIDER

Fatal beauty dooms forest cats, though this warehouse in Manaus (**upper left**) may soon hold other goods. New laws prohibit the killing of jaguars, ocelots, and margays, and the buying and selling of their pelts. Legal protection has reduced the annual slaughter, but poachers—spurred by continuing demand—still kill many of the animals. The United States recently banned importation of the skins.

Wielding huge sweeps, Peruvians raft bananas down the Ucayali River (**above**). Also delivered by boat, smoked rubber arrives at a Brazilian processing plant (**left**). The balls, some weighing 200 pounds, recall a heyday of profit and shame, when tycoons reaped near-instant fortunes through brutal exploitation of Indian rubber gatherers. The boom peaked out in 1912, when Southeast Asian plantations took over the market with rubber cultivated from Amazon seeds.



Reviewing anti-guerrilla tactics, a special force of Bolivian rangers conducts maneuvers near the Brazilian frontier. This unit captured revolutionary Ché Guevara in a 1967 battle with insurgents.

Workmen dip souvenirs from a test pool of black gold at Peru's first major oil strike in the jungle. A two-day celebration marked the November 1971 discovery. Peruvians hope for the same economic lift that neighboring Colombia and Ecuador are deriving from recently discovered jungle oil fields.

me at San Pablo de Loreto, on the Amazon below Iquitos. But one day I hitched a ride in a hydroplane with Father Guy Gervais, who flies rescue missions for an organization called "Wings of Hope." He dropped me at San Pablo along with medical supplies for six French-speaking Canadian nuns who help run the leprosarium for Peru's Ministry of Health.

The afflicted colonists—of several races—were literate, excellent hosts, and remarkably resolute. Professional hunter Carlos Valderrama Lopez didn't let progressive loss of fingers and feet deter him from pursuing his life's work. Many an evening he strapped tennis shoes to his stumps, gripped a flashlight in his teeth, wired a shotgun to his shoulder, and went into the jungle alone. He often bagged a wild boar.

Saturday night at the town hall I sat out a dance with Sister Annonciade, who, like all the nuns there, wore ordinary dress. A trio called Los Sufridos was singing:

If only you out there
Would grant that we in here
Have hearts and are aware
Of love and really care. . . .

"Their physical discomfort is bearable; social rejection is infinitely more painful," said Sister Annonciade. "That's why we're at the party. I never learned how to dance back home in New Brunswick. But I'm learning."

The sisters lent me a fast speedboat to reach Leticia, Colombia—my next stop down the Amazon, where Colombia, Brazil, and Peru come together. Over the years, some of my best moments on the river have been my seven visits with Leticia's leading citizen, Mike Tsalickis.

Mike began collecting wildlife 30 years ago in Florida. He was then an Eagle Scout with 103 merit badges. Now he collects and raises animals for zoos and research, including marmosets and monkeys shipped to the United States for hepatitis- and malaria-prevention studies. Mike is also famed for wrestling anacondas and guiding safaris.

When I arrived, Mike asked, "How's Chi Chi doing in Virginia?" Chi Chi is the wild capuchin monkey he gave me three years ago.*

"Losing her jungle ways," I answered. "With nothing to fear, she sleeps like a child, lolls in her hot bath, then watches TV all day,

*For more about Mike and Chi Chi, see pages 772-3 of "Colombia, From Amazon to Spanish Main," in the August 1970 NATIONAL GEOGRAPHIC.

insisting on color, no less. She coos at her favorites, especially Ed McMahon, and screams at bad guys and cat-food ads. She laughs at pratfalls, and of course she hates to go to bed."

Monkeys are the most visible animals of the jungle and a chief source of food for meat-eaters, including the aborigines. There are no great animal herds, as in Africa, and no huge beasts (the tapir, weighing up to 500 pounds, is the largest). None prey on man.

Early explorers died of starvation for lack of game, yet much of the River Sea's population lives by hunting and trapping animals for hides or food. Despite new conservation laws, millions of animals are taken yearly, including tens of thousands of jaguars and ocelots, valued for their pelts.

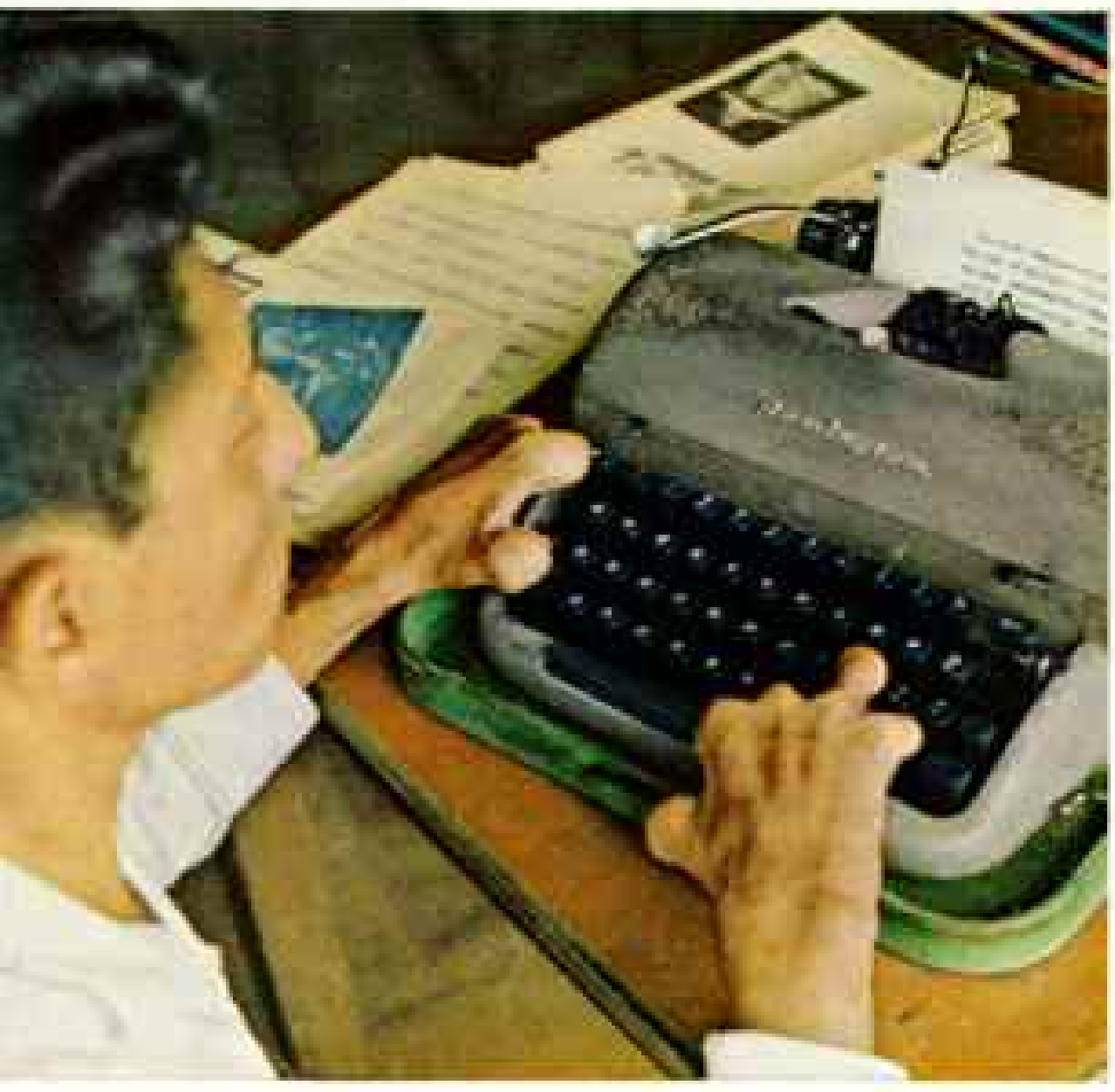
Forest Tribes Fade Into History

Turtles once nested on beaches everywhere; a century ago the pioneer Amazon naturalist Henry Walter Bates reported that riverfolk gathered at least 48 million eggs a year. Only two decades ago the waters swarmed with so many caimans that in one year nearly five million hides were exported from Brazil's State of Amazonas alone. Now government controls seek to restrict the slaughter. It is time; by 1969 overhunting had reduced the take for all Brazil to a mere 300,000!

But of all jungle life, the species most endangered by man is man himself: the forest Indian. His numbers were never great, two million, perhaps, when the Europeans arrived. Today a few thousand survive, while most of mankind multiplies. Even in Brazil, where government and private agencies attempt to protect the Indians, outside influences have been catastrophic. Of 230 tribes known in 1900, 87 have become extinct, and only 33 can still be classified as isolated.

Until John B. Dunlop invented a practical rubber tire, tribes hidden in the deep jungle escaped the fate of other Indians. But with mounting demand for rubber, thousands were captured and put to work at gunpoint to tap the scattered trees of the virgin jungle. Since Indians seldom adjust to forced labor, many perished.

By 1910 the price of a pound of rubber reached $2.88. Increased demands for *seringueiros*, rubber gatherers, brought workers from northeast Brazil deep into Indian territory. The tribes were further decimated by guerrilla warfare with these outsiders, as well as by Old World diseases.



Leprosy cripples the hands but not the spirit of Manuel Rodriguez, librarian at Peru's San Pablo de Loreto. One in every 125 Amazon Basin inhabitants suffers the affliction. Research has dispelled the myth that leprosy is highly contagious and has brought repeal of laws requiring the quarantine of patients. Many, however, choose to live in leprosariums like San Pablo in the company of fellow sufferers.

Genocidal pressures eased when the rubber boom collapsed 60 years ago. Cheaper rubber from Malayan plantations plunged the Amazon's wild-rubber trade into a depression from which it never recovered. In 1932 the price bottomed at 2½ cents a pound. Today the figure is about 18 cents.

The main artery of the boom was the Madeira, biggest of the brown-water tributaries, which rises in Bolivia and still traffics in rubber from there. Its headwaters flow from 21,000-foot peaks bordering Lake Titicaca, from mining tunnels in the tin town of Colquiri, and from culverts under La Paz, capital of Bolivia, to join the Amazon below Manaus in Brazil (map, page 461).

Roads from the highlands now couple with lowland rivers to provide landlocked Bolivia with an Amazon outlet. Near Bolivia's northern tip, where the Madre de Dios, Beni, and Mamoré join to form the Madeira, black rock outcroppings create impassable rapids. At the portages, rubber barons once set up headquarters of their private empires.

For two million British pounds and a pledge to build a railroad around the rapids, Bolivia in 1903 ceded 37,700,000 acres of disputed rubber-rich jungle to Brazil. From 1907 to 1912 American contractors used 21,717 workers from 42 countries to construct the "devil's railroad"; approximately one worker a day succumbed to Indian attacks, beriberi, malaria, yellow fever, or multilingual brawls.

The first 227-mile run "from nowhere to nowhere" was made in 1912. The railroad never got out of the red, since its inauguration coincided with the collapse of rubber prices. Now an all-weather highway carries nearly all the freight.

Old-timer Recalls the Legendary Rondon

Recently I boarded the rickety wood-burner at the upriver "nowhere," now the busy port of Guajará-Mirim, Brazil, on the Mamoré. Two bone-bruising days later I got off at Pôrto Velho, Brazil, the "nowhere" on the Madeira, below the cataracts, a major hub of river, road, and air traffic.

There I found a survivor of the 1907-1912 ordeal, Manoel Laurentino de Sousa, still unbowed, his hair still blond. He led me to the graves of North Americans who had died on the job. Tall, dripping trees had reclaimed the cemetery; we searched the shadowy forest floor for headstones buried in humus: J. R. Kennedy, died November 26, 1910, aged 26 years; R. Findley, E. C. Pickett, R. Keller, aged 21 at his death in 1909. . . .

Old Manoel passed the evening with me in a Pôrto Velho plaza. "A big day for me in 1912 was meeting Marshal Cândido Mariano da Silva Rondon," he said. "He was building telegraph lines to tie this frontier to the rest of Brazil. The Indians called the telegraph *lingua de Mariano*, Mariano's tongue."

Expeditions with Theodore Roosevelt brought Rondon world renown. Together the Brazilian and the former United States President explored the Rio da Duvida—River of Doubt—the Rio Roosevelt on today's maps. Frontier-born and part-Indian himself, Rondon championed the Indians' cause. He founded Brazil's Indian Protection Service, with the motto "*Morrer, se fôr preciso; matar nunca!*—Die if necessary, but never kill!"

When the marshal was 90, two years before his death in 1958, the government decreed that the territory of which Pôrto Velho is capital be named Rondônia in his honor.

Brazil Tightens Its Hold on Empty Lands

Currently, Projeto Rondon volunteers—men and women of the junior and senior classes in Brazil's eastern universities—promote community development in remote areas —and learn more about their own country. Their T-shirt mottoes reflect Brazilians' apprehension about nebulous control over thinly settled hinterlands: "*Integrar para não entregar*—Integrate lest sovereignty be lost."

Lt. Col. Inaldo Seabra de Noronha, commander of a bulldozer army, Pôrto Velho's 5th Engineering Construction Battalion, is not panicking. "Alarmists argue that if we don't occupy the Amazon, a consortium of nations might declare, say, around the year 2000, that the world's last livable but uninhabited region must be forcibly opened to excess foreign populations, from Asia, or somewhere like that.

"Some 4,000 men are working on our trans-Amazonian transportation system. Roads already tie into Bolivia and Guyana. Soon we'll reach Peru, Colombia, and Venezuela. Commerce? Well, right here in Rondônia, we're exploiting the world's richest tin deposits, discovered in the 1950's.

"These developments are safety valves for population pressures. By 1980 maybe five million Brazilians, mostly from the dry and overpopulated eastern bulge, will have found new homes along the highways."

Monument to the glory of Brazil's rubber barons, the opera house in Manaus welcomed European and U. S. performers at the turn of the century. When the market collapsed, the

lavish building closed its doors. Tax exemptions and free-port status granted in 1967 have revived the city's long-dormant economy; today the old theater again pulses with life.

Nor was Colonel Noronha alarmed about the assault on Amazon forests by 100,000 woodcutters of six nations—for land clearing, not lumbering; few of the myriad species have commercial value. "Much soil is thin, much is swampy. Only a fraction is fit to be farmed."

Highway BR-319 from Pôrto Velho doesn't yet reach Manaus, the Brazilian metropolis at the center of the River Sea, so I enjoyed coming back to Manaus on a four-day cruise down the broad Madeira. This once-isolated city has long epitomized the bygone opulence of the rubber boom, its empty opera house a symbol of faded glory. But in 1972 I found the grand old Teatro Amazonas newly crowded with patrons (preceding pages) and flanked by rising skyscrapers. Shoppers thronged the streets. This year tens of thousands of tourists poured in, mostly east coast Brazilians seeking a glimpse of their mysterious Amazon—and a bargain in imported luxuries.

The current boom began in 1967. Tax concessions drew industrialists and workers, and creation of a free port brought tourists. Jute factories now outdistance hide processing, and a steel mill has started production.

The most intriguing feature of Manaus for me is the fish market, an ornate cast-iron structure, imported from Europe and assembled during the prosperous 1890's. Boatmen start bringing in the catch at 11 p.m.; by 4 a.m. more than thirty species are on sale.

Most of the fish have Tupi Indian names, such as *acará-açú* (a handsome brown-and-orange fish) and the *tucunaré*, both gourmet favorites. The *pirarucú* (*paiche* in Peru), a common food fish in the River Sea, averages 70 pounds, and nine-footers weigh more than twice as much. Even heftier are the monstrous *piraiba* catfish, which attain 350 pounds, and which have, on rare occasions, swallowed children. (Not for sale is a nasty relative of the piraiba, the *candirú*, a tiny catfish that swims into human orifices and, because of barbed gills, lodges until removed surgically.)

Black-water Streams Drain the North

Part of the catch comes from the majestic Rio Negro, which flows 200 feet deep and 4 miles wide past Manaus, to surrender to the Amazon just below the city (page 452).

This stygian stream, the giant of the Amazon's black-water tributaries, flushes murky swamps and saturated forests that spread across Colombia, Venezuela, and northern Brazil, an area usually blanketed by clouds.

Unwilling taxi, a 20-foot anaconda slithers across Peruvian mud. The child, in the company of seasoned snake handlers, faces little danger from the water boa, which kills by suffocation. He can easily jump off should the rather sluggish serpent reverse direction to strike.

Bait-size boy paddles home with a man-size *pirarucú* that his uncle killed with a bow and arrow. Other large fish of the Amazon are the bull shark and the *piraiba* catfish, whose indiscriminate diet has been known to include even children.

Swamp leaves steeping in these 80°-to-90° F. source waters blacken the runoff.

So empty of people and goods is the river's entire upper region that I had to send a boatman ahead to stash six drums of aviation gasoline at hideaways for a floatplane flight into Venezuela's swamplands. There I wanted to trace the Negro to its emergence from that vague watershed where the upper reaches of the Orinoco split.

The Orinoco's main stream sweeps through Venezuela to the Atlantic, swelling to Mississippi size. The lesser channel, called the Casiquiare Canal—though really a navigable river—joins Colombia's black-water Guainia River, the Negro's source stream, and together they start the Negro on its southerly course. Naturalist Alexander von Humboldt confirmed the existence of this confluence of the Orinoco and Amazon systems in 1800. Nowhere else on earth are two major river systems joined by a natural canal.

At Cucui, a Brazilian military outpost on the Colombia-Venezuela border, I was grounded. Despite months of petitioning, I lacked authority to fly over Venezuela. Disappointed, I left pilot and plane there and hitched a ride upstream in a motorboat. In San Carlos, Venezuela, I vainly sought another boat for a cruise up the Casiquiare or Guainia. I'd about given up, when two beribboned Venezuelan officers approached.

"Our boat is damaged," said one. "I must pay wages to troops on the Casiquiare. Can you lend your speedboat?"

"And I have documents to deliver at Maroa up the Rio Guainia," said the other.

I shook my head sadly. "This boat is Brazilian and must return." Their faces fell. "Now, in Cucui I have an airplane—but no permission . . . not enough fuel. . . ."

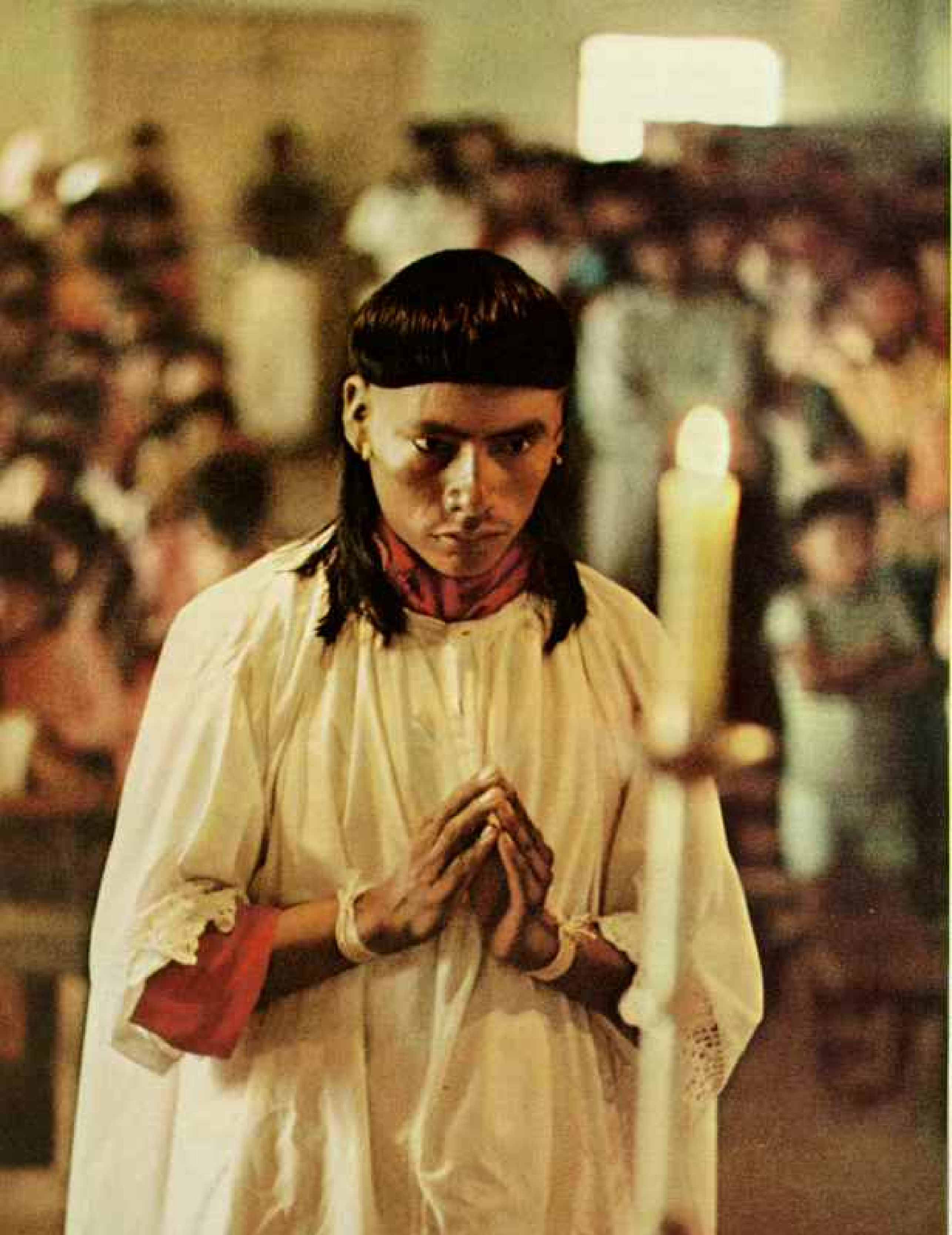
"A plane! Perfect! You have permission."

"And a drum of gasoline!" cried the other.

Settlers Rush Off to Share Oil Boom

Soon, with the necessary authority sitting beside me, I flew over the Casiquiare Canal and throughout Venezuela's small portion of the River Sea. From time to time my guests pointed out large airports under construction and the beginnings of roadways.

"So far, our Amazon development agency is ahead of Brazil in developing this frontier," said one. "Our main problem is shortage of people in Amazonas Territory. The 1941 census showed nearly 50,000. Then everybody



Symbol of change, a Xavante Indian serves as acolyte at a Mass in São Marcos, Mato Grosso (**left**). Among the most warlike of Amazonian peoples, the tall, proud Xavantes fiercely resisted all incursions until 1946. Now agriculturist Salesian missionaries at São Marcos and other Xavante villages help the Indians maintain their cultural heritage.

From her window on the wilderness, a missionary settlement by Peru's Lake Yarinacocha, Ruth McKinney daily observes the melding of eras—forest tribes reshaping their ways under the pressures of a changing society. Born in Oregon, she has spent most of her 14 years in Peru. Her parents are members of the Summer Institute of Linguistics. Ruth's father helps maintain the institute's fleet of planes.

dashed off to the Maracaibo oil fields. The next census dropped to under 11,000. Frankly, this is a tough place to make a living."

Underpopulation is a fact of life in this region. After I left the Venezuelan officers, I flew along the rugged divide between the Orinoco and Amazon systems without seeing any sign of habitation. Not till I put down in the lonely Uraricoera River region, far to the northeast, did I encounter another human being. There a stark-naked Waiká Indian, badly scratched from four days' hunting in the hills, offered to share his lunch with me: live caterpillars. Well, I like fried cicadas—they taste like shrimp. But *live* caterpillars? The Waiká lunched alone.

I reached the northernmost sources of the River Sea, feathery waterfalls veiling the sheer sides of monolithic Mount Roraima, a 9,094-foot table mountain where Venezuela, Guyana, and Brazil meet. Then I winged due south over uplands forested with tall white termite hills in even rows like tombstones in a forgotten Flanders Field.

Empty Plain Spawns a Metropolis

To emerge from all that emptiness and sight Brazil's Boa Vista, a semicircular city planned for a million population, was a startling experience (following page). It lies in the middle of a treeless plain on the west bank of the Rio Branco, a navigable tributary of the Negro. Today's 37,000 inhabitants depend largely on cattle for a livelihood.

Immense projects in mining and agriculture may spur population thrusts into these vacant lands during the 1970's. Around the rainswept Rio Trombetas, Alcan and Alcoa are exploring one of the world's largest bauxite deposits. Along the Jari, a tributary near the Amazon mouth, Daniel K. Ludwig, an American billionaire, bought a Connecticut-size tract five years ago (page 484).

"Mr. Ludwig foresees world shortages of food and paper pulp within a decade," said Joe Golson, a director of Jari Florestal e Agropecuária Ltda. "He's converting swamplands into rice fields and replacing rain-forest trees with commercial varieties. The boss sets a terrific pace. At his age—75—Mr. Ludwig is more interested in quick accomplishment than profit. This project may cost a hundred million dollars before it turns a nickel."

Brazilian nationals, too, are pushing development projects. Sweating 80 hours a week ripping up the forest, they are laying highways

With an eye to the future, Boa Vista sprawls symmetrically beside the broad Rio Branco in extreme northern Brazil. Now home to 37,000 persons, the planned city aims for a million by the year 2000. Surrounding savanna supports a growing cattle industry.

into long-hidden lands south of the Amazon: the territory of the blue-water tributaries.

The clear rivers laze north from ancient uplands in mid-continental Brazil, sparkling over crystalline rock and diamond-bearing gravel. Before they meet the main stream, they broaden into azure lakes with white beaches. Two of the terminal lakes measure a thousand square miles each. The rivers' names preserve the lilt of aboriginal languages: Tefé, Coari, Tapajós, Xingu.

The new roads knife north from the Mato Grosso uplands and west from BR-010, the Belém-Brasília highway from the River Sea's mouth to Brazil's federal capital. Termed a folly only ten years ago, BR-010 has already brought two million pioneers to new homesteads. For the first time in Amazon history, many people now settle away from the rivers.

The current westward thrust, which somewhat parallels United States expansion of a century ago, began with the ground-breaking for Brasília in 1957 on an empty plateau atop the eastern watershed of the River Sea. The iron horse opened the American West, but a new technology borne on aluminum wings, steel caterpillar treads, and rubber tires spearheads Brazil's westward migration.

The government permits investors to apply 50 percent of their income taxes to Amazon projects. A federal agency controls sale of new lands and requires settlers to retain half of their holdings in virgin forest.

Indians Yield Blue-water Realm

At Altamira, above the big bend of the Xingu, I accompanied Brazil's Interior Minister, Gen. José Costa Cavalcanti, on a three-day helicopter round of construction sites.

"We oppose haphazard settlement," he explained. "Our colonization agency, INCRA, controls a 60-mile-wide strip on both sides of the highway. We have already given 250-acre homesteads to several thousand families. INCRA encourages them to live in the 60-family *agrovilas* built every six miles along

Faithful to the past, Brazil's Krahô Indians retain the spoked-wheel village design of their ancestors, even when they move to a new site about every two decades. They live near the Tocantins River, on the eastern margin of the River Sea.

the highway. Every 25 miles we build an *agropolis* to offer more urban facilities."

The Indians have owned this blue-water interior until now; no one coveted the land. I asked General Cavalcanti about Article 198 of the Brazilian constitution, which guarantees forest-dwelling aborigines permanent possession of their lands and exclusive rights to its resources.

"Senhor, if all of us were hunters and gatherers, the entire world couldn't support ten million people. We will need room for 200 million Brazilians by the end of this century. Nevertheless, FUNAI is surveying Indian lands and setting aside parks and reserves there that will allow as much as 12 square miles per Indian."

FUNAI is Brazil's National Foundation for the Indian. In Brasília, FUNAI's English-speaking President, Gen. Oscar Jeronymo Bandeira de Mello, discussed the Indian problem with me.

"It seems that anyone—whether he's an anthropologist, evangelist, or newsman—thinks he has a better Indian solution than FUNAI's," said the exasperated general. He picked up a sample bag of rice labeled KARAJÁ INDIANS—BANANAL ISLAND. "The Indians must not be sidelined," he said. "They must enter the mainstream of Brazilian national life. To do so with dignity they *must* learn how to *work!*" He slammed the bag down on his desk. "This rice is proof that they can."

The general gave me special permission to enter Xingu National Park, a reserve for primitive people and wildlife, off limits to the public, at the headwaters of the Xingu River. There I found that civilization had slashed even into the heart of Indian territory. In 1971 highway BR-080 severed the north end of Xingu park. The sole surviving village of the Txukahamẽi, a branch of the dying Kayapó nation, was cut off from the park, its lands destined for cattle ranches.

One faction of the Txukahamẽis wanted to fight the road builders. The majority, led by

Portuguese-speaking Rauni, accepted FUNAI's proposal to move the tribe back into the park, about 20 miles upriver. Rauni reasoned they would not be molested, and they could paddle down to obtain such prizes of civilization as machetes and baseball caps—and, someday, even outboard motors.

"We fought among ourselves, and my side won," explained Rauni, his speech slurred by the three-inch wooden disk in his lower lip (page 485). "Seven Txukahamēis died in the fight. Not many." Not many? That was a twentieth of the whole tribe.

On his way upstream to carve his new village, Rauni received unexpected gifts at the ferry crossing for the new road. Guaracy Martins, a well-meaning land developer, loaded him with 12 hammocks and 220 pounds of hard candy. Senhor Martins spoke to Rauni in basic Portuguese right out of an old movie. "You, me, friends. Need help? See me. White man no go up river. Indian come down river anytime. Get everybody clothes. Get everybody job on ranch. Get plenty money."

Tribesmen Gain a Zealous Friend

A great good friend of the Indians for the past quarter century is Orlando Villas Boas, whom Brazilians consider a candidate for the Nobel Peace Prize. With his brothers, Leonardo and Claudio, he created Xingu National Park in 1961 to shield the local Indians from disastrous contact with outsiders and to reduce mortality from disease and intertribal warfare. They also brought neighboring tribes into the sanctuary.*

With Leonardo now dead, Orlando and Claudio are the mainstays of the Xingu park Indians; and no one visits the villages without their approval. Waiting at park headquarters, I greeted Orlando as he arrived in a DC-3 of the Brazilian Air Force. He had just seen his brother Claudio off on an expedition to contact the Kréen-Akarôre tribe, who were blocking construction of a highway. Orlando stepped off the plane barefoot, shirtless, mosquito-bitten, with a stack of his favorite comic books under his arm.

At supper he waved his arms excitedly as he talked about Cachimbo, an isolated airport that the Villas Boas brothers helped establish on a trailbreaking 1943 expedition. Claudio was using it as a base. "Cachimbo's

(Continued on page 489)

*The Villas Boas brothers wrote of their work in the NATIONAL GEOGRAPHIC for September 1968.

Unzipping the wilderness, Highway BR-080 opens virgin Brazilian forests to land-hungry ranchers. Population density in the whole Amazon Basin averages only two persons per square mile. Until now dense, roadless jungle has forced most people to cluster along the rivers.

Cowboy-and-Indian confrontation: Guaracy Martins, who promotes ranching, parleys with an elder of the Txukahamēis on the banks of the Xingu River. The Indians had to move 20 miles upstream when the highway slashed through their tribal reserve. The isolation of their new home minimizes the danger of clashes with settlers.

Green turned red, an effect created by infrared film, surrounds an experimental rice plantation (**above left**) on Brazil's Jari River. A project of American billionaire Daniel K. Ludwig, the mystery-shrouded paddies reportedly produce three tons of rice per acre—more than triple the world average. Predicting a paper shortage, the entrepreneur also began a pulpwood and timber plantation on the

5,600 square miles of Amazon land he bought in 1967. Here workers plant seedlings of *Gmelina*, a tree imported from Asia (**left**). Those that grow straight will be allowed to mature for use as cabinet wood; others will be harvested for pulp. Gmelinas will eventually provide as much as 1,000 tons of pulpwood a day, Ludwig hopes, without exhausting the jungle soils.

Clinging to a shrinking domain, Txukahamĕi Indians clear the forest for a new settlement. Traditional balsa disks distend the lips of Chief Rauni, at right, and another tribesman; they file a new edge on an ax.

The question of whether to move to a new upriver site, as ordered, or to stand and fight, shattered the peace of the original village. Proponents of relocation won the dispute, but only after seven of the 140-member group had died in an intratribal battle.

Little peek on the ear tickles a smile from a Kuikúro boy in Brazil's Xingu National Park. The fledgling kiskadee flycatchers, caught and trained by the child, spend their days on his shoulders. "Amazon Indians make pets of almost any creature they catch," the author reports, "except snakes and caimans, which look like alligators—and are about as friendly."

Fearsome mascot of the Kuikúro village for ten years, a harpy eagle (**upper left**) screeches defiance from its high-rise, teepee-shaped cage. Every Xingu group has such a captive, which never becomes tamed. Mexico's Aztecs called the dauntless birds "winged wolves," a tribute to the ferocity of their attacks on monkeys. Ignoring the bird in its conical house (**above**), boys for all seasons romp in a downpour that dampens everything but their spirits.

Radiating joy, a Kamayurá couple give way to affection during a tender moment in their four-month-old marriage. Kayanaká has just told her husband Ipanaká that she expects a baby.

Substitute for warfare: Wrestling, a favorite sport of Xingu tribesmen such as the Waurá (**below**), helps reduce tensions that in years past often resulted in killings. Grapplers of different tribes usually exchange gifts before bouts.

become a crazy place! A thousand men, 22 bulldozers flown in. Pushing down trees, pushing up sand—deep as the Sahara. They're leveling ground for an emergency jet airport. For jumbo jets!"

One day I walked nine hours through thin-treed forests and hip-deep swamps, following a naked Waurá guide to his tribe. Chief Malakiyauá met me and slung my hammock alongside a dozen others in his house—which measured 124 feet long, 60 wide, and 30 high. Five such buildings, thatched to the ground, housed 100 handsome Waurás—the entire tribe—plus pet monkeys, parrots, ducks, hawks, capybaras, and dogs.

For supper, Malakiyauá offered *beijú*, leathery unsalted manioc pancakes about two feet in diameter, and a palmful of hot-sauced fish paste laced with fine bones.

In the morning, women grated raw bitter cassava roots to make manioc cakes. Along the riverbank shallows men with bows and arrows hunted stingrays—dangerous to step on, delicious to eat.

Violent Sport Helps Keep the Peace

In the afternoon the men gathered at their lodge, the flute house in the middle of the village clearing. In the dim interior three fellows stomped back and forth playing low notes on giant magic flutes, which women are forbidden to behold except as a last resort to ward off fatal illness. The men finger-painted each other with *urucú*, a red vegetable pigment (page 495). They were getting ready to exchange presents, dance, and wrestle with Yawalapiti tribesmen, neighbors who live a day's journey away.

Orlando Villas Boas's foster son Aritaná, a Yawalapiti, described the custom to me. Aritaná is wrestling champion of a dozen Xingu tribes, all of which speak different tongues. "Enmities are held in check by such games. Besides, Orlando forbids war."

After the games, both men and women removed their leg and arm wrappings and ran to the river to bathe. After my swim I felt conspicuous getting dressed among a people who wore no clothes.

At evening campfire we men smoked green-tobacco cigars and held council. When cigars burned short, we scattered to the big houses. In the chill of the night my friends kept fires burning beside their hammocks. The smoke discouraged bugs—and my slumber.

As I swayed slowly to sleep I mused on how most Brazilians still think of their Amazon as the end of the world. Here with the Waurá it wasn't the end of the world. But it was very like the beginning.

I flew next to the Rio Tapajós, most beautiful of River Sea tributaries, with its high forested banks and long terminal lake. Downstream, where the Tapajós meets the Amazon, lies Santarém, fastest growing city in Brazil.

Confederate Exiles Find New Homes

After the U. S. Civil War, many Southerners moved to Santarém. Delano Riker Teles de Menezes, great-grandson of self-exiled Robert Riker of Charleston, South Carolina, pilots an air taxi based at Santarém airport. Delano introduced me to dozens of descendants of the Confederate Wallace, Jennings, and Vaughn families. None speak English.

Other Confederates settled in Belém, the metropolis commanding the portals of the River Sea (pages 454-5 and 492-3). Founded by Portuguese soldiers in 1616, Nossa Senhora de Belém—Our Lady of Bethlehem—is responsible for casting mainstream culture in a Portuguese mold.

When the Pope approved the 1494 Treaty of Tordesillas, dividing the non-Christian world between Spain and Portugal, all the New World west of the Amazon's mouth went to Spain, leaving the Portuguese with only the eastern bulge of Brazil. (See historical insets on the special supplement map, **South America**, distributed with this issue.)

In 1637 a band of Spaniards from Quito, Ecuador, led by lay brother Domingo Brieva, suddenly appeared in Belém. Fleeing killer Indians in Ecuador's jungles, they had retraced Orellana's 1542 voyage of discovery.

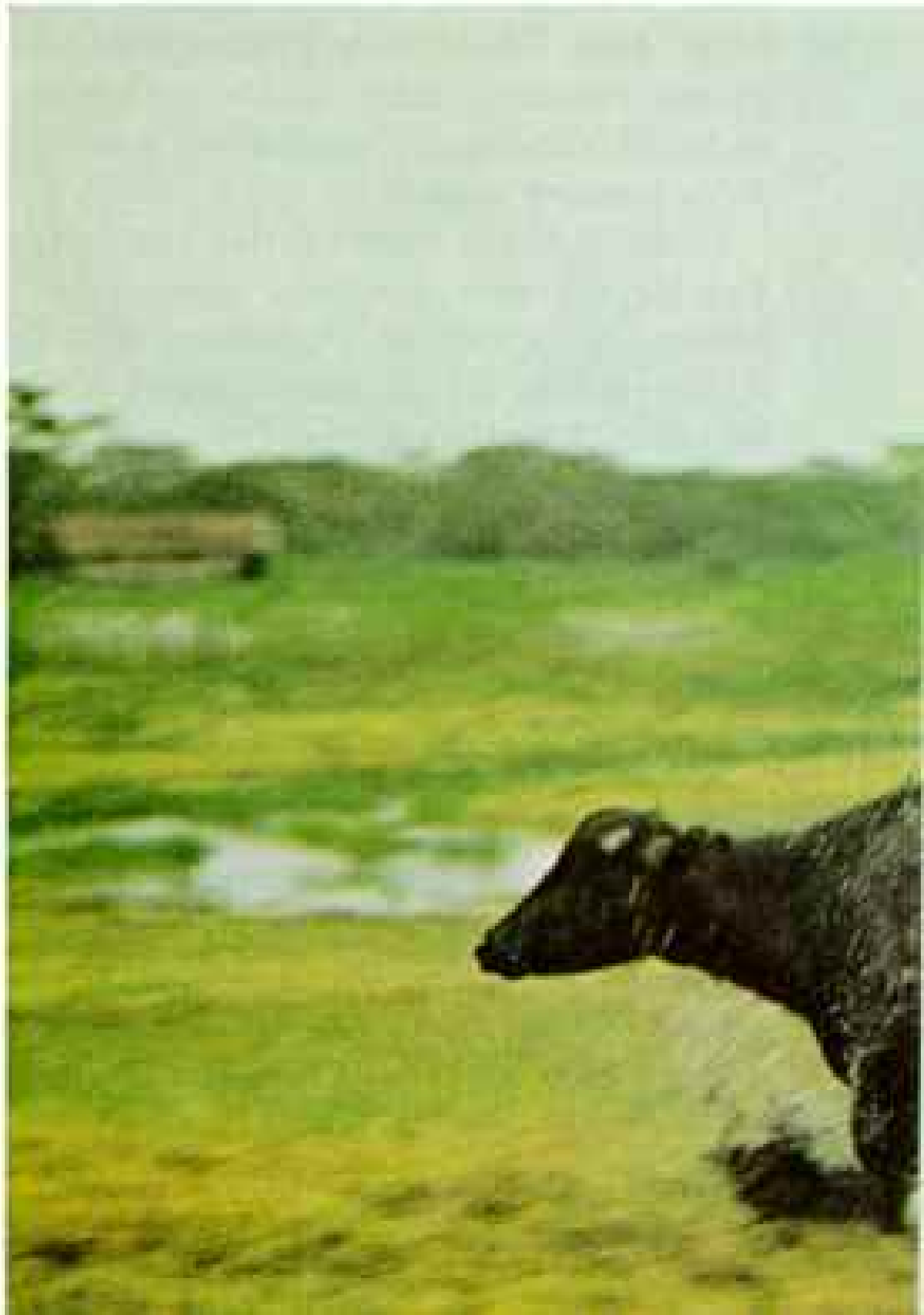
Their appearance prompted the governor of Belém to send 62-year-old Pedro Teixeira upriver with 47 war canoes, 70 soldiers, and 2,000 Indians—to this day the biggest of all Amazon expeditions. They used Brieva as guide and within a year reached Quito. Their unexpected arrival by the backdoor gave the Spaniards quite a start.

With Brieva leading the way again, Teixeira returned downriver to Belém, claiming for Portugal lands that comprise nearly half Brazil's present territory. Yet few Brazilians know of Teixeira's exploits; I couldn't even find a town on the river named for him.

To me, modern Belém is a sweet-smelling city. Its people enjoy pleasant scents, and

(Continued on page 494)

Awesome wall of water thunders into the mouth of the Amazon from the sea. Brazilians call the rare 12-foot-high tidal bore Pororoca—"the Big Roar." It occurs only when tides are unusually high.



Splashy dash across swampy pastures puts Brazilian cowhands within roping range of a young water buffalo on Marajó Island. The Switzerland-size landmass lies astride the 200-mile-wide mouth of the River Sea. Unlike most other domestic cattle, water buffalo—imported from India—thrive in Marajó's marshy wilderness.

Gateway to the Amazon, the 356-year-old city of Our Lady of Bethlehem—now shortened to Belém—grows like a hungry teenager. Social and cultural capital of northern Brazil, the city of 643,000 stands in vivid contrast to the tiny settlements that line nearby estuaries. Ocean-going freighters (**above**), chugging 90 miles up the Pará River to bring goods from throughout the world to an urban populace, share shipping lanes with river craft as varied as jungle dugouts bound for market and a sleek racing shell (**above**).

Fans of Brazil's national sport, *futebol*—our soccer—play in a park ringed by skyscrapers (**right, upper**).

With progress come problems (**right**). Brazilians build 440,000 automobiles a year, and despite high prices, enough find buyers to clog tree-lined avenues at rush hour.

PHOTOGRAPHS BY MANUEL PARES

markets sell concoctions of strange roots, herbs, and aromatic oils mixed with talc. Little boys hawk the powders, calling "Smell, mister." Trees bear fragrant blossoms.

But Belém has urban headaches. With its 100 inches of rainfall and a freshwater sea on three sides, it is still short of tap water. The city lacks adequate sewers, while the continent flushes past its doors.

As a young helmsman in 1935 I steered a freighter into the River Sea at Belém. Waiting to load mahogany for California ports, the vessel swung at anchor, six hours to and six hours fro in the world's highest freshwater tides. At slack water I watched for the Pororoca—"the Big Roar"—a fearful tidal bore reputed to thunder in with the flood tide and drag ships from anchorages. It never came.

I had read that Vicente Yáñez Pinzón, once skipper of Columbus's *Niña*, was crossing the Equator on his own expedition in 1500 when the ocean became muddy and began to freshen. Then, while he was coasting inshore, a terrible wave swept his caravel westward, bobbling it like flotsam. Everyone prayed; the wave subsided. Pinzón gave thanks to Santa Maria de la Mar Dulce, Saint Mary of the Sweetwater Sea, which became the first name of the Amazon on maps.

Fisherman's Friend Gets a Scare

Many subsequent accounts tell of an immense tidal bore, forcing back the current of the Amazon as far as 500 miles and inundating the floodplain. But never having met anyone who had seen or heard the Big Roar, I began to suspect that the long bow of Amazon storytelling had been overdrawn once again. What was the truth?

Learning that 60-mile-wide Caviana Island, one of several at the Amazon's mouth, had been cut in two in 1850 by a huge Pororoca, creating the Furo do Guajuru, now one of the river's outlets, I determined to see the phenomenon myself. But first I questioned old hands along the north bank.

They told me that the Pororoca occurs when tides are unusually high, when the full moon is setting, and where the water is less than four fathoms deep. A grizzled fisherman provided that final clue, the need for "bottom effect," which probably explains Pinzón's salvation: Apparently his caravel was swept from a shallow bank to deeper water.

With a toothless laugh, the fisherman told me how he had taken a city friend fishing before dawn, anchoring deliberately in the path of the Pororoca.

"When the wave rushed toward us, my friend panicked. I just sat and fished. The wave suddenly died and passed under us. I knew it would; I was anchored in a deep spot."

Plane Dives in Pursuit of Wave

One night when the full moon was sinking in the west, I took off from Belém in a single-engine landplane in quest of the Pororoca. By daybreak the pilot and I were circling in cool air 8,000 feet above the Furo do Guajuru. Seeing nothing, the pilot tried to turn back. He did not enjoy flying with the door removed so that I could take pictures. "Wait," I insisted. A streak of froth whipped out of the sea, writhed, and became a solitary wave, lifting and coursing upstream.

"Down, down!" I urged the pilot.

"No, our engine may overheat!"

A 100-cruzeiro note stuffed into his pocket persuaded him. Down we dived, winging over the bore as it curved across the wide channel (pages 490-91). The ends of the wave —a 12-foot-high wall of water—dragged trees from both banks. I could hear the Big Roar even above the noise of our engine, as the Amazon struggled with itself at its very end.

For what I watched was not the ocean sea invading the River Sea, but the enormous Amazon appearing to reverse itself at the moon's command. As Pinzón discovered far from shore in 1500, all that water is sweet. It seemed as if continental runoff from the brown torrent of the awesome Apurimac gorge, from the black-water Casiquiare Canal, and from the blue Xingu that flows by my friend Rauni's new village had lifted in one defiant surge back toward the Amazon's sources.

Then the moon set, its attraction faded, and the great wave gave in to the inexorable exit of the River Sea. □

Arrayed for the Dance of the Flies, a burly Waurá wrestler has girded his biceps to give him strength and endurance. Traditional Indian rites grow ever scarcer as *civilizados* compete with Brazil's forest people for the lush world of the Amazon.

THE SWALLOW-TAILED KITE

Graceful Aerialist of the Everglades

Photographs by RAY O. GREEN, JR.
NORMAN D. REED
MYRON H. WRIGHT, JR.

HIGHER, EVER HIGHER the bird spirals, riding thermals on motionless wings. Now floating with effortless elegance, it wheels and plummets earthward. Just as a crash seems inevitable, it levels off, and, without landing, snatches its unwary prey—a frog in Florida's Everglades National Park. Homeward bound, the hunter darts swallowlike through the pine forests, leaves the frog in the talons of its hungry offspring, and departs in search of another morsel or to skim along a pond for an in-flight drink.

Such is the spectacle of the swallow-tailed kite. *Elanoides forficatus* is easily recognized by its white head, blue-black wings, and deeply forked tail. Its wingspan averages three-and-a-half feet.

This 6-week-old fledgling (**right**), just out of the nest and too new to life to fear man, still wears the buff of adolescence. It let the photographer come as close as three feet, then clumsily fluttered to the ground from its low perch. When offered a stick, it clambered aboard like a tame parrot and—raised to its former height—remounted the branch.

Late February or March brings these swallowtails from South America to the Southeastern United States, where they breed. Cavorting in ever-changing breezes, the gymnasts of the sky drift, then swoop and chase each other in the circuslike performance of courtship. Even the chore of nest building becomes a spellbinding exhibition; airborne adults scarcely alight as they snap off dead twigs and clumps of Spanish moss for their treetop aeries. Pairs mate in March or April, and by May their nests usually hold two mottled eggs.

MYRON H. WRIGHT, JR.

BENEATH A FLASH of white that identifies a kite chick (**left**), Myron Wright scales the 50-foot nest tree to prune limbs blocking the camera's view. Two weeks after the chick hatched, the three photographers erected a steel tower (**below**) and capped it with a cramped canvas cube (**right**). The blind made possible rare close-up photographs of one kite's progress from downy hatchling to full-feathered young adult.

To make this unique portfolio, the photographers trekked over the Everglades' pocked limestone floor, a Swiss cheese of treacherous pitfalls. For six weeks they took turns visiting the blind, enduring squalls, 100-degree-plus heat, and hordes of mosquitoes.

KEY C. GREEN, JR. (LEFT) AND MARION H. WRIGHT

TURNING ITS BACK on doting parents, the 30-day-old fledgling (**right**) huddles over a meal, temporarily cold-shouldering offerings of more food. Adult plumage already clothes much of the youngster, which was in fleecy down only 12 days before (**left**). Voracious throughout youth, it demands—and gets—food almost constantly. Parents hunt most of the day for large insects, frogs, reptiles, and even the young of smaller birds, which they pluck as naked as supermarket chickens before serving. One day this pair fed their nestling 27 times in three hours. The baby downed all offerings, then greedily peeped for more.

Kite pairs, nesting alone or in loose groups, valiantly defend their young against intruders of all sizes. When a red-shouldered hawk violated this family's airspace, the parents dived repeatedly at the larger but slower bird, scolding it into retreat.

Wilderness dwellers, swallowtails once flocked by the scores from the Great Lakes to the Gulf of Mexico. But wanton killing and deforestation have reduced numbers, and such gatherings no longer occur. Today these kites breed almost exclusively in the extreme Southeastern United States (**below**). They are not officially an endangered species, but no one knows how many exist. Some kites don't mate, and those that do usually raise only one chick. The birds have few natural enemies, but mortality is high, and eggs and hatchlings are sometimes blown out of treetop nests.

BYRON W. WRIGHT, JR. (LEFT), NORMAN G. BYER (ABOVE), AND RAY G. GREEN, JR.

SCOOTING DEFTLY between the pines, an adult swallowtail (**left**) carries a green snake it swooped up from the undergrowth and killed with a bite. The bird's tail serves both as brake and rudder, scissoring or twisting to permit abrupt shifts in speed and direction. Briefly alighting at the nest, the kite skins its quarry, carves it into bite-size chunks for the chick, and dashes off again.

Dropping through the forest (**top**), the other parent approaches the nest in an easy glide. Rakish build and a favorable wingspan-to-weight ratio suit the bird so well to its ethereal medium that it rarely touches the ground.

The fuzzy 18-day-old nestling (**above**), too young for takeoff, flutters to keep its balance as tree-swaying gusts rock its home. Dark tips of emerging flight feathers fringe the trailing edges of the chick's wings.

FINALLY FREE of the nest's confines, the stubby-tailed youngster perches alongside a parent. Still an awkward pilot after two weeks of flight trials, the 56-day-old needs another sinew-stretching month of experience before making the midsummer journey south. Little is known of the birds' whereabouts or habits from that time until they return the following spring.

In an attempt to determine the swallowtail's migratory pattern, photographers Green, Reed, and Wright hope to tag an entire family with bands and colored plastic markers. The project is ambitious, but the three remain optimistic. "Our study was once just a bunch of ideas on paper, but already we've got some unique pictures and a lot of useful information," says Reed. "Why not keep trying?" □

ROY O. GREEN, JR.

Quicksilver and Slow Death

By JOHN J. PUTMAN
NATIONAL GEOGRAPHIC STAFF

Photographs by
ROBERT W. MADDEN

"A MINERAL of a perfectly singular kind," wrote Englishman John Hill of mercury in the 18th century. "It penetrates the Substance of all Metals, and dissolves, and makes them brittle." Today many of us have come to share the old scientist's wonder at mercury's perfect singularity—but our wonder is mixed with fear of the element as a pollutant, and with confusion about the extent of the danger it poses.

The confusion is understandable. For years most of us thought of mercury, if at all, as that silvery liquid in thermometers. Then, suddenly, we became aware of mercury's double nature. It can be a deadly enemy, striking down even the unborn. Yet it plays a vital role in our daily lives.

We learned of a New Mexico family poisoned after eating meat from a hog fed with mercury-treated seed, of rivers and lakes closed to fishing because of mercury contamination, of canned tuna being removed from supermarket shelves, and of giant industries shaken by charges of pollution. Then came scientific reports that challenged some of the government's protective measures.

Earlier this year grim reports from Iraq reminded us again of mercury's perils: When a large shipment of mercury-treated grain seed was distributed, villagers used it to make bread and to feed animals. Some 450 people died and thousands more were afflicted.

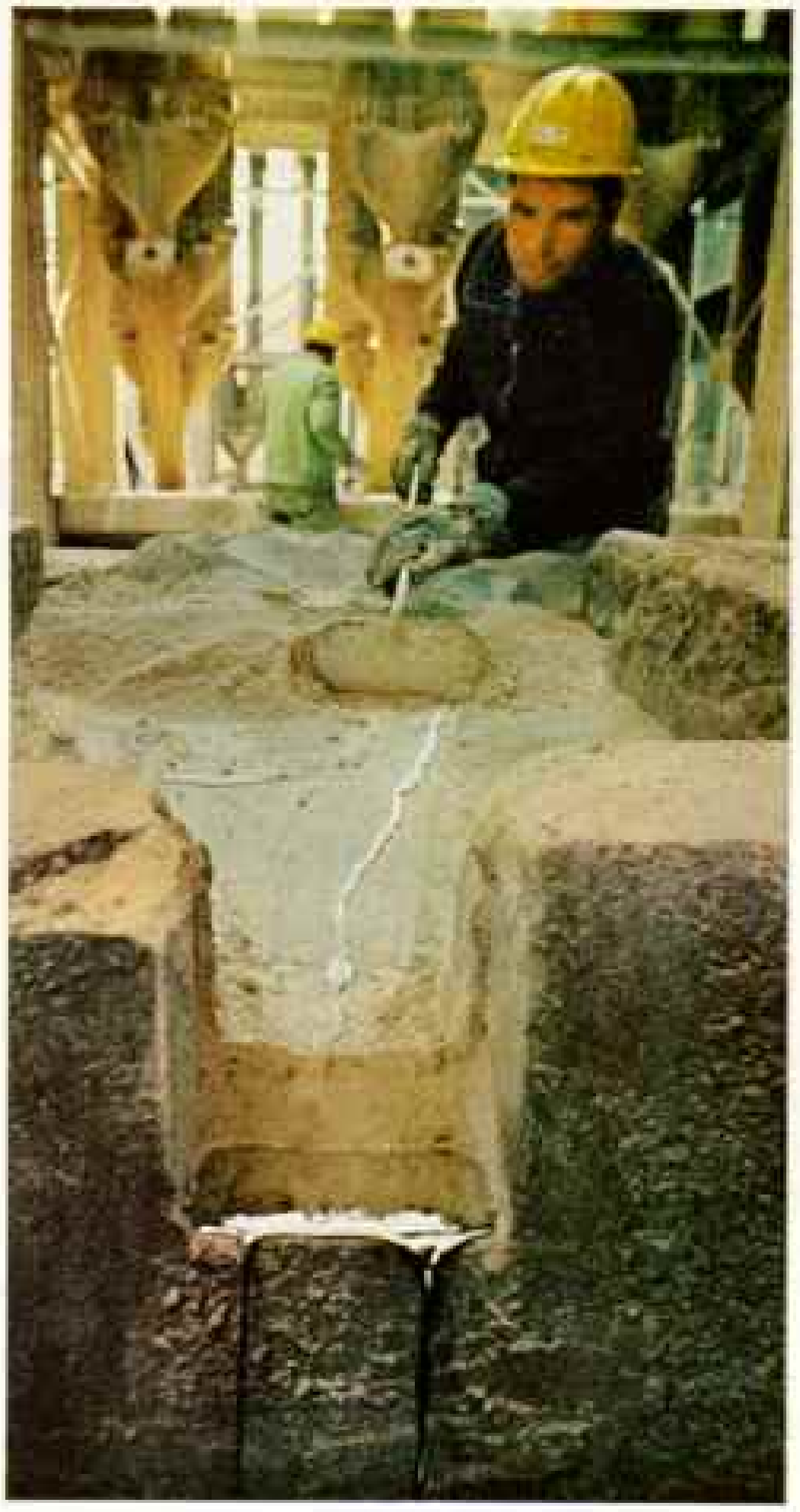
Looking into the mercury question, I traveled across the United States and around the world: to Spain, where men have mined the element since before the time of Christ; to Japan, where a score of teen-agers still suffer the agonies of mercury poison ingested while in their mothers' wombs; to Sweden, where scientists and government officials, acting to save vanishing bird populations, pioneered mercury-control studies.

The answers I received sometimes differed, but on one thing all were agreed: "The great mercury scare" provides a textbook example of the kind of problem we will meet again and again in our chemical-filled age. The lessons we draw from it can serve us in confronting similar challenges to come.

The story of mercury, also called quicksilver, begins some 4½ billion years ago, when the earth was formed. It is an element, a metal, like copper and iron. It is about 1.2 times heavier than lead. But unlike any of these, it has a melting point of −38° F. (iron, by comparison, melts at +2,795° F.), so that we usually see mercury as a liquid. During the passage of eons, it worked its way throughout the earth's surface—appearing in rocks, soil, water, air, and living organisms.

At some prehistoric time a man was attracted by a red rock. He picked it up, mixed bits of it with water, and found that it could be used to draw on the walls of caves. The rock was cinnabar, the sulphide ore of mercury. Archeologists have found it used as a pigment

Fluid as water, brilliant as silver, heavier than lead, mercury spills through a mine worker's fingers. A unique element—the only metal that is liquid at room temperature—mercury has fascinated mankind for centuries. Ancients used its compounds for medicines and pigments. Today thousands of products—from thermometers and light switches to pesticides—depend on its unusual properties. But recent tragedies, caused by rising levels in the environment, have shown that mercury can be a deadly servant.



BONANZA OF MERCURY ORE yields to an air drill at Almadén, Spain (**above**). Earth's richest mercury lode, Almadén produced about three million pounds last year, almost 15 percent of the world's total output. The mine is so rich that drops of metal actually ooze from the rust-colored rocks.

The ore will be crushed, then heated to release and vaporize the mercury. Cooled, the distilled vapors form free mercury and a gray

National Geographic, October 1972

sludge that is mixed with lime at boeing tables (**upper left**). As the lime absorbs water, more quicksilver trickles off to a collecting pot.

Floating on mercury (**left**), a veteran miner demonstrates the metal's high density—13.5 times that of water. Mercury's great cohesiveness prevents it from wetting skin or clothes. Being liquid, however, it penetrates the finest crevices. Once out of the vat, this man turned out his pockets and shed his shoes to shake out droplets of the metal.

The Almadén mine, exploited since Roman times, now employs some 1,200 miners. Local law restricts them to eight working days a month because of the toxic effects of mercury vapor. Most workers shun fresh-air breaks because they are paid according to how much they produce, not how long they work.

in the ruins of ancient Egypt and Babylon and at Mohenjo Daro in Pakistan.

Aristotle, in the fourth century B.C., was the first to leave us a written record of the element itself; he called it "liquid silver." Five centuries later the Greek physician Dioscorides wrote that cinnabar was "good for eye medicines . . . it heals burnings, and the breaking out of pustules." But, he noted, the element itself was dangerous if swallowed.

When the Romans became masters of the Mediterranean, they found new uses for mercury and its ore. Pliny the Elder tells us that cinnabar was used on holidays to redden the face of the statue of Jupiter on Rome's Capitoline Hill and for writing books and decorating walls and tombs. Mercury was used in amalgams to coat copper objects with gold and as a refining agent to separate gold from dust and dirt.

To the alchemists of medieval days, mercury seemed a magical substance—an elusive silvery liquid that appeared when a blood-red stone was roasted in a retort. Ancient Hindu sages adjudged it an aphrodisiac; Chinese wise men saw in it the secret of immortality and mixed it into their elixirs.

Arabian and European alchemists deemed mercury one of the two "contraries" (the other was sulphur) that combined deep in the earth to form all other elements. They sought to turn base metals into gold by duplicating the process in their laboratories, giving proper attention to astrological signs. It was the alchemists who gave mercury its name—after the fleet-footed Greek god.

Mine Dominates the Life of a Town

To recapture the aura of mystery that mercury exercised over the ancients, I visited the mine Pliny called "the most famous for the revenues of the Roman nation." Set in the Sierra Morena, 130 miles southwest of Madrid, it remains the richest of all mercury mines (preceding pages). Its name, and that of the town above it, is Almadén—"mine."

Padre Jesús Carrion, the mine chaplain for 25 years, met me in the Plaza Generalisimo at dusk. It was that hour in Spain when waiters set up their tables in the street, families stroll and chatter, and old widows come to their tiny balconies to look down and remember.

"Our town exists only because of the mine," Don Jesús told me. "It is an inseparable part of our lives. Its galleries run under our houses; the new shaft elevator tower nudges our oldest ruin, a 12th-century castle. Almost every family has a man in the mine.

"It's not a bad thing, for the pay and benefits are good by Spanish standards. And because of a health regulation two centuries old, the miners work only eight days a month, and so can hold a second job. Our miners are also barbers, law clerks, shopkeepers."

The next day I went down with the miners, dropping by elevator 1,650 feet into the Spanish earth. The main trucking gallery at level 19 was 23 feet high, ribbed with concrete arches and veined with hoses for pneumatic equipment. Electric-powered trains rumbled by with loads of red-hued cinnabar.

Standard Flask Holds 76 Pounds

Assistant Mine Engineer Gabriel Vigara Castillo told me the ore deposits occurred in three great almost vertical seams named "San Pedro y San Diego," "San Francisco," and "San Nicolás." I asked him how much longer they would yield their treasure. He shrugged: "We simply don't know how much lies below or near our present galleries. But we plan to be in business for years to come."

I followed the ore topside, saw it crushed by giant machines, then roasted in oil-fired furnaces at nearly 1,500° F. The mercury rose as a vapor, was piped into condensers, and eventually emerged 99.9 percent pure.

At the storage house a man turned a spigot and carefully measured out the silvery treasure into steel flasks, each holding 76 pounds of mercury (about 2½ quarts). Through that hand-operated spigot, I was told, passed about 13 percent of the mercury produced in the world—some three million pounds annually.

Before I left Almadén, Don Jesús invited me to visit the miners' hospital. It held few patients: a man hit by a falling rock, another by a timber. In one room the walls were lined with powerful lamps, the floor marked with a circular path. "The miners call this the 'beach,'" Don Jesús told me. "Sometimes a man inhales too much mercury vapor in the mine and develops a tremor. If it's a severe case, the doctors send him here for treatment.

"He strips and walks round and round in the heat, sweating out the mercury. Most respond rapidly and are returned to work. A few don't, they are pensioned."

I lingered for a time in the beach. It was my first contact with mercury's power to cripple and kill.

Pliny noted hazards of working with mercury. "Persons employed in the manufactories . . . protect the face with masks of loose bladder skin to avoid inhaling the dust, which is most pernicious." The 18th-century Italian physician Ramazzini, one of the fathers of industrial medicine, reported that from mercury mines there issued "the most cruel bane of all that deals death and destruction to miners." He told of a young gilder who used the element in an amalgam for coating copper objects with gold and silver. He died, "his face wan . . . and cadaverous, his eyes bloodshot, his breathing difficult, with mental stupor. . . ."

As mercury found new uses, new incidents of poisoning followed. Workers in the felt-hat industry dipped furs into vats of mercuric nitrate solution to make them pliable for shaping. In the process they absorbed the compound through their skin and inhaled mercury vapor. The result: tremors, loss of teeth, difficulty in walking, and mental disability. Legend has it that the Mad Hatter in Lewis Carroll's *Alice's Adventures in Wonderland* was patterned after such a victim. In the United States the hatter's disease was known as the "Danbury shakes"—after the Connecticut hatmaking city.

Through the years mercury poisoning struck others: munitions workers, thermometer fillers, laboratory technicians. Even British constables fell ill after frequent use of a fingerprinting compound. But mercury poisoning still seemed almost exclusively an occupational hazard that could be controlled by proper precautions.

Metal's 20th-century Uses Are Legion

And so, as man moved into the modern technological age, mercury moved with him. By 1969 world production reached some 20 million pounds, and one industry expert counted more than 3,000 different uses for the element.

Dentists have long used a 50-percent mercury amalgam in tooth fillings. The mercury dissolves an alloy of silver and tin, and this compound solidifies on application. Last year more than 160 million such fillings went into American teeth.

Flip a silent light switch or listen as an automatic thermostat activates a furnace or air conditioner—your unseen servant is often a little blob of mercury sliding in a glass tube to make or break an electric circuit.

The fluorescent lamps that brighten offices and schools, providing 70 percent of America's lighting, are activated by mercury vapor. So, too, are many of the powerful lamps that turn night into day on our city streets.

Added to paints, floor waxes, furniture polishes, and fabric softeners, mercury inhibits the growth of bacteria and mildew. Laundries and diaper services have used it for the same function. It was formulated in medicines as an antiseptic (mercurochrome), as a diuretic, even as a treatment for syphilis.

Farmers found it an inexpensive and effective pesticide for treating seed and spraying plants—as did gardeners and groundkeepers. Physicians use it to measure both temperature and blood pressure, and weathermen to gauge atmospheric pressure.

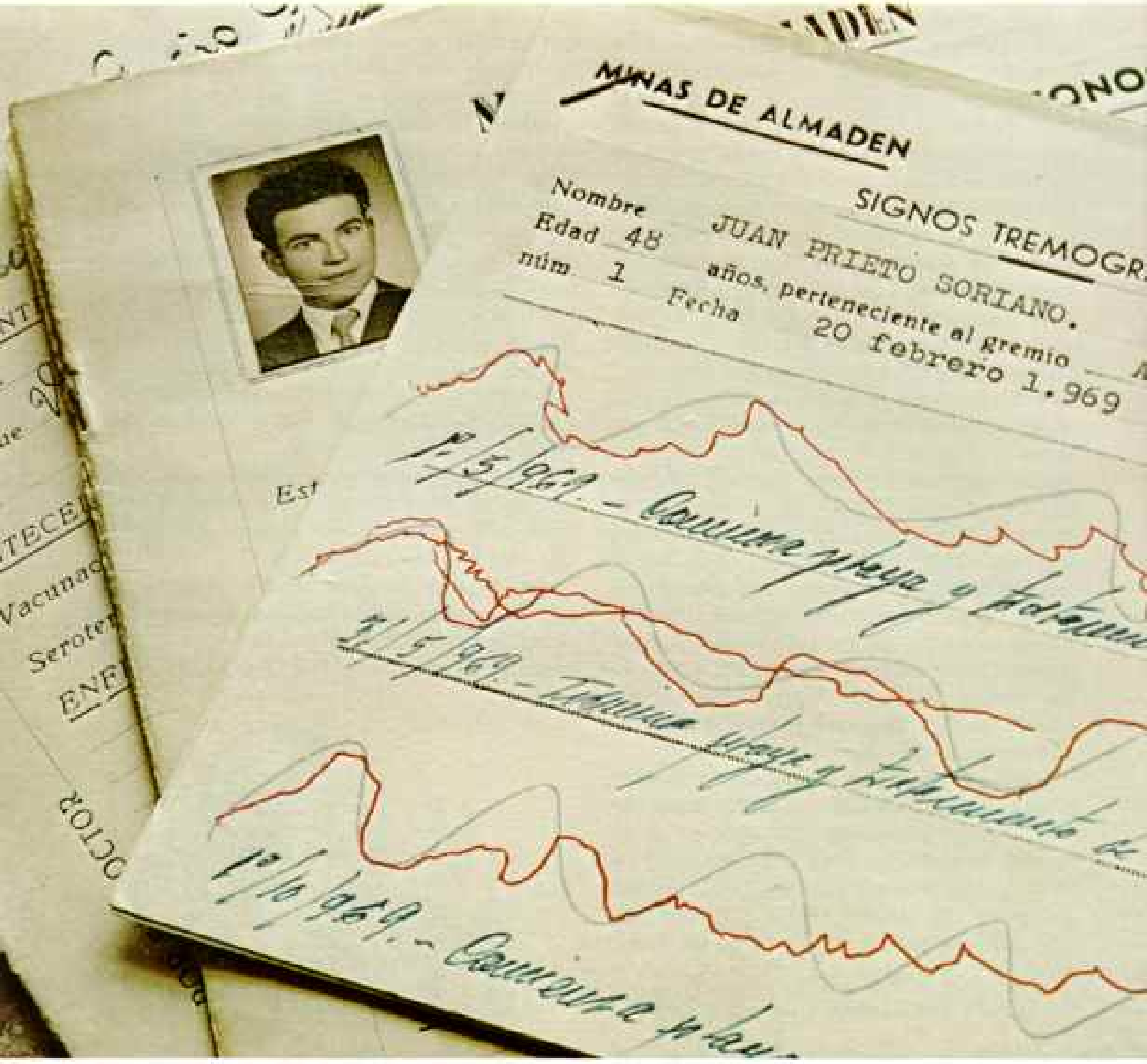
In modern chemical industries mercury and mercury compounds play hundreds of roles. They help make our plastics, our paper, our clothing, our camera film.

For decades mercuric fulminate detonated the explosives used in industry, mining, and war. Then, with the dawn of the Atomic Age, mercury found a new role: participating in

1865 ILLUSTRATION BY JOHN TENNIEL

Twinkle, twinkle, little bat
How I wonder what you're at

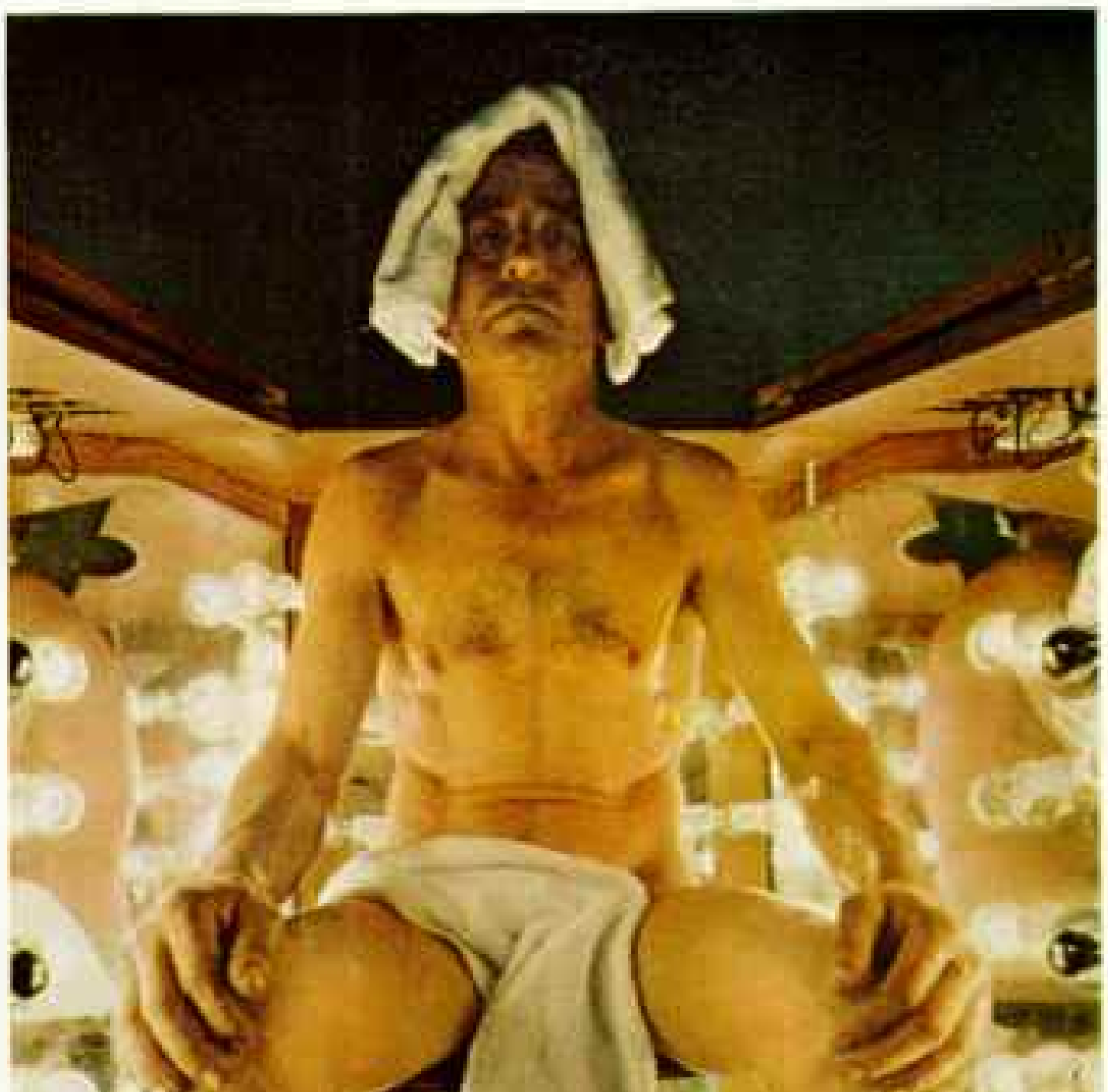
Spouting one bit of gibberish after another, the Mad Hatter in Lewis Carroll's *Alice's Adventures in Wonderland* exhibited a trait common to many 19th-century hatmakers—incoherent speech. Working long hours with mercury-treated pelts, they absorbed the poison through their skin and inhaled mercury vapor, which caused them to shake and to slur their words.



QUICKSILVER'S TRADEMARK, a jagged scrawl, testifies to a mine worker's tremors, caused by years of breathing mercury fumes. Asked by a doctor to trace over the smooth penciled waves, 48-year-old Juan Prieto Soriano could not complete the simple task, and was pensioned.

Chronic mercurialism, as the disease is called, progresses slowly, affecting many parts of the body. At Almadén some former workers cannot walk or feed themselves; a few shake so violently that they must be strapped into bed.

Alfonso Calderón Gonzales (**top right**) pushed mine cars for 25 years before symptoms appeared. Almost too dizzy to stand, beset by headaches and tremors, he receives treatment at the mine hospital. Alternating between a lamp-studded hot box and the "beach"—a room bathed in ultraviolet light—he hopes to sweat out mercury through his pores. Some inhaled mercury can be expelled in this way, but



most of it binds to body proteins and leaves only after many months.

Particularly insidious because its fumes are invisible and odorless, elemental mercury vaporizes readily, even at room temperature (**right**). Lit by a conventional lamp, a vial of mercury throws the shadow at left; no fumes appear. Ultraviolet rays—absorbed by mercury—outline the other silhouette, which shows mercury vapor billowing from the vial.

the separation of lithium 6, an isotope involved in the fusion reaction in hydrogen bombs.

When American astronauts left for the moon, they carried long-life mercury batteries to power emergency lights. The same batteries power military radios, the sensors dropped along enemy supply trails in Viet Nam, and the cardiac pacemakers that have been sewn into hundreds of thousands of patients to keep their hearts beating steadily.

From Japan Comes a Dire Warning

It was in 1953 that man received his first notice that mercury's marvels came with a price tag higher than occasional occupational illnesses. That year in villages around Minamata, a small city on Japan's island of Kyushu, fishermen and their families began to fall victim to a mysterious and catastrophic disease. When I journeyed there, I found some of the villagers still paying that price.

Shinobu Sakamoto, 15 years old, lives in the village of Yudo. When she appeared in the doorway of the room where her mother and I sat talking over cups of green tea, I was struck by her loveliness: almond eyes, a bright smile, and a willowy body. She tossed down her book bag and spoke to us. The words came out not in the rapid flow of her mother's speech, but slowly, as if with pain, and cruelly distorted.

Mrs. Sakamoto answered with a smile and the girl walked—with a tottering, jerky gait—into the next room. I heard a television set snap on. Now and then, as Mrs. Sakamoto and I talked, we would hear the girl's gentle laughter from the other room.

Shinobu is one of 202 people who were poisoned by contaminated fish from Minamata Bay. Fifty-two died, including Shinobu's older sister. Most of the victims had eaten the fish, a three-times-a-day staple in such humble seaside villages.

Shinobu had been poisoned while still in her mother's womb. Mrs. Sakamoto herself had experienced no symptoms. But the poison in her bloodstream had worked its way past the placental barrier to wreak its destruction on the unborn Shinobu.

"We did not know anything was wrong with her until, at about 3, we noticed she had difficulty walking and holding up her head; she fell down often.

"We took her to the hospital. By then the cause of the poisoning was known. I was told there was no cure. We could only try to train

CRIPPLED BY POLLUTION, Shinobu Sakamoto struggles to fasten her sweater buttons. She was inadvertently poisoned by wastes from a chemicals plant at Minamata, Japan (**right**). In the 1950's the factory discharged lethal methyl mercury into Minamata Bay. Transferred through the food chain, the mercury became concentrated in fish, from which it passed to the population.

BODY BY JAMES L. STANFIELD

her to use the undamaged parts of her body and brain to perform the necessary functions of living.

"At first, our only hope was that she could walk. Then, we prayed that she could go to school. Now our hope is that she will be able to take care of herself when we no longer can, especially when we die."

Shinobu can now eat with a spoon but not with chopsticks. She can put on her clothes but has difficulty buttoning them. She can catch the school bus to attend a special class for handicapped children, but she cannot play with the other children because of her difficulty in walking and the danger of falling.

Medical Detectives Confront a Mystery

Mrs. Sakamoto showed me the girl's school diary, filled with difficult Japanese characters. Some were correct. In others the strokes veered off into meaninglessness. "She writes sentences, but we cannot read them," Mrs. Sakamoto said.

I asked if she could understand her daughter. "Usually only by her gestures. One word I can understand—*kaachan*, 'mother.'"

I visited other patients: a husky young man who could no longer work because he was unsteady on his feet; a 13-year-old girl who lay night and day on a straw mat, blind, stiff, and occasionally convulsed with involuntary laughter; a hospitalized old man whose arms and hands have been drawn into tight knots at his chest.

That the toll at Minamata did not climb higher was the result of years of patient scientific detective work.

When the first victims appeared in 1953, local doctors made various diagnoses: brain tumor, cerebral palsy, syphilis, Japanese encephalitis. Three years later they had 30 patients, and realized they were confronted with an epidemic. They called for help from the Kumamoto University School of Medicine, 50 miles to the north. Among the specialists who responded was Dr. Tadao Takeuchi, a small gentle-mannered pathologist.

"By the time we entered the case," Dr. Takeuchi told me, "there were 54 patients, almost all from fishermen's families. Most told us they had become ill after eating fish. Other villagers reported seeing cats walking in circles, crows falling from perches. Both eat fish.

"We fed some of the fish to experimental animals. Some were stricken. We still had no idea what the poison was.

"I performed autopsies on the animals and on human victims. The results in each case were the same—a reduction of neurons, brain cells, in the cerebrum and of the granular cells of the cerebellum."

The findings explained the symptoms perfectly: ataxic gait, convulsions, numbness in the mouth and limbs, constriction of the visual field, and difficulty in speaking.

"We searched the literature for a toxic substance causing these symptoms. Months after we had begun, I came across a British report on poisoning by methyl mercury—an organic mercury compound far more toxic than the element itself or its inorganic compounds. Everything began to fall into place."

Analysis of the fish and of the victims showed remarkably high levels of mercury—as much as 24 parts per million in the bay's small crabs and 144 parts per million in kidneys from human victims.

Patiently the Kumamoto team traced the methyl mercury from the shellfish back through the water to the effluent pipe and sludge of the town's principal industry, the Chisso Corporation. Its regular output included chemical fertilizers, industrial chemicals, plastic materials, and synthetic fibers.

Brain Suffers the Greatest Damage

About a year before the first victim appeared, however, the factory had begun mass production of acetaldehyde and vinyl chloride, used in the plastics industry. In both processes, mercury compounds serve as catalysts. During the reactions, some methyl mercury was formed, then passed with other wastes through the plant's effluent into the bay.

Fish and crustaceans, pumping the water through their gills and feeding on contaminated marine life, absorbed and concentrated the methyl mercury in their tissues, transmitting it ultimately to the fishermen and their families.

I asked Dr. Takeuchi what happened when the methyl mercury was absorbed by the human system.

"We found some damage in the bone marrow, lymph nodes, nerve fibers, liver, and kidney. But the catastrophic damage results from methyl mercury's ability to penetrate the 'blood-brain barrier'—a protective system that bars most toxins."

The process of destruction is not fully understood. The mercury may attach itself to sulphur groups within cell proteins and

membranes, wrecking their normal processes.

Japan experienced a second outbreak of Minamata disease in 1964 at Niigata, on the main island of Honshu. Spurred by the double tragedy, the government set up an agency to regulate industrial pollution. Dr. Takeuchi expects Niigata to be the last episode.

At Minamata the Chisso factory has ceased its deadly discharges, mercury levels in the water have gone down, and fishermen once more ply their trade.

First Seedeaters, Then Birds of Prey

There was a second notice of mercury's high cost to the human environment. While people were dying at Minamata, birds were perishing in Sweden. Among the first to observe a decline in bird populations was Erik Rosenberg, an author and naturalist.

"It was in the 1950's that I began to notice a reduction in our corn sparrows and yellowhammers," he told me at his home in Örebro a few months before his death at age 69. "About a month after the farmers sowed their winter grain, I would find lame birds in the fields. Their nests would hold eggs, but the eggs would not hatch.

"The seedeating birds were the first to vanish, then the hawks—kestrels, peregrine falcons, marsh harriers, and hen harriers—that preyed on the seedeaters."

Swedish farmers had been treating their grain seed with an alkyl mercury compound, usually methyl mercury. Mr. Rosenberg and others theorized that the treated seed was poisoning the birds. Analysis of dead birds confirmed high mercury levels.

Decisive action did not follow immediately. The farmers had been using the compound as a pesticide since the early 1940's with excellent results: increased crop yields and the disappearance of plant diseases.

The event that finally triggered Sweden's sweeping assault on mercury pollution was a

Laboratory sleuths on quicksilver's trail, Swedish scientists helped alert the world to mercury's wide-ranging impact on the environment. In 1967 Dr. Arne Jernelöv, foreground, and an associate proved that some microbes change inorganic mercury to the methyl form, making all mercury compounds potentially dangerous. Doctors Gunnel Westöö, Torbjörn Westermark, Alf Johnels, and Maths Berlin, from left, investigated mercury's increasing levels and toxic effects on living organisms. As a result of their work, Sweden swiftly banned many uses of mercury.

A family's lasting grief

SEVERAL YEARS AGO, Ernest Huckleby of Alamogordo, New Mexico, started feeding waste grain to his hogs. Treated with a methyl mercury pesticide called Panogen (**above**), the seeds were intended for sowing, not feed, and bore a pink warning dye. The hogs showed no immediate effects (**top right**), and Mr. Huckleby continued the feedings until slaughtering time in 1969.

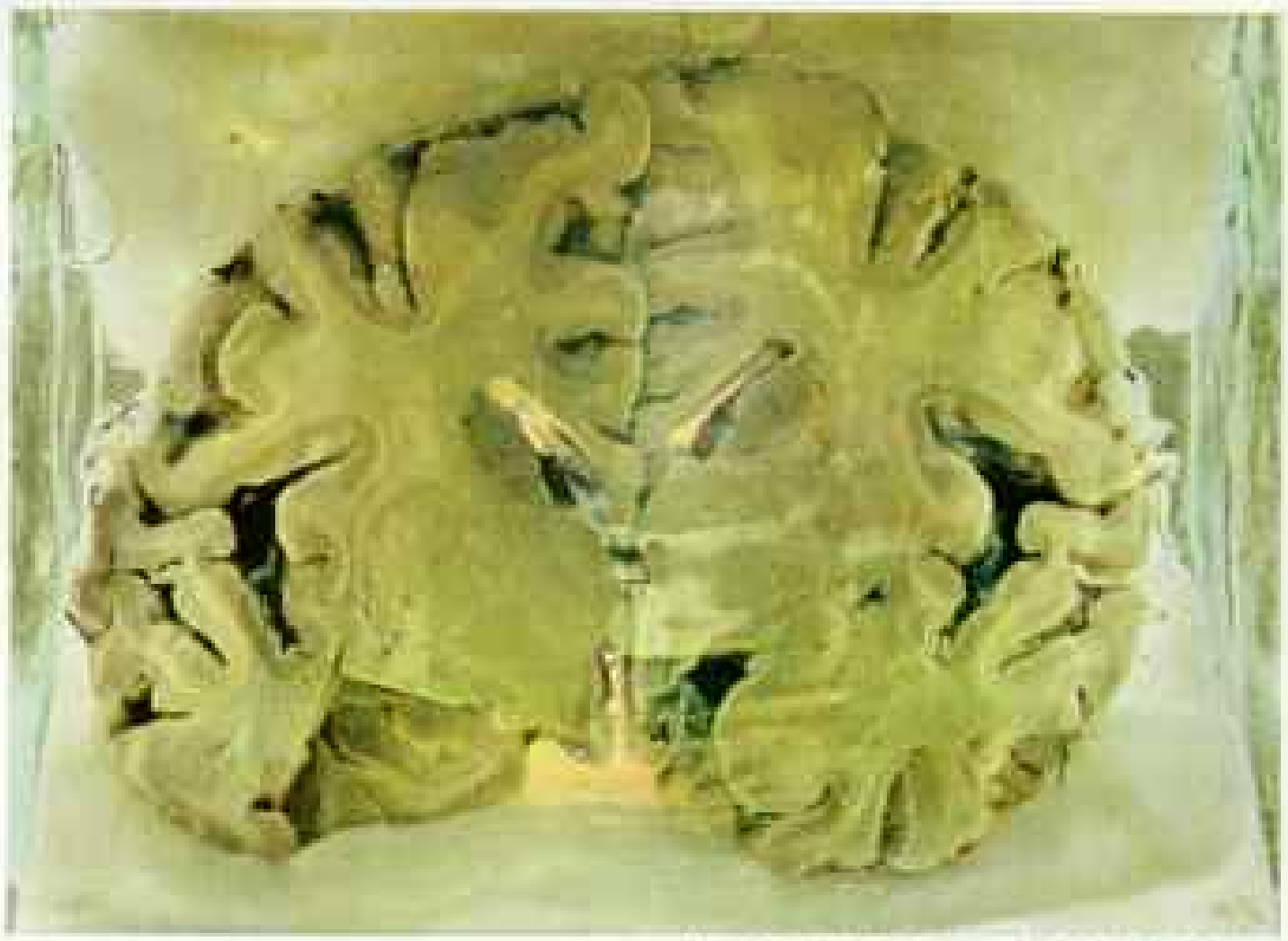
After his family ate the meat of one hog, disaster struck. Four children suffered severe nerve damage, including Ernestine (**right**), who lost sight, speech, and muscle control. Michael, unborn at the time, entered the world blind and retarded (**facing page**).

Fast-working researchers tracked down the villain: The methyl mercury had concentrated in the hog's body, and was passed on to those who ate its flesh.

ALL BY JAMES P. BLAIR

THE BRAIN SUCCUMBS to mercury's ravages more readily than other tissues. Borne by the bloodstream, methyl mercury penetrates brain membranes that bar most other poisons. First it damages the organ without appreciable loss of cells (**top**), then erodes whole pockets of tissue (**middle**). Worst hit are the brain's visual, hearing, and equilibrium centers, thus explaining the effects of mercury poisoning—blindness, deafness, and loss of balance.

Seeking an antidote, Dr. Thomas Clarkson of the University of Rochester's Medical Center tests the ability of various synthetic resins to inactivate methyl mercury (**below**). Given orally, the resins trap the poison, enabling the body to excrete it instead of retaining it, as usually occurs.



JAMES L. STANFIELD (ABOVE) AND ROBERT W. MADDOCK

decision made by Austrian health authorities in Vienna. Citing reports of mercury contamination in Sweden, they impounded a carload of imported Swedish eggs.

Dr. Torbjörn Westermark (page 517), a nuclear chemist, was one of the scientists called in to resolve the question of the eggs.

We talked in his office at the Royal Institute of Technology in Stockholm. "Analysis by neutron activation showed the eggs to be within safe limits, and they were sold. But in the process we opened up a Pandora's box.

"The eggs and other Swedish foodstuffs ran two to four times higher in mercury content than the same foods from Denmark and other European nations where the methyl mercury compound was not used. It became clear that some of our farmers, despite warnings, were feeding treated seed to animals."

It was also determined that residues from mercury sprays and the seed dressing affected mercury levels in crops.

Dr. Westermark continued: "Then we decided to look at fish. We theorized that some of the seed dressing leached from fields into rivers had gotten into the fish. We were proven right in suspecting high levels of mercury in fish, but wrong on its source.

"Investigation showed that mercury levels in fish ran highest in industrial areas, particularly around chlor-alkali plants and pulp and paper mills. Both used mercury, but not in the methyl form found in the fish.

"This last small puzzle was solved by two young scientists, Sören Jensen and Arne Jernelöv. Duplicating stream-bottom conditions in their laboratory, they found that microscopic organisms convert elemental mercury and mercury compounds into methyl mercury."

Potent Effects May Last For Decades

By 1966 the Swedish Government had banned the use of alkyl mercury in agriculture and placed severe restrictions on the use of other mercury compounds.

Dr. Jan-Erling Larsson of the Swedish Environment Protection Board told me that the results had been dramatic. Mercury levels in Swedish food have dropped to those of other European nations, and bird populations have returned to provinces where they had been reduced or had totally disappeared.

But Dr. Larsson added that troublesome problems remain—problems that now concern American scientists. "First, the mercury deposited in some of our lakes and streams in past years may remain there for decades. Fish in these waters still show high mercury levels. We have found no feasible method of removing or neutralizing these deposits.

"The second problem is a matter of our ignorance. About one percent of our waters remain blacklisted. In more than half these cases, we can attribute the contamination to pollution. But in the other cases, about 40 percent, we simply don't know the source. It may be from atmospheric pollution. This is an area we're examining today."

Tragedy Brings Public Awareness

American scientists had followed the Japanese and Swedish experiences, and in 1969 the Food and Drug Administration established an 0.5-parts-per-million guideline as the maximum safe limit for mercury in fish. But it was not until 1970 that mercury pollution became a matter of public concern in the United States. The news reports that triggered the interest centered around three men.

Ernest Huckleby, a laborer in Alamogordo, New Mexico, obtained waste grain seed treated with the same methyl mercury compound that poisoned birds in Sweden. Bags of such seed carry a tag warning that the contents are poisonous to animals and humans, and the seed is dyed a bright pink. But as the recent poisonings in Iraq proved (and this was the third outbreak in that nation) such warnings are not always enough.

Mr. Huckleby fed the grain seed to his hogs. Later he butchered one and he and his family ate the meat almost daily for three months. As a result, three of his children were severely crippled. A fourth child, poisoned in his mother's womb, was born blind and retarded (pages 518-19).

Also in 1970, Norvald Fimreite, a Norwegian graduate student at the University of Western Ontario, reported on a two-year investigation of mercury contamination in Canada. The results showed high levels of mercury in seedeating birds such as partridges and pheasants in Alberta and Saskatchewan, where farmers used the same mercury compound as in Sweden. Then he determined that fish from the Lake St. Clair and western Lake Erie areas—both polluted by discharge from chlor-alkali plants—contained levels of mercury as high as seven parts per million. His findings, confirmed by other studies, led officials to establish fishing

HOW MUCH IS TOO MUCH? National Canners Association chemists test tuna at Berkeley, California, to ensure that they meet the government's guideline of no more than one-half part mercury per million parts fish (**above**). But sports fishermen in Lake St. Clair legally catch—and eat—pike, some containing 15 times as much of the poison. "No one ever got sick from mercury here," insists Michigan guide Ray Trombley (**right**).

Sampling the floor of Washington's Bellingham Bay, an Environmental Protection Agency vessel (**far right**) takes cores near the Georgia-Pacific Corporation's chlor-alkali plant. The factory sharply reduced discharge of mercury into the bay two years ago. Methods to remove mercury-laden sludge that accumulated on the bottom of the bay are now under study.

restrictions in the suspect waters of Ontario, Michigan, and Ohio.

Finally, Dr. Bruce McDuffie, a professor at the State University of New York campus at Binghamton, decided to analyze tuna from cans on his kitchen shelf. He found levels above the FDA's 0.5-parts-per-million guideline. Later he found even higher levels in frozen swordfish purchased at his local market.

Prompt government action followed each disclosure. The Department of Agriculture banned the use of alkyl mercury for seed preservation. The Food and Drug Administration, after its own analyses, ordered the withdrawal of 12½ million cans of tuna and advised Americans not to eat swordfish. The Department of the Interior began testing plant sites for mercury contamination, and filed suits against operators of nine chlor-alkali plants. In time, more than thirty states reported mercury contamination in rivers and lakes, and some posted warnings or followed the lead of Michigan and Ohio by imposing restrictions on fishing waters.

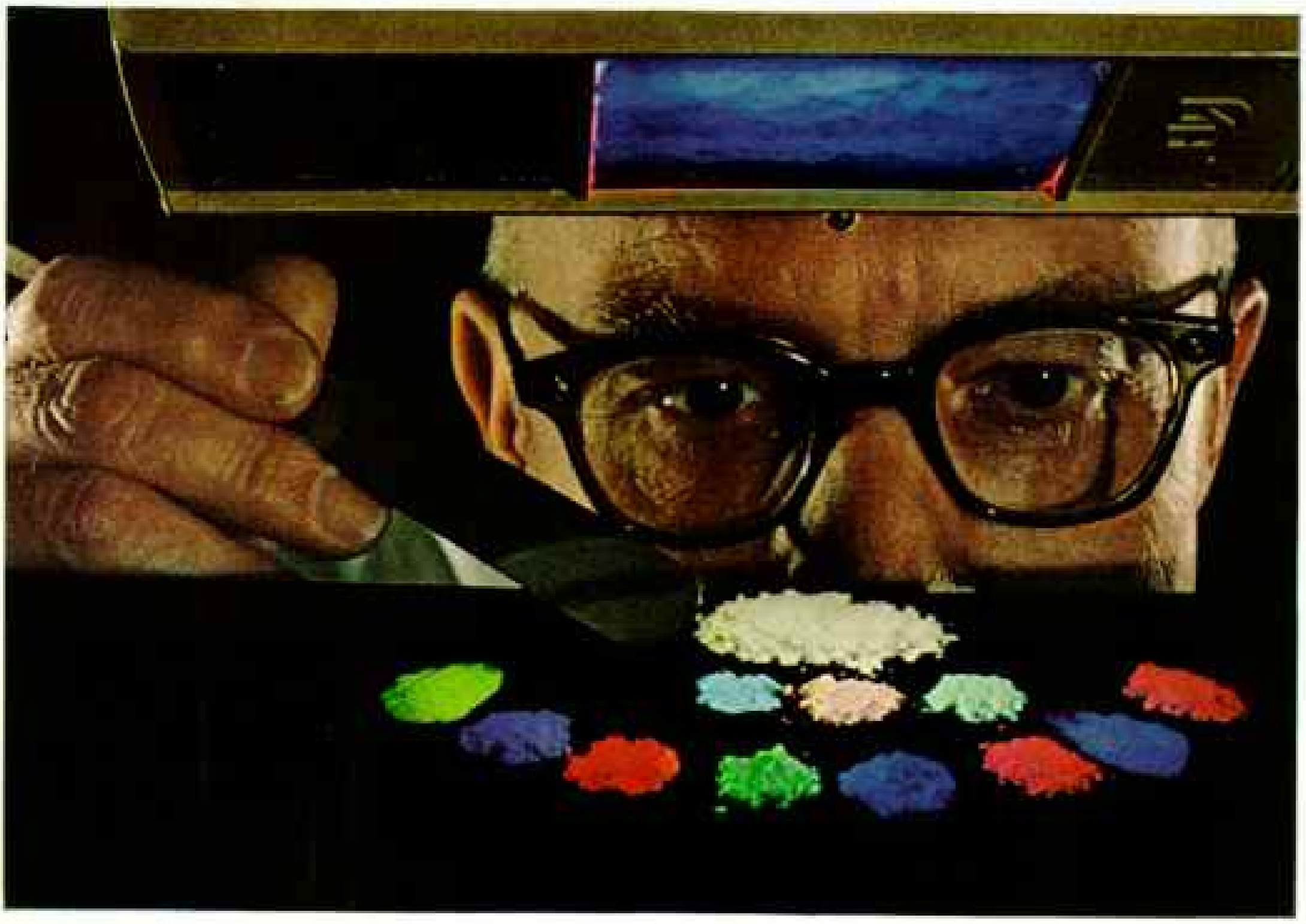
As I traced mercury's trail across the United States, I found heartening evidence that mercury pollution was being reduced—but I also discovered controversy, and the somber fact that we will be living with mercury's evils for a long time to come.

Scientists have estimated that by 1970 chlor-alkali plants alone were releasing more than a million pounds of mercury a year into the environment. Within two months of the government suits, a survey of 50 varied industrial users showed mercury pollution of water reduced by 86 percent.

To find out how one plant had reduced mercury discharges, I flew to Washington State. Dr. Harold H. Houtz welcomed me to the Weyerhaeuser Company's chlor-alkali plant at Longview on the Columbia River.

UNTIRING GENIE, mercury works its magic in many electrical devices, including industrial switches, here aglow in an assembly-line test (**left**). Each glass tube imprisons two or more electrodes and a glob of mercury. The brief blue flash occurs when the tubes are tilted and the mercury flows away from the electrodes, breaking the circuit.

Rainbow of special light-producing compounds called phosphors gleams under a purplish mercury-vapor lamp (**below**). General Electric Company engineers developed the white material at center, a blend of colored phosphors, to coat the inside of fluorescent tubes. Mercury vapor fills such lamps, and produces bluish light and ultraviolet rays when a current passes through it. The phosphor coating transforms the ultraviolet radiation to visible light.



A "captive" plant, it was built to service the corporation's adjoining pulp and paper mill. The chlorine and the alkali (caustic soda) are used to bleach wood pulp.

To manufacture these products, brine is pumped through a series of large cells. A film of mercury coats the bottom of each cell. When a current passes through the brine, it releases sodium by electrolysis. The sodium combines with the mercury, from which it can be recovered by a simple process.

"We employ mercury cells rather than an alternate system because they yield a purer caustic," Dr. Houtz explained. "We needed 7,600 flasks to establish the plant.

"We lost mercury at several stages of the operation. Once we learned that the loss presented an environmental problem, we acted to cut off every path of escape."

He showed me drainage systems rebuilt to prevent plant spills from entering the normal effluent, new devices to remove mercury vapor from gases, and an impoundment area to hold mercury-contaminated sludge removed from the brine as it is recycled.

Results of the cleanup were revealed on an instrument called an Olin Mercury Monitor. Every 12 minutes it automatically measures and records the mercury content of water flowing from the plant's two effluent pipes. The recorder read between 2.5 and 5 parts per billion, a level that would even meet the interim government guidelines for drinking water.

What Else Can Do Mercury's Job?

Other industries may be forced to abandon the use of the element. This year the United States Environmental Protection Agency moved to ban all mercury pesticides used in paints. The industry consumes about 10,000 flasks a year. But mercury will continue to be used by manufacturers of electric lamps, switches, and batteries; and by dentists, laboratory technicians, and others. Few practical substitutes exist, and a government study concluded that these uses of mercury present "minimal hazard."

The problem with these products comes from their disposal after use. They often find their way into a sewage system or incinerator. Burned, the used product releases its mercury into the atmosphere. In sewage it flows into rivers and streams.

Dr. Frank M. D'Itri of Michigan State University's Institute of Water Research told me of other sources of mercury pollution. "I estimate that the burning of coal and other fossil fuels by power plants and other users in the United States could release as much as 1,800 tons of mercury into the air a year.

"One team analyzed samples from the Greenland ice sheet. They found mercury levels in the atmosphere remained stable from 800 B.C. until the 1950's. Since then the levels appear to have doubled—a result, it is believed, of industrial pollution, and a speeding up of the natural escape of gases from the earth's surface as man scrapes and clears land for new roads, homes, and industries."

Since 1970 the EPA has been monitoring industrial pollution. The agency is seeking a total ban on the release of mercury into the Nation's waters, and proposes to restrict mercury losses into the atmosphere.

Some scientists say the agency's limits may be too high—allowing some plants to lose as much as five pounds of mercury into the air every 24 hours. Others, including industrial plant managers, call them impossible to meet.

Tuna Industry Suffered Losses

No one I talked with doubted that methyl mercury poisoning was a threat—Minamata and Sweden proved that—but controversy swirls around just how much mercury is harmful. The answer is simply not known.

I talked with Charles R. Carry, Executive Director of the Tuna Research Foundation, in his office on Terminal Island at San Pedro, California. Outside, the air was sharp with the smell of the sea and of tons of fish being cooked in the surrounding canneries.

"We produce about 22 million cases—some 440 million pounds—of canned tuna a year. About half is caught by American boats, most of the remainder by Japanese, Taiwanese, and South Koreans. When the first scare headlines hit, sales in some areas dropped nearly 40 percent. We've made substantial recoveries, but there are probably some people who will never go back to the product.

"We feel the government's 0.5-parts-per-million guideline is unnecessarily strict, but we are acting to ensure that it is met," Mr. Carry concluded. "We have urged skippers to avoid catching the larger tuna; they seem to run to higher levels of mercury. We've also suggested that they shun certain areas where earlier catches ran above the guideline."

The swordfish industry was hit even harder. Japanese and other foreign fishermen supplied 95 percent of the 26 million pounds of

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the fish consumed each year in the United States. Confronted with the FDA's findings that 95 percent of swordfish run above the guideline, the foreign fishermen have simply stopped sending their fish here.

How does the mercury get into tuna and swordfish? Charles Carry told me: "These fish are caught at sea, far from industrial pollution. The mercury must come from natural sources. Scientists estimate that the oceans hold about 50 million tons of mercury, largely the result of land erosion.

"Tuna and swordfish concentrate this natural mercury. At the top of the food chain, they ingest vast quantities of smaller fish and absorb their mercury."

Pipe-puffing Dr. Vincent P. Guinn, one of a team of scientists at the University of California at Irvine, supported Mr. Carry's views. "We analyzed seven preserved tuna specimens dating from 1878 to 1909, then we compared the results with those from five recently caught.

"Our findings: The old fish averaged 0.95 parts per million, the recently caught fish 0.91. We can only conclude that mercury levels in tuna have not changed appreciably during the past 90 years."

Poison Causes Chromosome Damage

In Washington, D. C., I put these questions to Richard Ronk, who investigated mercury contamination for the Food and Drug Administration. He agreed that in the United States there had been no proven cases of mercury poisoning from eating fish. "But please understand that our job is to prevent this. If we waited until there was an epidemic, we would be derelict. And contamination, man-made or natural, is still contamination.

"In setting the 0.5 guideline, we drew on data from the Japanese and Swedish poisonings. To be safe, an average-size adult should eat no more than two ounces a day of fish that reach the maximum 0.5 limit.

"We have run tests on other fish and foods. The only problem seems to be with the larger tuna, with the swordfish, and with fish from contaminated fresh waters."

Other scientists, worried about the subtle long-term effects of mercury poisoning, feel that even 0.5 parts per million is too much.

A glimpse of these effects may have been provided in a report from researchers at Florida State University. They found that levels of mercury in water as low as one part per million could reduce photosynthesis and growth in phytoplankton—organisms at the very beginning of the aquatic food chain. Other investigations on plants and animals have shown that methyl mercury can cause aberrations in chromosomes—the agents that control heredity in living cells.

"Until suitable techniques are developed to study these effects," an FDA researcher warned, "the only means of protection is to keep exposure to mercury at the lowest possible level."

War on Mercury's Evils Only a Start

The story of mercury pollution is a familiar one: man drawing on future accounts to meet present needs. In Stockholm's Riksmuseet, Dr. Alf Johnels, who had helped spot Sweden's mercury problem, summed it up.

"It was a matter of human failure. We cannot see beyond immediate needs: Mercury did the job, so we used it and trusted the earth to absorb it. Not until people and birds died did we find out how wrong we were.

"If mercury were the only pollutant, that would be one thing. But every day we're pouring into our environment tons of other substances—cadmium, lead, industrial chemicals like the polychlorinated biphenyls called PCB's. Some are stable and will be with us a long time. And we have no idea what their long-term effects will be.

"We who work in museums know about vanishing species—they are here, as always, then one day they are gone. Their environment has changed.

"Only if we think in terms of generations, and are willing to pay the price of keeping the world clean of our own foulings, can we have confidence that man will not join that list of vanishing species.

"With mercury we have made a beginning. Now we must begin on the others." □

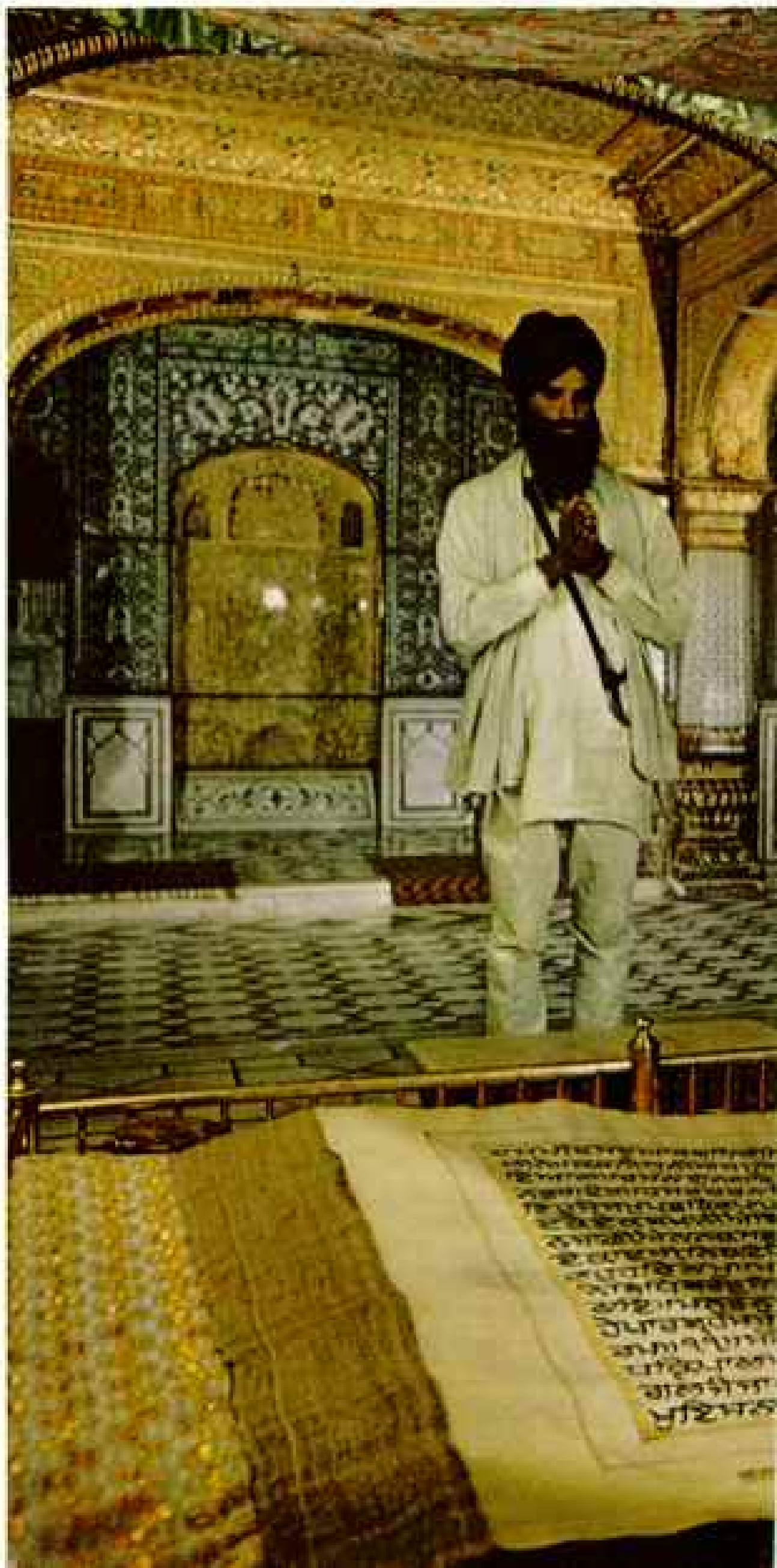
On a company store, signs of hard times: Once the Nation's foremost mercury producer, the Idria, California, mine shut down last April after mercury prices tumbled to a fifth of their former level. Legal restrictions and industry's reduced use of the metal caused the price drop. Most workers left in search of new opportunities; a few, like Nick Esteban, remain in the company town, hoping the mine will reopen or other job offers will come through.

India's Energetic Sikhs

A PALE LEMON SUN squeezed through the shutters of the first-class compartment in the Frontier Mail going north from Bombay to Amritsar and Pathankot. I opened my eyes to the new morning light—and gazed in astonishment at the robust figure on the lower berth opposite.

He was a brawny, black-bearded handsome man, sitting cross-legged and massaging his long black hair, which fell well below his shoulders. He gathered it all up, twirled the ends into a knot on the top of his head, and fastened the knot with a tiny wooden comb.

Then he combed out his curly thick beard. He brushed it vigorously, applied a sticky fixative to it, and adjusted a nylon net around it.



By JOHN E. FRAZER

Photographs by
JAMES P. BLAIR

NATIONAL GEOGRAPHIC PHOTOGRAPHER

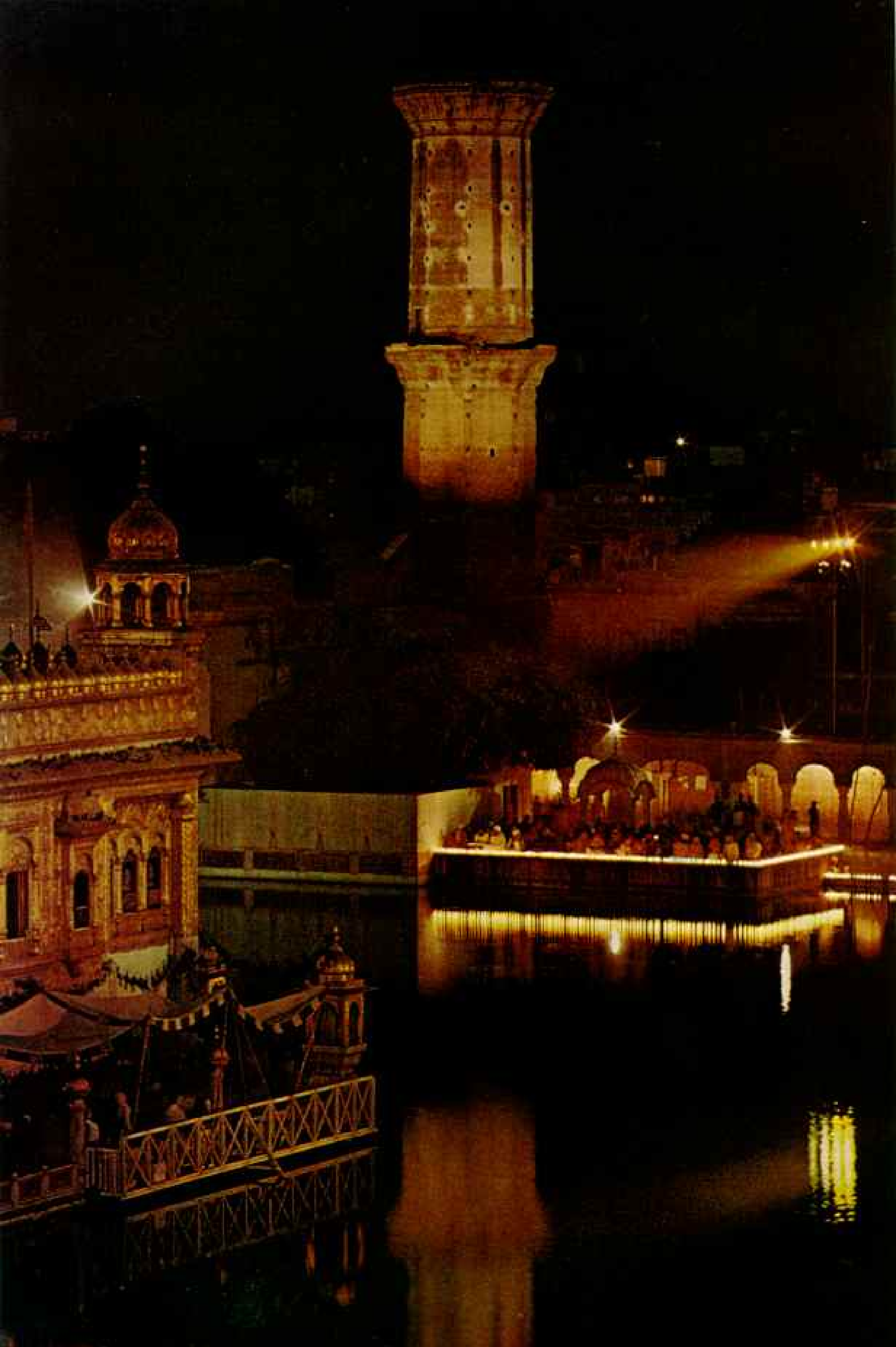
Finally, about his head he wrapped 15 feet of starched maroon cloth to form a turban. I must say he was a most impressive figure when it was all over.

That was my first close-up, years ago, of an authentic type of one of the world's most remarkable people—the Sikhs (from the Sanskrit *shishya*, disciple). There are ten million of them in India, the majority living in the Punjab, the Sikh homeland (map, page 533). Their impact on the nation, which has a total population of 550,000,000, is out of all proportion to their number.

Almost all Sikhs, like my companion on the train, flourish the beard and the dashing turban. I discovered why, not long ago, at the

"There is one God. He is the supreme truth." Thus begins the morning prayer of a Sikh, follower of a religion that blends elements of Islam and Hinduism. Here in the Golden Temple at Amritsar, a worshiper reads a copy of the Guru Granth Sahib, which includes prayers, the wisdom of the Sikh gurus, or teachers, and the writings of Hindu and Moslem saints. Renowned as soldiers, athletes, and farmers, Sikhs are recognized by turban, beard, and steel bangle (**left**).

RISING SERENELY *from its sacred pool, the Golden Temple shimmers in Amritsar, holy city of the Sikhs. Gilded copper and marble studded with gems encase this most famous of Sikh shrines. Celebrants gather to observe the birthday of Guru Nanak, who founded the religion in the 15th century.*



Punjab town of Anandpur in the Siwalik Range of the Himalayas. There, in a brilliant white *gurdwara*, or Sikh temple, I listened to the chilling tale of Guru Gobind Singh (1666-1708) and the "Five Beloved."

Gobind Singh was the tenth and last of the Sikh gurus, or teachers. A poet, a Sanskrit scholar, a huntsman, a warrior, and a deeply religious man, he was also practical. He determined to establish a Sikh brotherhood hardy enough to survive the antagonism of kings and emperors, especially the Mogul Emperor Aurangzeb, who had beheaded Gobind Singh's father, the ninth guru.

"It was during the spring of 1699," said the *granthi*, the gurdwara reader of the scriptures, as we sat on the floor under a ceiling fan. Through the temple window I could look out upon the green Himalayan foothills, a patchwork of sunlight and shadow.

"On this very site," he continued, "Guru Gobind Singh pitched a tent."

Below the tent, on the plains, a throng of Sikhs from the countryside had assembled. Guru Gobind Singh towered before them all —and asked for an incredible sacrifice. Was there a Sikh willing to give up his life, then and there, for the guru?

Five times, said the granthi, Guru Gobind Singh asked this; five times heroic Sikhs responded; five times the grim guru emerged from a tent, his steel sword dripping blood. But he had killed five goats, not Sikhs—and his valiant volunteers, now robed in saffron and garlanded, became the "Five Beloved," the first initiates of the Khalsa, the society of the guru's own.

The Five "K's" Set Sikhs Apart

The vast majority of Sikhs today, I learned, become members of the Khalsa; and all Khalsa members adopt the five "K's," symbols introduced by Guru Gobind Singh. They are *kesha*, the long hair wrapped in a turban; *kanghia*, the wooden or ivory comb; *kachha*, military knee breeches; *kara*, a steel bracelet; and *kirpan*, a sword (nowadays, usually a tiny facsimile inset in the comb). All Khalsa men take the surname Singh—lion—though not all Singhs are Sikhs.

"Gobind Singh wanted a people who could be recognized from afar," said the granthi. But legend says that the guru himself put it more trenchantly: He wanted every Sikh to be brave enough to fight 125,000 foes.

Thus one of the things Sikhs are most famous for is their military prowess—fierce valor in Indian history, outstanding records in the British-trained Indian Army. But they are much more than that.

Today the Sikhs are probably the best farmers in India. They are conspicuous winners in the Indian world of sport. And they still furnish a larger proportion of their population to the Indian armed forces than any other community in the nation.

A Sikh is speaker of India's Lower House of Parliament. A Sikh contractor built the United States Embassy in New Delhi. A Sikh is governor of Rajasthan, and a Sikh is India's foreign minister.

Punjab Thrives on Feuds and Farming

The Sikh lives with more gusto and is more enterprising than most Indians. He drives more recklessly, if that is possible. He is lusty, sometimes arrogant and uncouth, fond of money and of good eating. He has a passionate love of alcohol, but will not smoke.

The Sikh countryman also has a fierce temper. "There is a Punjabi proverb," my friend and interpreter Jaswant Singh, of the Punjab state government, told me, "that a Sikh farmer is usually in jail or in the law courts."

Feuds over land, women, water rights, or an insult linger bitterly for decades.

The Punjab is farm country, one of the world's most heavily irrigated regions, and 80 percent of Punjab farmers are Sikhs. In India they lead what has become known throughout the East as the "Green Revolution."

One hot premonsoon day, I went with Jaswant Singh to the village of Chotala near Tarn Taran to see the Green Revolution in progress. The *sarpanch*, or headman, is Gurdip Singh, about 30—handsome but somewhat forbidding, with a revolver in a holster under his arm and a shotgun over his shoulder.

"A village feud," whispered an official. "He must protect himself."

Gurdip invited us into his new six-room concrete house, and, as we drank tea, he explained: "I own 15 acres and I plant two crops a year—wheat and maize. With the old seeds, five years ago, I harvested 10 maunds of wheat an acre. Now I plant the new dwarf varieties of wheat, and this year I harvested about 33 maunds an acre."

At a fraction more than 82 pounds to the maund, that is roughly 2,700 pounds, compared to the average wheat yield of about 2,000 pounds an acre in the United States.

Not far from Gurdip's farm, along the Grand Trunk Road, I had further striking evidence of the Sikh farmers' new prosperity. We clipped past Sikh after Sikh at the wheel of India's shining new status symbol, the tractor. There are more tractors now in Punjab than in any other state of India.

Better known to the world than Punjab's role in the Green Revolution are the tragic events that preceded it 25 years ago. In 1947 India became free, but at a price—the partition of the country into India and Pakistan. In northern India the Punjab bore the brunt of the split. The eastern segment, about 38 percent of the old Punjab province, remained with India, while the western segment, about 62 percent, joined Pakistan.

Hindus and Sikhs in Pakistan moved to India, and Moslems in India went to Pakistan. More than ten million people exchanged countries. The refugees came afoot, by horseback, in carts, by train. No one knows how many thousands of Sikhs, Hindus, and Moslems were murdered when peaceful villagers, enraged by tales of violence, themselves became violent. Soldiers looted. Police looked on.

Women Carried Poison as a Last Resort

I talked in New Delhi with Capt. Ude Singh Dhillon, a lean, straight-backed Sikh of 69 who led a caravan of his people from Pakistan to India. The caravan was 17 miles long, and in it were 150,000 persons, 5,000 bullock carts, 2,000 horses, and 200 camels.

"We would start marching at 4:00 a.m.," Captain Dhillon told me, "and cover about fourteen miles a day, and we walked for ten or eleven days. We were organized by villages —at the end of the day a village leader would ride up and report to me on the progress of his village. We were attacked, but not often—we had guns, and at every encounter we retaliated. The younger women carried poison. 'If we are caught,' they said, 'we will kill ourselves.' About 200 people died on the march, mostly men, most from heart failure.

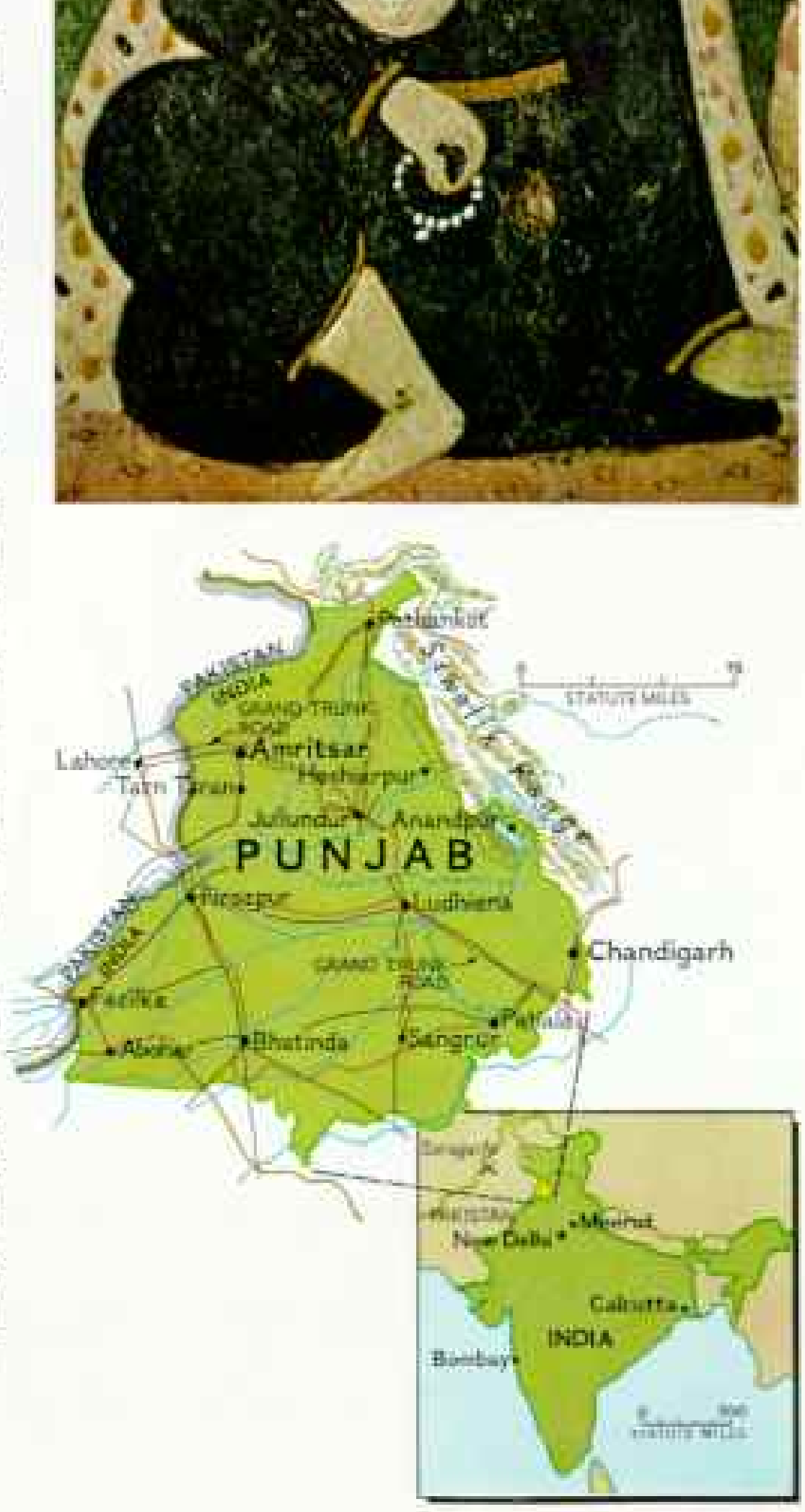
"When we got to India people asked, 'What do we do now?' I said, 'I don't know myself.' "

What *did* they do?

They went to the cities, and, being Sikhs, they found work. An American in Bihar told me, "The Sikhs here who had been uprooted from Pakistan were selling lace and buttons and grain on the sidewalks 20 years ago. Now they own buildings, and they are the backbone of the transportation industry."

India's Energetic Sikhs

Martin Luther of the East, the Hindu Nanak sought reformation of his faith, but unlike his German contemporary, he went on to create a new religion. Wandering throughout India in quest of followers, Nanak found most of them in the north. Even today the majority of the nation's ten million Sikhs live in Punjab.



And on the farmlands of Punjab an administrative reform gave the Sikhs and the Hindus a new start. Acre by acre, the state consolidated land holdings that, over the centuries, had been fragmented. Some were too narrow to allow a bullock to turn while plowing. Then the land was redivided into larger properties, on which some 400,000 to 500,000 families were settled.

The slaughter of Hindus and Moslems during the great migration between India and Pakistan would have horrified the founder of the Sikh religion. Hindu-born Guru Nanak (1469-1539), a gentle teacher and poet, heard the call of God and declared, "There is no Hindu, there is no Moslem"—that is, in God's sight all are equal.

Sikhs today believe that God is one, and formless; they reject the Hindu pantheon of gods; they reject asceticism, fasting, and vegetarianism, though most of them, like the majority of Hindus, will not eat beef. They believe, as Hindus do, in the transmigration of souls and in karma (destiny); and, like Christians, they believe in God's grace, in a revealed scripture, and in prayer.

Food Breaks the Caste Barrier

In principle, Sikhs reject caste, which is still a vital part of the Hindu system despite laws that modify its practice. Yet the majority of early Sikhs were converts from Hinduism, and, as with Hindus, the old caste ways still cling. Each of the three basic divisions of the Sikhs—Jats, non-Jats, and untouchables—lives behind boundaries that the others cross with difficulty. But change occurs.

The distinctions of caste fade away in the *guru-ka-langar*, the "kitchen of the guru," which is part of every gurdwara. At the impressive Golden Temple in Amritsar, the holiest of all Sikh gurdwaras (pages 530-31), during the celebrations of the five-hundredth anniversary of Guru Nanak's birth, I watched as 50,000 Indians were fed in one afternoon from the open-air langar.

Sikh and non-Sikh, regardless of caste, income, social rank, or political power, all sat down in rows and ate together. They were carrying out the wishes of Guru Nanak, who established the kitchen not so much to feed the hungry as to abolish caste and teach men humility before each other.

The fare at Amritsar, though suitably humble, was abundant. Sikh *sewadars*—helpers—carried tons of wheat, potatoes, cereal, and *halwa*—a sweet—from huge iron caldrons to serve all comers on leaf plates. "Most of these provisions," said my friend Jaswant Singh, "are from donors, and they come by the cartload from villages. The cooking and serving are all done by volunteers."

Book Takes Place of Human Leader

After the birthday celebration, I inspected the Golden Temple at leisure. There is a Sikh prayer that implores God for an "unhampered dip" in the sacred pool that surrounds the temple; this is a reference to times past when kings forbade worship at Amritsar, with a penalty of death for disobedience. Sikhs came to pray anyway, and many were slain.

During the 18th century, Afghan invaders blew up the temple several times. The sacred pool was desecrated by debris and by the bones of men and cows.

No shoes are worn in a gurdwara; shoe leather is ceremonially unclean to Sikhs. Visitors may wear socks into the temple precincts, if they have never been used before, or they may go barefoot after washing at the entrance. I wore socks. Jaswant Singh and Narinderjit Singh, Curator of the Central Sikh Museum and Information Officer of the Golden Temple, went barefoot.

A head covering is mandatory, and so, as we went in the north entrance of the temple grounds, I knotted the four corners of my handkerchief and placed it on my head. Then we moved past tall Sikhs in blue turbans and blue tunics, swords at the waist, went down two short flights of stairs, and emerged into the fierce light of a Punjab noonday sky.

There, shining before us, lay the hallowed pool, and placed in the middle of it, its gold leaf reflected in the water, was the resplendent Golden Temple.

The sunken pool is about 500 feet square, and is bound by a pavement of white and black marble. "Let us take our walk around

Eyes sparkling, a Sikh boy offers a shy greeting. Like most male members of his faith, he bears the name Singh, Hindi for lion. Sikh schools teach three languages—Punjabi, Hindi, and English—and instill the special pride of the faith into the next generation.

Shocks of straw signal harvesttime in India's Punjab, where a new wheat variety has more than doubled the yield per acre in the past ten years. Production in 1972 gave the nation her first grain surplus in history. Energetic and innovative, Sikh farmers were among the first Indians to plant the hybrid seed.

Odd yokemates, camels and bullocks power the plows of these Sikhs in the southwestern part of Punjab. The farmers know that camels would rather fight than plow if hitched together.

Sikh's pride, a tractor pulls a wagon loaded with men spreading decomposed corn stalks to fertilize a radish field. Notorious throughout India for their intrepid driving of trucks and taxicabs, Sikhs delight in any mechanical vehicle.

the pool," said Narinderjit Singh, and we began the *parikarma*, the "clockwise circumambulation." Ahead of us, beside us, and behind us bare feet shuffled lightly. A bather dipped, and emerged to shake water from his head, and an old man unrolled a reed mat and lay down against a wall to sleep.

In a Sikh gurdwara there are no images, altar, or pulpit. The object of Sikh reverence is the scripture itself, the Guru Granth Sahib, and Sikhs bow before it, walk around it, and, if they wish, sit on the floor to listen to the *ragis*, or singers, proclaim verses from its sacred pages.

We walked across the marble causeway that connects the Golden Temple to the west pavement; at the temple door Jaswant Singh and Narinderjit Singh knelt and touched their foreheads to the sill. The Granth Sahib was not far inside the door, on a dais under a canopy studded with jewels.

This sacred book is today the focus of the Sikh faith. In 1708 when Gobind Singh, the last Sikh guru, was near death, he summoned the leaders of the Khalsa to him and declared that the Granth Sahib—rather than an individual—would be the Sikh guru after him. Gurushiip, henceforth, was to be invested in the scriptures.

The book contains about 6,000 verses in several languages, on 1,430 pages. It includes writings not only of some Sikh gurus, but also of Hindu and Moslem bards and saints; Gobind Singh's writings are compiled in a separate volume—the Dasam Granth.

Persistence Rewards a Patriarch

Despite the acceptance of some Hindu ideas in their scriptures, most Sikhs are wary of Hinduism. Master Tara Singh, the wily patriarch who worked for political control of a new, shrunken Punjab for the Sikhs by a long campaign of nonviolence, said, "Hindus want to absorb us. We want to stay Sikhs."

He cajoled, threatened, pleaded, marched, and suffered to win a "Punjabi-speaking"—that is, a Sikh—state carved out of Punjab. But India resisted. Demonstrators were put

Shower of marigolds greets a Sikh and his bride as they take the traditional four turns about the sacred book. The bride holds her husband's flowing scarf, signifying their union. Even today among Sikhs and other Indians, parents play matchmaker, often advertising or asking friends for help in finding a suitable spouse.

in jail. Tara Singh was imprisoned nine times. Finally, in 1966, India's Parliament yielded, and a new Punjab came into existence, which Sikhs (the majority of the state population) ruled for the next five years.

"But we win, and then we quarrel," a Sikh said to me in frustration. In June 1971, bitter factional disputes ended in the resignation of the government. Punjab today is run not by the Sikh majority but by the Congress Party, put in office in the stormy March 1972 elections. That party is headed, of course, by Mrs. Indira Gandhi, India's Prime Minister.

Give a Sikh a Car He Can Drive

Whatever the vicissitudes in the political life of a Sikh, his private life is characterized by unquenchable vitality, and he tends to choose the more energetic occupations.

There are 300,000 trucks in India and 80,000 buses; half (almost 100 percent in Punjab) are owned by Sikhs and more than half are driven by Sikhs. Knowing the Sikh's "warrior-caste mentality," you scuttle willy-nilly when a truck roars down on you, for a truck will never get out of *your* way. "There is no death more noble to a Sikh truck driver," said a caustic friend, "than self-destruction on the Grand Trunk Road."

Sikhs also monopolize large sectors of India's taxicab business—notably in Calcutta, where there are 5,000 taxis, and in Delhi, which has 3,750. Sikh taxi drivers (or, to be fair, some of them) have their own rules of the road. The Sikh plays an Indian version of "chicken." Having achieved a brisk forward speed, he adjusts his turban with both hands. Without slackening, he gazes over his shoulder at fellow Sikhs at taxi stands to see whether he knows anyone. He waves. But even *he* dodges trucks. Only the fortunate survive.

Onkar Singh Barail, a graduate with a B.Sc. degree in physics and chemistry, runs a taxi stand part time in partnership with his brother. There are about 200 taxi stands in Delhi, most of them with a telephone. You ring up, day or night, and a cab arrives—an admirable system. Two or more drivers sleep each night at Onkar's stand, on *charpois*, wooden cots strung with webbing of jute or cotton. "Men without a family take turns sleeping here," said Onkar.

"We have eight drivers," he continued, "six are relatives. A Sikh family naturally supports its relatives."

"Yes, but how is it," I asked, "that so many Sikhs seem to wind up in the taxi business?"

"I think my father was responsible for most of the Sikh taxi drivers in Delhi," was Onkar's surprising answer. "Sixty years ago he was a police sergeant. He started a stand on the side, and he put members of his family on other stands around the city, and they put members of their families on other stands."

The qualities that make Sikhs India's doughtiest cabdrivers also enter into their supremacy among Indian sportsmen. Twelve of India's 18-man field-hockey squad in the 1964 Tokyo Olympic Games were Sikhs, and nine out of the 17-man squad in the 1968 Olympics at Mexico City. Golf, track, tennis, wrestling, and mountaineering also are Sikh sports. Of the nine Indians who climbed Mount Everest in 1965, three were Sikhs.

The preeminent Sikh profession, of course, is soldiering. "There are no finer fighting men in our Indian Army," wrote Brigadier Sir John Smyth in the days of the British rule in India. Afghans, Persians, Moguls, Pathans, the Turks at Gallipoli, the Italians, the Japanese in Burma, the Chinese in the Himalayas, and the Pakistanis—all can testify to Sikh valor.

Gallant Stand Made at Saragarhi

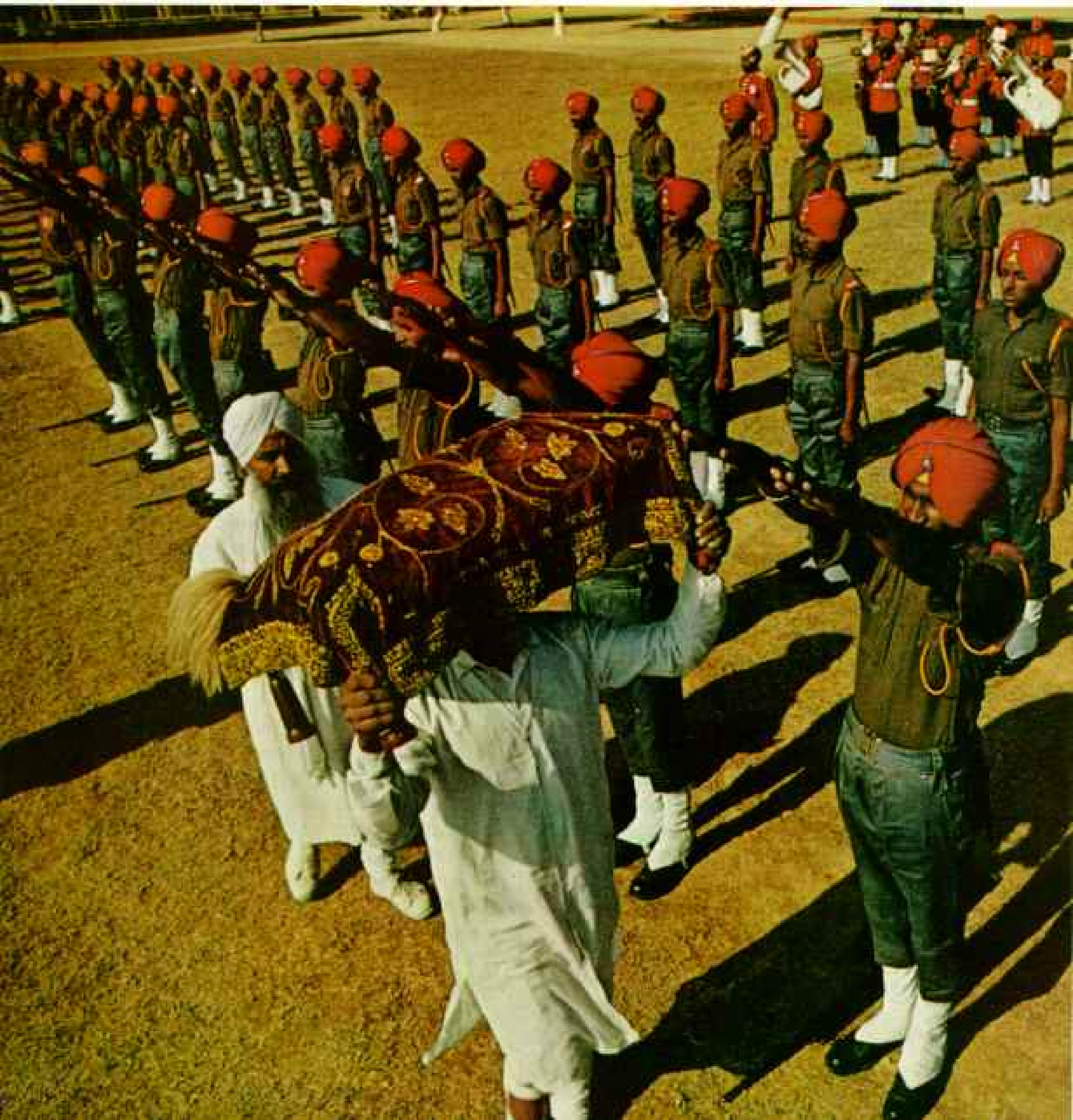
At Meerut, in Uttar Pradesh, I visited the Sikh Regimental Centre, training ground for the famed Sikh Regiment. The commander, Col. Gurbakhsh Singh, told me proudly, "We have the largest collection of Victoria Crosses, or the equivalent, in the country."

So that I would understand why, Col. Gurbakhsh Singh recounted the epic story of Saragarhi, a small outpost on the Samana Ridge in northwest British India. Twenty-one Sikhs manned the post, and on September 10, 1897, Orakzai tribesmen began to assemble for an attack. By September 12 they numbered 10,000.

Fighting broke out early in the morning of the 12th. The enemy stormed the walls, set fire to the post, and called for surrender. The 21 Sikhs refused. No reinforcements could approach the outpost—and 20 Sikhs were killed. Then the signaler, Sepoy Gurmukh Singh, the last man alive, signaled the headquarters, "They are getting in now. Shall I take a rifle or go on signaling?" He received his orders, picked up a rifle, and fought—and he too was killed.

September 12, since that time, has been a ceremonial holiday for all Sikh regiments. Sikh soldiers and officers alike are imbued

Martial heritage stiffens the backbones of these new members of India's Sikh Regiment (**below**). After touching the national flag in a pledge of loyalty to the constitution of India, raised hands here touch the passing Granth Sahib in a similar pledge. Cpl. Joginder Singh (**right**) shouts a command at the parade of new soldiers, proud to be a part of one of the most decorated regiments in the world.



with the Saragarhi spirit. So, at heart, are the Sikh people.

As I came to the close of my tour of the country of the Sikhs, I thought I knew where the Sikhs had been and where they are today. But where are they going?

That very question also agitates the Sikhs of India, and their chief worry is the state of Sikh politics. "It is our misfortune that politics and religion have never been separated," said Kunwar Mohinder Singh Bedi, a Sikh poet, sportsman, and retired government official. But to many Sikhs the two are inseparable. Religion united them as Sikhs, and they vote as Sikhs.

They do not vote as one party, however, but as two or more parties. Thus charges are hurled, and the Sikh community suffers. And when, as in Punjab lately, corruption is said to flourish in government, all Sikhs get a bad name. Moreover, party politics affects the gurdwaras. An elected administrative board rules the Sikh shrines, and campaigns are conducted like political battles, with all the usual bickering and flamboyant vote-seeking. Charges of corruption are also heard in the gurdwaras, and sometimes drastic action is taken.

Driving past a newspaper office in New Delhi one day, I read a flash report: ARMED SIKHS OCCUPY SISGANJ GURDWARA.

"How many Sikhs are inside?" I asked the armed and helmeted police guarding the famous temple that afternoon.

"About two hundred."

Actually there were 40. They had seized the temple at two o'clock in the morning, had locked the gates, and had forbidden anyone to enter.

"We tried everything possible to stop corruption," I was told later by Nirlep Kaur, the gentle but firm-handed woman who led the confrontation. "The only way left was force."

Now the Government of India has taken charge of the gurdwara until Sikh control can be established on a new basis—but it is a trying time for Sikhs.

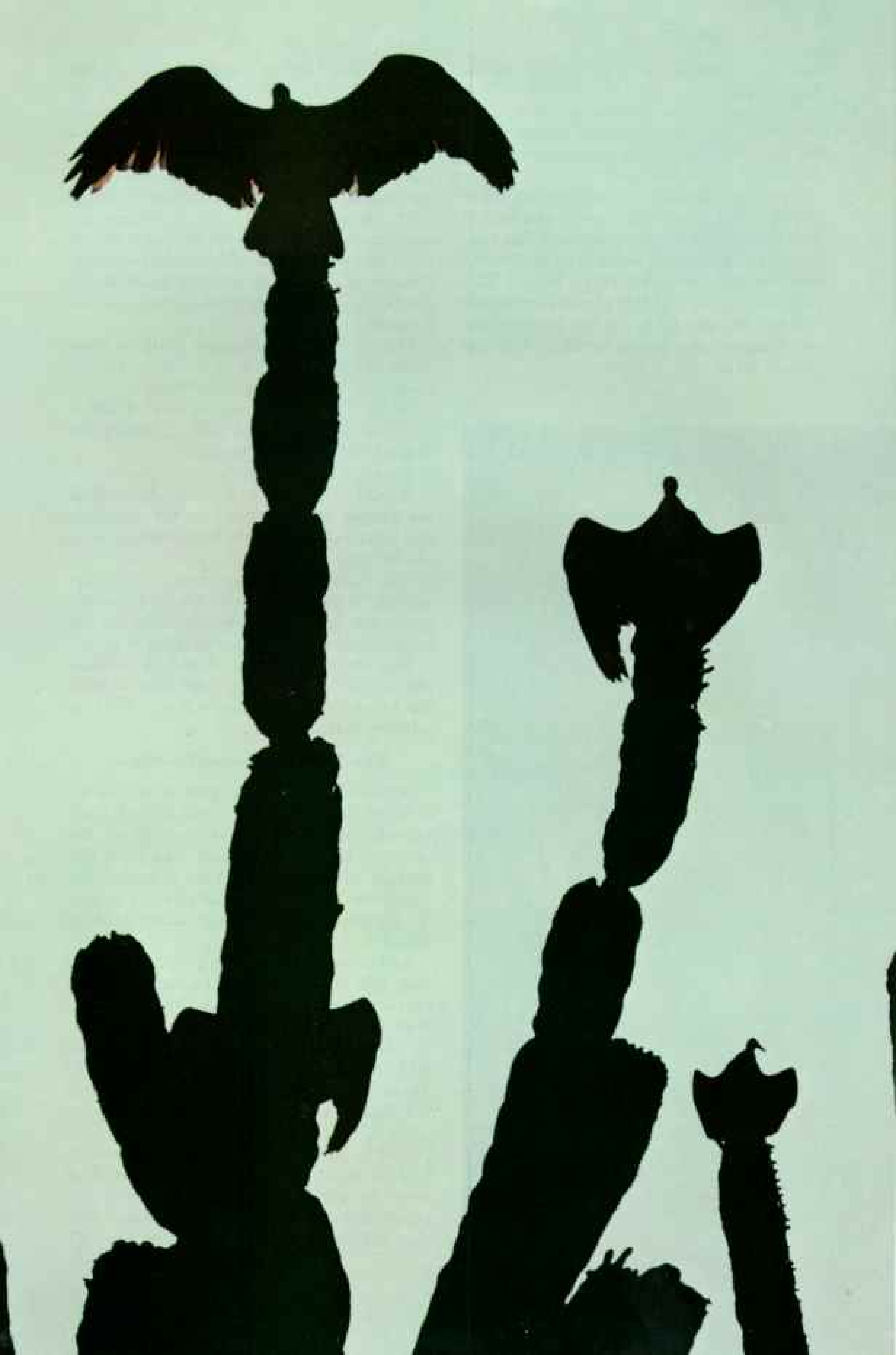
New Trends Endanger Traditions

A second cause for concern is loss of interest in Sikhism. A Sikh goes abroad, finds himself "different," shaves, and breaks the ties with home. The affluent Sikh finds less time for religion. Youths angry at corruption, uninformed about Sikh traditions, or stirred by Communists (who are active among Sikhs) may turn elsewhere.

And there is always the possibility of an easy slip into Hinduism. Perhaps an even graver danger, according to Dr. Man Singh Nirankari, a retired Amritsar eye surgeon, "is the tendency to stress the symbols of Sikhism rather than the spirit of the faith. There is revulsion if a Sikh cuts his beard, but not at a failure of character.

"Still," he said, "I am optimistic."

And though I am an outsider, I too am optimistic about the future of the Sikhs. The problems are very real, but the Sikhs are proud of their history and their religion, and they will not lightly let Sikhism decline. □



Baja California's Rugged Outback

ARTICLE AND PHOTOGRAPHS BY
MICHAEL E. LONG
NATIONAL GEOGRAPHIC STAFF

HIS NAME was Francisco Arámburo, and he was a serene and thoughtful man, a seller of books in his native city of La Paz. He had brought me to the dunes that rim the Bay of La Paz, to a place where, in his words, "the desert meets the sea." We stood together in the growing dusk.

"When I was a student on the Mexican mainland," he said, "my friends made fun of me and called me *beduino*—one who lives in the desert. They talked of cactus and sand as if these were things to be ashamed of. Many of them thought La Paz was in Bolivia.

"So did the people at the post office," he added, with a wry smile. "Sometimes they sent our mail there.

"But we Baja Californians are proud of our desert and our isolation. I have been to other places, to Paris, London, Rome. Once I was in Grand Central Station

Living totem poles—cactuses capped by vultures—bespeak the "real" Baja California, the sea-girt peninsula that lies beyond Tijuana's bright lights. Once the domain of soldier, missionary, and miner, Baja's wilderness today draws adventurous visitors who succumb to the lure of a sere and unspoiled land.

during rush hour—I went to a restaurant until things calmed down.

"And your Las Vegas. It's like a cold shower. It makes the blood circulate, but you cannot stay in the shower forever.

"Look," he said. Across the bay, La Paz was a thin line of lights near mountains limned by a rising moon. With gentle strokes, water caressed the sand at our feet. Somewhere a seabird piped.

"This is the sensation of Baja," Francisco said. "Here we do not sell noises or neon signs. We have a different merchandise—solitude, sun, peace, pure air."

Rough Road Threads an Empty Land

I was in the mood for such "merchandise," after my unconventional journey here. With a colleague, Dick Lehman, I had driven the grueling Mexican 1000 (pages 569-575). The race had taken us from the city of Ensenada, below the United States-Mexico border, to La Paz, near Baja California's southern tip.

With that wild and memorable adventure behind me, but with almost no impression of Baja other than of sand, salt flats, and boulder-strewn gullies, I determined to take my time driving northward. I wanted to explore out-of-the-way places in this haunting land that few outsiders ever come to know.

A slender spur of land, Baja, or Lower, California juts southeastward from the United States along Mexico's Pacific coast (map, next page). Administratively, the peninsula is divided into the State of Baja California in the north, with its capital in Mexicali, and the Territory of Baja California Sur (south), with La Paz as its capital.

The land is arid, mountainous, and thinly populated; most of its million or so inhabitants live in coastal towns or in the border cities of Tijuana and Mexicali. Except for an estimated 40,000 residents in scattered oases, the rugged interior is unoccupied. One can drive an entire day there and see only a handful of people—a trucker hauling gasoline, a brace of cowboys seeking roaming stock, an occasional intrepid tourist.

Colonized by Jesuit missionaries after the Spanish conquest of Mexico, Baja California remains today much as it was then—unspoiled, mysterious, remote. The reason is the "Road," a forbidding route, until recently largely unpaved, that runs the length of the peninsula and that has long discouraged all but the most determined travelers. Now the old road is passing.

The Mexican Government has built an asphalt highway from Cabo San Lucas, in the extreme south, 420 miles to the gulfside town of Santa Rosalía. In 1968 a four-lane roadway was completed between Tijuana and Ensenada. Two lanes reach 97 miles farther south to Camalú. Crews work steadily to finish the 1,000-mile highway by December 1973.

"There is a Mexican saying," an official told me, "that if you open a highway, you open the whole world. We expect an explosion of tourists when our highway is completed."

An explosion they will surely get. Increasing numbers of visitors already stream south from the United States by land, sea, and air. But until the highway is finished, those who dare Baja's rocky midriff are advised to have sturdy vehicles, plenty of spare parts, and supple backbones.

After the Race, a Slow-paced Return

My own vehicle was a Volkswagen, armored against the hazards of the still-unforgiving road. The car had a skid plate under the engine, heavy-duty shock absorbers and clutch, and oversize tires. The engine's air intake was in the passenger compartment, which was reasonably free of dust.

I had christened the car "Boojum," after Baja's bizarre polelike tree (page 558). A boy in Ensenada had his own name for Boojum: "sond boggee"—sand buggy.

Having experienced Baja swiftly, and by the seat of my pants, I now planned a leisurely route south from La Paz to Cabo San Lucas, and from there up the peninsula's outback to Ensenada. Enrique (Quique) Hambleton, a young Mexican educated in the United States, would join me as interpreter.

Before setting out, I savored Francisco

"**The shark lunged at me,** but I knocked him on the nose with an oyster basket." A battered diving helmet on his knee, 79-year-old Salomé León reminisces about his days as a diver. Pearling was once the principal industry of La Paz, major city of southern Baja, but it ended when an unknown ailment killed the oysters in the 1940's. Salomé, like many others, turned to fishing.

Gnarled finger of land, Baja California split from the mainland millions of years ago, creating a wilderness of pitched mountains and forbidding deserts. Legions of truck drivers carved the Baja Road; now, each November, racers challenge it for fun (following article, pages 569-575). Sections of a new paved highway, poking south from Tijuana and north from Cabo San Lucas, should link up by December 1973. Tongue of the sea (**right**) laps Balandra Beach, one of many coves in Baja's more than 2,000 miles of coastline.

Genus Volkswagen, species "Baja Bug," the author's car churns through sand as fine as flour. The vehicle had oversize tires, reinforced suspension, and a skid plate to shield vital underparts. Yet the Baja Road exacted its price: four broken shock absorbers and three ruined axle bearings.

Gritty smile gleams from beneath the moustache of Mike Nielson during his first trip to Baja. One of a hardy band who delight in their own discomfort, he threaded the peninsula in an open jeep.

Arámburo's beloved La Paz. Throughout the city sprays of bougainvillea drooped over houses painted in gay pastels. Shops, offering duty-free bargains in watches, tape recorders, and perfumes, closed at one o'clock to reopen lazily at four or later.

La Paz—the City of Peace—was once the city of pearls. From the time of Cortés, divers roamed the shallow coastal waters seeking pearl-bearing oysters. In the 1940's a mysterious ailment killed the oysters, and most of the divers became fishermen. One of these was Salomé León, a man with a broad chest and quick gestures that belie his 79 years. Quique and I called on him at his red brick house on a quiet side street.

"Don't think we made a lot of money diving," Salomé told me, shaking his finger. "We had to bring up thousands of oysters just to get one with a pearl in it. Once I found an 11-carat pearl—it was perfect, as green as a palm leaf. The buyer gave me 1,500 pesos, a cow, 90 kilos of sugar, and a sack of beans. The cow was fat and pretty, but she didn't have any calves, so we ate her."

As he talked, Salomé's wife, a handsome, sturdy woman, stood smiling shyly and nodding her head, her arms folded above an immaculately white apron. She offered not a word, but remained unobtrusive throughout our visit.

Later, with Salomé as guide, we drove 54

miles over the mountains behind La Paz to his fishing camp. As we bumped along—the road was bad, though bearable—Salomé told me how weary he used to grow walking the route years ago, when it was just a trail. "When I got to La Paz, even the hat on my head was too much weight," he sighed.

At Bahia de la Ventana we passed several fishermen's houses. "I had 21 children," Salomé said. "Of the ten boys, all except one became fishermen. These are their homes and this is my village." He drew himself erect. "I am *el Fundador*—the Founder." Hordes of grandchildren looked on as he showed me his diving helmet, dented and green with the patina of the sea (page 544).

"The divers used to bump heads underwater," Salomé explained. "We could speak to each other when our helmets touched. It was a great pleasure to search for oysters. When I found a lot of them, I would sing and whistle in my helmet."

Salomé's sons mended their nets on the beach. An afternoon breeze frothed the surface of the gulf. "Here I am happy," said Salomé, his graying hair ruffled by the wind. "And remember"—the finger shook again—"I still fish six days a week, at my age!"

Fishing ground for Salomé and many of his countrymen, the Gulf of California was created millions of years ago, when Baja split away from mainland Mexico. Cracking

along the San Andreas Fault, the borning peninsula began a slow northwesterly drift, shedding great chunks of rock, which became islands as Pacific water flowed in.

On these islands life has evolved in unusual ways. In 1953 a rattleless rattlesnake, *Crotalus catalinensis*, was discovered on Santa Catalina. Here, too, barrel cactuses—giants of the species—grow ten feet tall.

At Cabo San Lucas, where Baja finally succumbs to the sea, fly-in tourists relaxed at the fortresslike Hotel Finisterra, perched improbably on a high ridge of granite rocks (page 555). In the lee of these rocks English pirates once waited to prey on Spanish galleons. Now yachts swung lazily offshore.

Restless Wanderers Once Roamed Baja

I walked the beach where Pacific rollers plumed, in contrast to the placid gulf waters a few hundred yards away. On the sand bikini-clad bathers sunned, and beyond the breakers a solitary whale cruised northward. I climbed to the hotel, pausing now and then because of the steep steps. I counted them—186. Topside, I asked a balding guest how often he had climbed them.

"Four times," he replied wearily. "The first time, the last time, never again, and don't mention it!"

Baja California is all but surrounded by water, yet the peninsula's rainfall is meager: one to three inches annually in desert areas. Crossing the parched and forbidding crags of the Sierra de la Giganta, Quique and I dipped down to the community of Loreto. Here in 1697 the Jesuit Juan María Salvatierra landed to found the first mission—and the first permanent European settlement—in Lower California. Enduring hunger, drought, and sporadic Indian attacks, the Jesuits established 18 missions in Baja.

The Indians were wanderers who spent their lives searching for food. Of riches or architecture they had none, though paintings in mid-peninsula caves (page 559) suggest their forebears had leisure enough for artistic pursuits.

The "black robes," as the Jesuits called themselves, described the Indians as childlike, simple, and devilish. The Indians would often taunt the priests when the latter made mistakes in the Indian tongue. On one such occasion the missionary Juan de Ugarte, a man of great strength, hoisted a disrespectful member of his flock by the hair and shook

Determined diver, a brown pelican plummets toward a fish dinner (**facing page**). Ocean-borne DDT threatens the survival of pelicans nesting on islands off Baja's northwest shore. Even with new controls, it will take years to rid the environment of the persistent chemical.

Leaping for freedom, a striped marlin fights to shake loose a hook.

Day comes to a golden end in La Paz, veiled by desert dust. The Bay of La Paz glistens beyond the bell towers of Our Lady of Guadalupe Church (**following pages**).

him several times. Afterward, a Jesuit historian reported, the man and his companions remained "quiet and attentive."

Most of the churches founded by the Jesuits are today bare and ruined shells. Some have vanished without trace. But San Javier—named for St. Francis Xavier, one of the first Jesuits—still stands, a somber centerpiece in a sheer canyon 22 miles southwest of Loreto.

At the three-day fiesta of San Javier, I found the pious mingled with the profane. Inside the church, Padre Modesto Sanchez Mayon, bent with the weight of his 75 years, baptized and heard confessions. Outside, vendors hawked their wares and young people danced. I was startled to hear the "Pennsylvania Polka." Men drank beer in a tented bar erected a seemly distance from the church.

Next morning the dance floor was deserted, the bar empty, and the church full. After Mass, six men emerged, bearing a statue of San Javier on their shoulders, followed by solemn-faced worshipers. From time to time the bearers paused and eager hands reached up to attach peso notes to the saint's garments.

Farmer Antonio Navarro explained, "I promised San Javier I would give the church 100 pesos—that is eight of your dollars—if he would bring us rain. And"—Señor Navarro reverently removed his hat—"four days later we got lots of rain. I came 160 kilometers to pay the money."

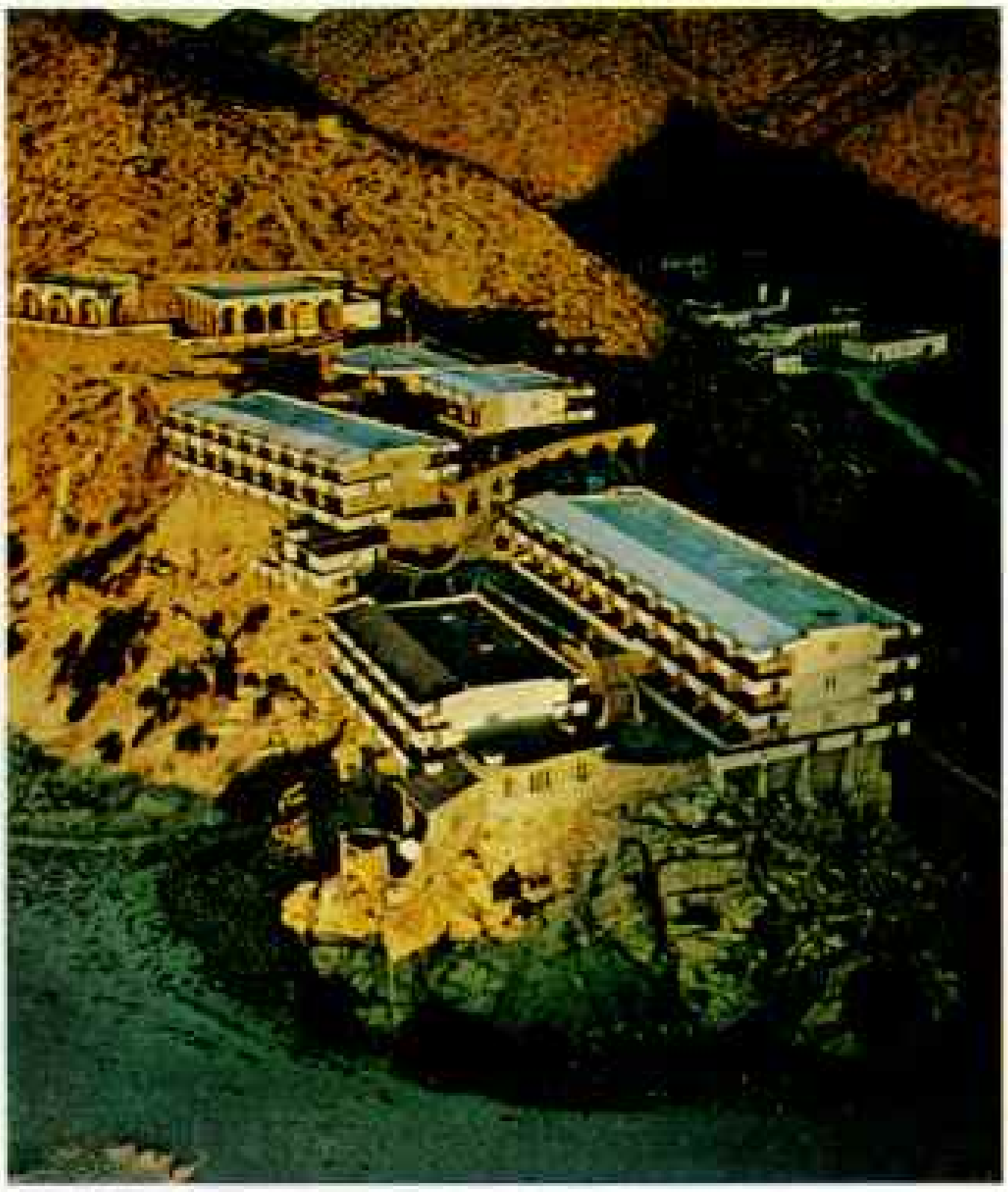
Another man, rotund and serious, offered no money when the procession passed him. "They believe in miracles," he told me. "Myself, I have never asked San Javier for anything." He paused and smiled. "And San Javier has never done anything for me."

When the fiesta was over, Boojum refused to budge. Someone had removed a spring attached to the carburetor. A rubber band proved an adequate substitute and lasted more than 300 miles.

Lottery Winnings Do God's Work

On the way back to Loreto, Quique and I sought shade at a little ranch. There, three sisters of the de los Santos family were *domingueando*—Sundaying—which is to say, relaxing. Loreto, Rosario, and Jovita—two spinsters and a widow—welcomed us. I noted that an extra place had been set at their humble table. Soon Padre Modesto arrived in a vintage truck, and the sisters invited him to lunch. The good father declined.

"I have a baptism in Loreto," he explained.



After centuries of isolation, the city of La Paz **(far left)** is now connected to the mainland by planes and ferries. Jets fly daily to Tijuana and Los Angeles. "Around the turn of the century," said a resident, "it was easier to go to Hamburg or San Francisco by boat, than to Mexico City by road."

Hotel on the rocks, the Finisterra **(left)** sits atop a jagged promontory at Cabo San Lucas, Baja's southern tip. Newest of the cape's luxurious resorts, the hostelry, whose name means "Land's End," was built of granite quarried from nearby hills. Some visitors arrive in their own yachts, after sailing along Baja's west coast. Others come to the hotel's airstrip in light planes.

"But you must stay," Rosario insisted.

"I will be late," the priest replied.

"But Padre," Rosario cooed, "we have *leche, queso, frijolitos*—milk, cheese, little beans." The priest settled for a box lunch and left. Quique and I soon followed.

I had heard that Padre Modesto had promised the Virgin he would rebuild Loreto's church, which had been damaged by an earthquake in 1870, if he won the Mexican national lottery. After the baptism I asked him if the story was true. The priest smiled.

"When I came here in 1947, only the walls were standing. The sight pained me, and I asked God for a chance to restore the church. Everybody helped. The governor gave cement and steel, the bishop in Tijuana sent 1,000 pesos every month, and the people held fiestas and dinners to raise money.

"Then, in 1952, I won 500,000 pesos in the lottery. When the people found out, *terminó todo*—everything stopped. No more fiestas. No more dinners. Even the bishop stopped sending money. I began to get letters. Strangers would write and say 'I am your cousin. . . .' 'I need an operation. . . .' or, 'My husband left me and I need money.' The mail was falling on me like rain.

In dawn's soft light, fishermen from the village of Loreto harvest mackerel from great circular nets called *chinchorros*. More than 800 species of fish make the Gulf of California one of North America's richest fishing grounds.

Riding point on a miniature herd, a *vaquero* leads his *compadres* along a dusty road north of San Ignacio. The cowboys wear quarter-inch-thick leather chaps as armor against cactus spines. Desert shrubs provide meager grazing; Baja nurtures only a third of the beef its people consume.

"With the additional funds from the lottery, we finished the reconstruction of the church in 1954, but there are still a few details, some stonework, some ornamentation. I have always bought lottery tickets, but I never won again. . . ."

The padre stopped speaking, and I looked up from my notes. Weary from the days of the fiesta, he sat with his chin on his chest, asleep.

Northwestward of Loreto, Quique and I drove along the shores of 25-mile-long Bahía Concepción. Its waters were disturbed only by feeding fish; its beaches, except for a few fishermen and campers, were vacant. We paused where the road rims Coyote Bay, one of many inlets that notch Concepción, and savored the silence.

Highway Threatens Lonely Splendor

Suddenly, six helmeted riders thundered past on motorcycles laden with camping gear. Next came a green pickup truck with two nuns in it who waved, veils streaming in the wind. We set up our tent at the water's edge.

And there we met Mabry Ogle of Grants Pass, Oregon, camped with his wife, daughter, and son-in-law. After dinner we sat not by a campfire but in the dark, the better to see the stars.

"I've made so many trips here I can't count 'em," Mabry said, chewing a battered pipe. "Started coming after the war. If we averaged ten miles an hour then, we thought we were doing real good. I used to sit here and watch the Mexican trucks grinding around Coyote Bay. They'd come poppety-pop down the hill in the lowest gear they had, all lit up like Christmas trees—each driver put extra lights on his truck to make it different.

"We got scallops ten inches wide in those days. Clams by the bushel. But now you have to work real hard to get a dozen. Times are changing. And that easy road up there. That'll be the end of the Baja I knew."

Quique agreed. "When the highway is completed, you will have to look hard to find the real Baja. In the past it was all around you."

Perhaps. But some things, I thought, would never change: the sweet scent of desert air, the gentle pulse of waves upon the beach, the steady flame of stars across the sky. These, nothing could disturb, not even the resounding snores of Mabry that night, relaxed once again at his favorite spot.

Next morning at Tordillo Bay we found a bulldozer scarring the shore and workers erecting a rock wall. What for?

"A trailer park, Señor."

A trailer park! Maybe Mabry and Quique were right.

A touch of history clings to Mulegé, a coastal town north of Bahía Concepción. Here on October 1, 1847, the Mexican militia fought

a landing party from the sloop of war U.S.S. *Dale* to a draw. Other minor skirmishes took place until the treaty of Guadalupe Hidalgo, concluded on February 2, 1848, put an end to the U.S.-Mexican war and acknowledged Baja California as Mexico's territory.

Nineteenth-century American soldiers came to conquer the peninsula; 20th-century citizens come to admire it. And their dollars contribute to Baja's economy.

"We ship 250 tons of dates annually to the mainland," Mulegé's *delegado*, or mayor, Ernesto Aguilar told me, "but tourists from the U.S. are our main source of income." I noted that the town's hotels were jammed, the airstrip crowded by light planes.

Unlike the hotels, Mulegé's small prison has room to spare. I visited it one morning with jailer José Mesa, and found no guards, no locked cells—and no prisoners.

"We have prisoners," José reassured me. "Eight of them, but they are all working on the highway. We let them out at six in the morning and they return in the evening. Then they may go out to dinner or to the movies."

With such freedom, I assumed their offenses were minor.

"They are all homicides," said José. "But do not worry, they are not dangerous. They have proved their good behavior. I am only sorry they are not here to welcome you!"

A pall of reddish smoke from an old copper

Ho, ho, a boojum, definitely a boojum," said desert ecologist Godfrey Sykes when he viewed these strange trees in 1922. He took the name from the fanciful beast in Lewis Carroll's *The Hunting of the Snark.* Botanists know the boojum as *Idria columnaris;* Mexicans call it *cirio*—a long candle. The weird trees exist on a winter's ration of perhaps two inches of rain.

WILLIAM BELKNAP, JR. (ABOVE)

Haunting riddles from the past, men and animals drawn life-size or larger adorn the wall of a cave in the Sierra de San Borja. Anthropologists believe the figures, created about the time of Columbus, symbolize the dominance of hunters over the hunted: Men tower above a doe, right, and a mountain sheep, left.

smelter veiled the town of Santa Rosalia. With clapboard houses set in dismal rows, pyramids of tailings, and rusting relics of locomotives, it was Mining Town, Anywhere. In 1885 a French company began exploiting rich copper deposits here, and Santa Rosalia prospered. Square-riggers brought coke from Hamburg to fuel the smelters, wood from Vancouver to build the town. In 1953, with the mines' output slowing, the French departed. A year later the Mexican Government and private interests bought the smelter.

"The purpose," manager Jaime Vargas told me, "was to keep Santa Rosalia from disappearing. There are 12,000 people here, and we have not been able to find another source of income for the town."

The countryside to the west seemed to share Santa Rosalia's distress. Elephant trees lifted bare branches. From the stems of the spreading ocotillos, no buds bloomed. But trucks, bulldozers, and graders roared, wresting a road from this intractable land. A road that might help Santa Rosalia survive.

I drove a twisting grade, newly carved from volcanic hills. Below lay the worn and perilous ruts of La Cuesta del Infiernillo—the Slope to Hell—a series of serpentine switchbacks that for many years had been the despair of Baja truckers. The pavement ended a few miles beyond, literally with a bang: Rocks. Dips. Potholes. Washes. You do not drive this rugged track, you endure it.

Daniel Sets Out to See the World

Halfway to the town of San Ignacio we were hailed by a thin lad in a torn shirt and ragged black trousers. He came into the car smiling and shivering, and I gave him a jacket. He said his name was Daniel, and announced he was walking to Tijuana to be with his sister.

"Walking from where?" I asked.

"Villa Constitución, señor," he replied. "I work in the fields."

Realizing he had already traveled some 200

miles, I told him Tijuana lay nearly 600 more to the north. "Isn't that a long way to walk?"

"I ride now, señor," he reminded me. "And I ride sometimes with the trucks."

He rolled up his trouser and showed me numerous scabs on his leg. "I fight with my friends," he explained, sparring with his fists, "and I fall into the cholla"—a small cactus with needlelike spines (page 566). Having picked more than a dozen cholla barbs from my own hide, I knew the cuts were painful, but Daniel smiled gamely. I asked what he would do in Tijuana.

He pursed his lips, thought a moment, then his face brightened. "I clean the cars!" he said triumphantly, making vigorous scrubbing motions on Boojum's windshield.

At San Ignacio I gave Daniel food and watched as he set off down the street with a sprightly step, to see sights he had not seen before. He turned and waved, this tattered and spindly boy of the fields, and my heart ached for him. He was 12 years old.

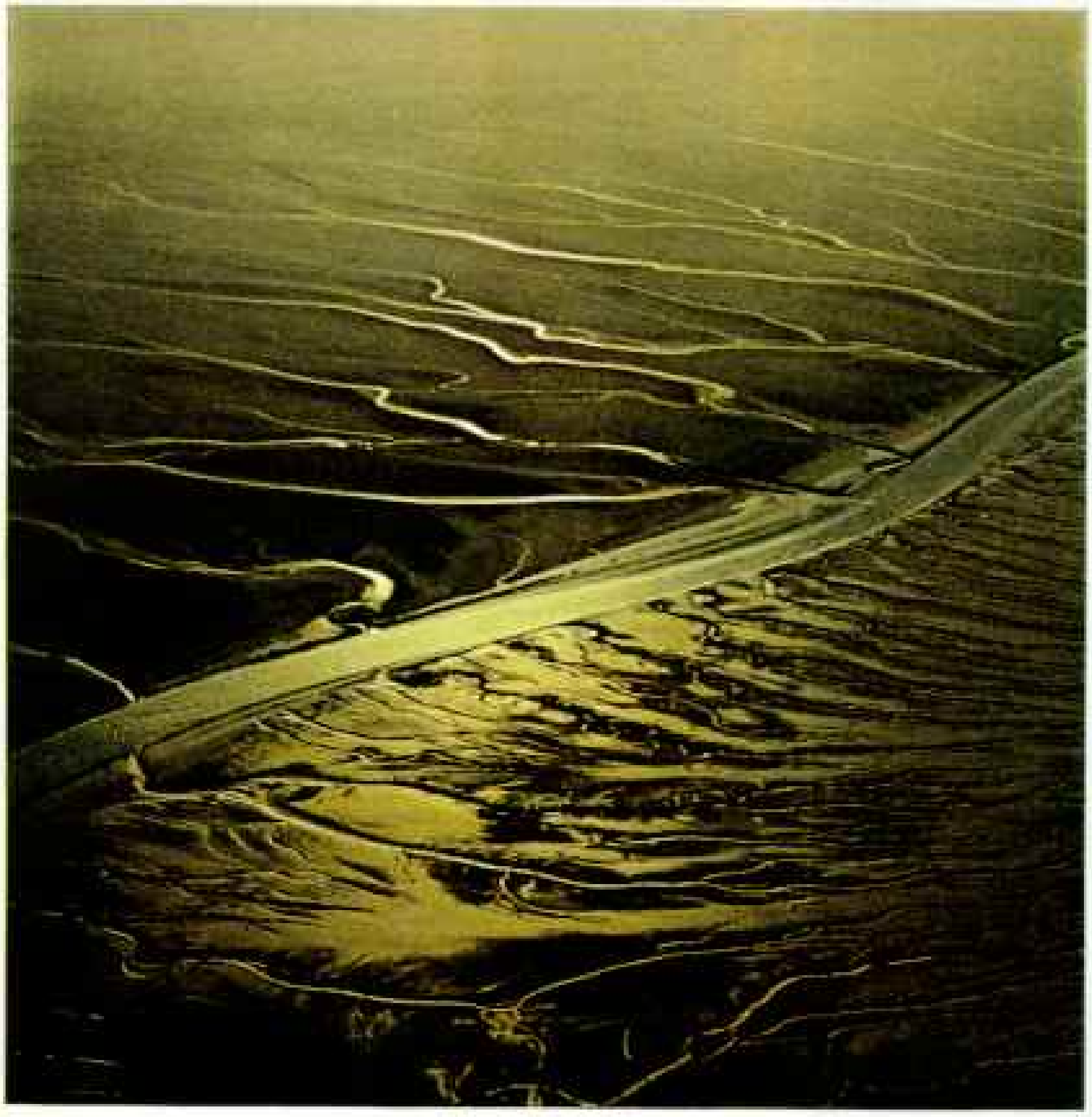
Secure in the rhythm of a simple life, residents seldom leave the mountain hamlet of San Francisco (**left**). Some 40 villagers live in houses made of cactus stalks, fieldstone, and palm thatch. They raise cattle and goats, and plant tomatoes, peppers, and corn. A padre comes to their adobe church once a year, jogging on muleback over a narrow trail through a 3,000-foot-deep gorge.

Still ranching at 70, indomitable Señora Sostenas Amador tends a few cattle and pigs in the mountains south of La Paz. "I feared you would crash," she said when the author arrived by helicopter. "I prayed to the Virgin you would not be hurt." Señora Amador, who lives a five-hour walk from the nearest town, had never seen a helicopter.

Beyond the rim of nowhere, the Sierra de San Borja (**right**) marches to the horizon. Few humans inhabit the range's mesas and steep canyons, home to the cougar, the mountain sheep, and the deer. Nineteenth-century prospectors searched the nearly waterless hills in vain for gold and silver. The cinder cones of two volcanoes that flamed less than 5,000 years ago crown this view.

Surf dimples the sand, but no footprints scar an unsullied Pacific beach (**left**) west of Cabo San Lucas.

Only tidal waters from the Gulf of California wash the mud flats of the Colorado River delta (**below**). Born bold and fresh in the Rocky Mountains, the southward-flowing stream loses its sweetness as water siphoned off for irrigation picks up salt from the soil and then returns to the river. Irrigation projects in seven states and in Mexico's Mexicali Valley diminish the Colorado's flow until it disappears into the sand a few miles from its former mouth.



Laboring in the Mexican sun, a harvester picks Mexicali Valley cotton. Plagued by the bollworm and the salinity of Colorado River irrigation water, the valley's cotton yield has declined by 70 percent since 1966; a fifth of the farmland is no longer arable. From wells near Yuma, Arizona, the United States now pumps fresh water into the Colorado to dilute its salt content.

Next morning Quique and I drove out of town—Daniel was not waiting, but I wished him well—and endured the road to El Arco. There we headed west, skirting the fringe of the Vizcaíno Desert. The roadbed changed from rocks to sand, the vegetation to stunted barrel cactus and matted grass. It was only 43 miles to the community of Guerrero Negro —Black Warrior. A Sunday drive, I thought, but the road turned suddenly south.

We stopped at a ranch to ask directions and found it abandoned. At another, the rancher told us we were headed for the heart of the Vizcaíno. "Go back five miles and turn left," he advised. We did, and became more confused. One road blended into another. The evening fog rolled in, obscuring the sun. Which way west? Another ranch, abandoned. The sky was overcast now, the air chill with the approach of night.

I was ready to break out the tent when Quique suddenly said, "Listen." Above the whine of the wind, we heard the roar of trucks. Homing in on the noise, we shortly saw the welcome lights of Guerrero Negro.

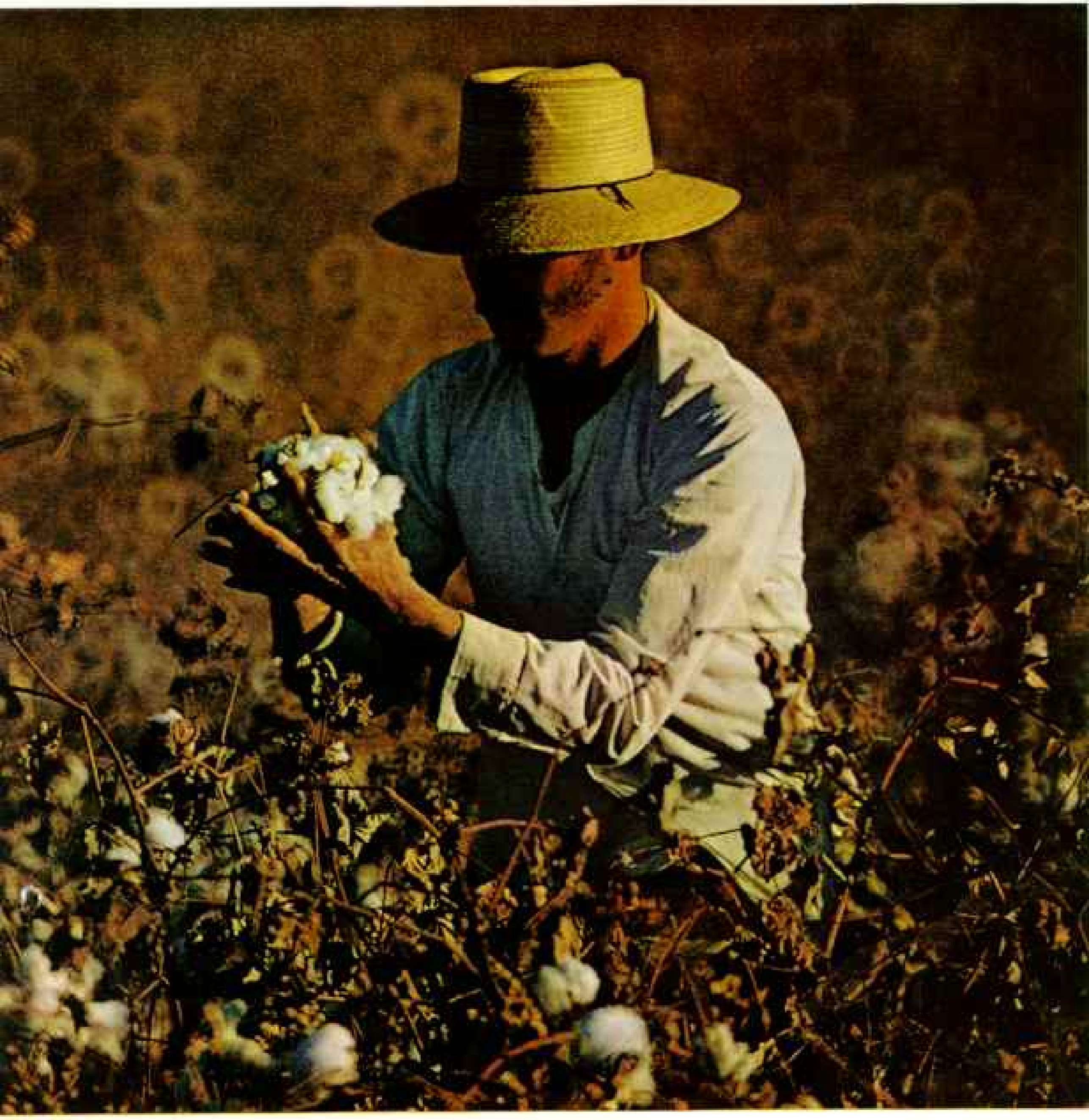
Mammoth Trucks Haul Loads of Salt

"Awfully easy to get yourself lost out there," Charles Sweeney informed us the next day. "Really," he added, "it's downright dangerous. People have died in the Vizcaíno."

Sweeney, a ruddy-faced Londoner, commanded a company of British occupation troops in Palestine after World War II. Today he supervises the personnel of Guerrero Negro's enormous saltworks, which yields 5,000,000 tons a year on 60,000 acres of crystallizing ponds. The salt is hauled to a nearby port by gigantic trailer trucks weighing 600 tons each when loaded.

With driver José Maldonado, I rode one of the trucks on the run from the ponds to the port. Like most Baja truck drivers, José had given his vehicle a name, el Berrendo—"the Antelope." Powered by a 1,000-horsepower diesel engine, the Antelope lumbered along at about thirty miles an hour, pulling three trailers laden with salt. We stopped on a grating, and in gushes that lasted mere seconds, 420 tons of salt flowed from the trailers into a pit below. There the salt would be cleaned and conveyed on belts to a waiting barge, then transferred to an oceangoing ship.

At Los Pollos (The Chickens), a restaurant in Guerrero Negro, I seasoned my soup with table salt from distant Ensenada. "Sometimes we run out of salt," owner Enrique Achoy told me. "*¡En la casa del herrero, azadón de*



palo!—In the house of the blacksmith, you find a wooden hoe!"

Quique and I headed north, enduring the road once again, plunging into piles of dust that left us gagging and choking. It did no good to close Boojum's windows—the particles filtered through the car's air vents and floated, smokelike, inside. We tied handkerchiefs around our mouths and nostrils and suffered the dust.

There are worse ways to travel in Baja, however, and we heard about one of them at Punta Prieta. "English Spoken Here," proclaimed the sign of Mike Ortiz, trucker and restaurateur. Mike told us about a doctor and his wife who spent six weeks on a pair of burros, trekking the 296 miles from Tijuana to Punta Prieta.

"The doctor was excited," Mike said. "He wanted to go all the way to Tierra del Fuego. But the wife"—he slapped his thighs in amusement—"she was so tired and dusty. I wonder if they made it." When we left, after a delicious lobster dinner, Mike shook hands

and bade us return. "But don't you try no burros!"

For several nights we camped among the boojum trees, and woke each morning to find them shrouded in Pacific fog. Climbing, curving, spreading, drooping—they are the oddest plants in Baja, and perhaps the longest lived of its desert species. Botanists calculate that some boojums reach 600 years of age.

Beyond the town of El Rosario a highway crew worked south. I met the superintendent, Ángel Väsquez, whose truck was mired in the sandy trail. "I was trying to see if I could pass without getting stuck," he explained. "I didn't make it."

A little farther on we left the main route and took a side road through granite outcrops and tall pine trees of the Sierra de San Pedro Mártir—the Mountain of St. Peter Martyr—ironically crowned by El Picacho del Diablo, the Devil's Peak. At 10,154 feet, Diablo is the highest point in Baja California.

Living Symbol of Baja's Wilds

We stopped at a meadow, and the only sound was the hum of the wind through the trees, like the roar of distant surf. On a nearby ridge 9,200 feet high, the National University of Mexico had established an observatory. The astronomers were elsewhere, but we met the maintenance personnel at their camp, and that evening went to view the stars and planets.

Technician Raúl Moreno B. trained the telescope on Polaris, and I watched the star pulsing with prismatic bursts. Ghost-white Saturn was next, rimmed with eternal rings. The other men took turns at the instrument. Arnoldo Campa scanned the horizon. "I am looking for *mi novia*—my girl friend—the evening star," he said. "She is a star of many colors. She appears briefly in the early evening, but tonight I do not see her."

We piled into the truck and headed for the camp. From the pines at our left, a cougar leaped into the beam of the headlights, bounded down the road, and vanished in the gloom. I felt a chill; the beast had come from the direction of the observatory. "While we were observing the stars," Arnoldo said, "he was observing us."

The cat symbolized to me all that was wild and worth preserving in Baja California, and I hoped that others might see him as I had —roaming free.

We started down the mountain next day,

Scalloped ranks of sand dunes rest on beds of ancient salt near Guerrero Negro lagoon. Called barchans, the dunes migrate as much as 50 feet a year, driven by steady northwest winds.

Scourge of desert travelers, spines of the cholla cactus can pierce skin, clothing, and even shoes. In dry years ranchers burn the barbs from the plants so hungry cattle can nibble the stalks.

accompanied by an ominous clatter from the rear of the car. Stopping at the headquarters of the crew engaged in improving the observatory road, we asked a mechanic's advice.

"He sound like a bad bearing," was the reply. "I recommend you avoid rough roads."

"Ha!" said Quique. "Ho!" said I.

The mechanic smiled apologetically—60 miles of dirt and rock remained between us and the surfaced highway to our destination, Ensenada. But we inched along, enduring Baja's outback roads for one last time, and made it to the highway. There the car acted strangely. I thought a tire was flat; I stopped to check, and it was not. When I reached 50 miles an hour the engine popped. Still, nothing wrong.

"Face it," said Quique, "Boojum just isn't used to pavement." So we endured the pavement to Ensenada. □

DRIVING
THE MEXICAN 1000

Rocks, Ruts, and Sand

By MICHAEL E. LONG
NATIONAL GEOGRAPHIC STAFF

I TIGHTEN THE CHIN STRAP of my crash helmet and lean forward, hard, to be sure my shoulder harness and seat belt are secure. My fellow driver, Dick Lehman, sits motionless, his fingers making deep indentations in the foam-rubber padding of our steering wheel. His eyes watch for the flick of the starter's flag.

This is the beginning of the Mexican 1000, actually an 832-mile dash down Baja California, from Ensenada to La Paz. Before us lie mountains, sand, rocks—and grief. Usually, almost half the racers break down. Many who don't, wish they had!

Along the route, repair crews man nine checkpoints. They will get a lot of business—broken axles, blown engines, fractured brake drums, dust-choked carburetors.

Dick and I are amateurs, racing for the

Running a rock-littered gantlet, a driver pilots his dune buggy down the Baja Road, perhaps the world's roughest racecourse. The Mexican 1000 draws increasing attention to Baja California, once called the "forgotten peninsula."

SAM ABELL

Unembraceable me! To shield his face from flying rocks, racer Jack Krizman wears a helmet with a chin guard. It proves a problem to his wife, who tries to give him a parting kiss. Bearded spectator (**right**) views the race through a tinted visor.

CHARLES O'REAR (ABOVE AND LOWER RIGHT)

MICHAEL E. LONG (ABOVE AND LOWER LEFT)

Knight of the road, Alexander Wells waits his turn at the starting line (**right**). Foam pads protect his headlights. A steel roll cage will reduce chances of injury if he flips over. Helmet, gloves, goggles, and flameproof suit complete his attire. After only 80 miles, an axle broke.

Get me to the spree on time. Vic Abruzzese always races in a tuxedo, anticipating the fete for finishers.

fun of it. So are many others: doctors, pilots, teachers, firemen, a judge, a housewife, a locksmith. Fewer than 40 of the 222 starting vehicles are driven by professionals.

On this bright November morning Ensenada echoes to the rumble of exhausts from motorcycles, dune buggies, trucks, and sedans—and from our vehicle, a Volkswagen reinforced for the road with heavy-duty clutch and shock absorbers, and a roll bar to protect us if we turn over. I have named the car "Boojum," after Baja's extraordinary tree.

Since 8:01 a.m., the drivers have departed at one-minute intervals. At 11:40, the flag dips for us.

With a throaty, ascending growl, Boojum winds up to 80 miles an hour. Dick guides the car around sinuous curves and down hairpin switchbacks. On our map—a tip sheet prepared by a veteran racer—I note an alarming comment: "Mile 24.59. Cliff. Slow!!! There have been many *bad* accidents here."

1:10 p.m. Dick brakes into the first checkpoint, the town of Camalú. I take the wheel. Four miles downroad the pavement ends and our ordeal begins. First, cobblestone rocks. Then sand, pounded to powder by generations of Mexican trucks. It spurts against Boojum like splashing water and makes a gritty, whining song in the tread of the tires.

A pickup truck roars past and spits up a rock that caroms off our windshield. Fortunately, the glass doesn't break.

Dick, a National Geographic advertising representative and not a patient man, spurs me: "Put it in second! *Second!* Now third! Watch the soft stuff!"

"For heaven's sake, Dick, let me drive!"

2:20 p.m. I've got the rhythm now. To my surprise, I've even passed a couple of other racers. Ahead, at the top of a rise, the road disappears. I see spectators there, some with cameras. I ask Dick what's happening.

"Map indicates a bad dip," he replies.

GERRY ELLIS, IMAGE INTERNATIONAL (ABOVE)

No crowd cheers his passing. Alone among cactuses and boojum trees, John Howard spurs his dune buggy toward Rancho Santa Ynez, one of nine mandatory checkpoints. Eight categories of vehicles took part—from motorcycles to beefed-up Volkswagens.

SAM HOUSE.

Spewing a dusty contrail, a racer darts across Chapala's dry lake bed. At checkpoint El Arco, author Mike Long (**right**) sits dazed after 12 jarring hours. Long, a former jet pilot but a novice racer, shared driving chores with National Geographic advertising representative Dick Lehman, standing by the car. A broken axle bearing forced the team out of the race after 565 miles, when they were running sixth in their class. At San Ignacio, sparks sizzle as a welder fixes a crippled vehicle (**left**). Breakdowns stimulated ingenious repairs. When patches failed to seal one punctured inner tube, the driver poured condensed milk through its valve. The makeshift sealant lasted 430 miles—then the clutch broke.

W. E. GARRETT (ABOVE AND TOP)

CHARLES O'REAR

They made it, more or less. Jim Kirby (**left**) lost all his engine oil, ruptured a tire, and ricocheted off a cow. Borrowing oil from a passing racer, he finished in 21 hours and 54 minutes. He was one of only eight solo drivers to complete the race. Kirby plans to run the 1972 event with his wife, Jean, who greets him here.

Chuck Schneider and Dave Donnan (**right**) broke their front axle with 145 miles to go. Continuing on three wheels, they managed 65 more miles, then their transmission blew up. Towed by another driver almost to the finish line, they goaded the stricken transmission to a few final grinds and staggered across under their own power.

Former Indianapolis champion Parnelli Jones won the race in record time —14 hours and 59 minutes. He drove a specially built pickup truck that reached speeds of 140 miles an hour.

"They're probably waiting for you to crash. Better slow down!"

I do. The track ends abruptly, dropping 50 feet into a wash. I swerve to the right, and a front wheel collides with a watermelon-size rock. The jolt almost tears the steering wheel from my grasp.

2:40 p.m. Checkpoint El Rosario. "You're 20 minutes ahead of schedule," a mechanic exclaims. "Outtasight!"

4:45 p.m. We have been on the road five hours. Dick careens around wicked curves, over rocks half hidden. Suddenly a tire blows out. We limp to the checkpoint at Rancho Santa Ynez for repairs.

6:30 p.m. Dark now. We speed through a boojum forest. The tapered trunks soar 40 feet, and writhe in uncanny shapes. Tendriled branches loop groundward. Tops sprout like candelabra fit for a sorcerer to light his way at night. In the fickle play of our headlights they present a scene so beyond the fantastic that beneath their wandlike forms I can conjure a grazing unicorn.

7:40 p.m. On the dry bed of Laguna Chapala (preceding pages) I get Boojum into high gear for the first time in nearly 200 miles. The sensation of smoothness is brief. Soon we encounter corrugated ruts, here called *permanente*, after the waves in a woman's coiffure. It's like driving on square wheels.

Hours pass. The car pitches, bounces, lurches, and I realize we are not in a race at all. We are in physical combat with this abominable road, a fitful struggle orchestrated by the drumming of rocks on the car's

GUILLERMO ALDANA C.

underside. After a while it produces a peculiar delirium.

Dick stops the car and says: "You better drive. I just saw a boulder on the road. It turned into a gigantic green apple. I drove right through it!"

Midnight. Checkpoint El Arco. Chilled, I don a jacket and ski gloves and pull out, only to encounter another adversary, fog. But now we are halfway home. I am consumed with determination: Get to La Paz, get to La Paz!

2:45 a.m. Click-click-click. Snap! The speedometer cable breaks, the needle falls to zero. Then an insistent clanging—a shock absorber is broken. I creep into San Ignacio.

5:30 a.m. First light of dawn. Dick at the wheel again. Cardon cactuses and elephant trees are silhouetted in the mist. Beneath us lies hubcap-deep sand. Cars mired everywhere.

6:27 a.m. Running another gantlet of rocks, we hear a grinding, sickening noise. Boojum slows, then stops. Dick shifts gears frantically but the engine transmits no power to the wheels—an axle bearing is shattered. Dick and I look at each other, but there is nothing to say. We are marooned near a crossroads called Los Dolores—the Sorrows.

Of little comfort that we are only 123 miles from pavement, with a clear shot at La Paz. Small consolation that scores of other vehicles have suffered similar breakdowns. Red-eyed and dusty, exhausted after nearly 19 hours of driving, we contemplate our dismal situation in the morning stillness.

We have challenged the Baja Road. And the road has won. □

Swimming With Patagonia's

By ROGER PAYNE, Ph.D.

Marbled by dancing sunlight, a 45-foot whale surfaces

Right Whales

Photographs by WILLIAM R. CURTSINGER and CHARLES R. NICKLIN, Jr.

in its winter refuge off South America.

Swimming With Patagonia's Right Whales

SPRAY-SWEPT SOLITUDES of Argentina's coast harbor a recently discovered herd of southern right whales—so named because their rich store of blubber and whalebone once made them the "right" species to harpoon. Even today, despite an international covenant among 14 countries to protect the endangered creatures, outlaw whalers eye this and other remnant herds. Though faced with the possible loss of their subjects, scientists are gleaning a treasury of facts about the lifeways of these gentle, infinitely fascinating mammals.

CLOSE TO SHORE, below the high escarpment, a herd of whales frolicked. The tide was in, and the great animals rolled and turned and churned the clear water with their flukes. We could have hit them with stones thrown from our brushy sunbaked vantage, 100 feet above the beach.

"Keep on the lookout for Y-Spot," I said, handing the binoculars to my wife, Katy. "She's almost bound to be somewhere nearby."

North and south the wild and lonely coast of Patagonia faded into the haze. In the windy spring of southern Argentina, this September day was one of exceptional calm. I could make out five or six vast, dark shapes like submarines. They were southern right whales *(Eubalaena australis),* a once-abundant species that is now perhaps the rarest of all wide-ranging mammals.

Along this sparsely inhabited stretch of coast, whales came to mate and calves cavorted in the easy playfulness of the nursery. From our clifftop perch, the whales' sheer bulk—one or two were longer than fifty feet and would weigh as many tons or more—dwarfed the members of our research team moving among them.

Photographer-divers Bill Curtsinger and Chuck Nicklin were quietly swimming with the whales. Andy Pruna, our motion-picture cameraman, and Pedro, the boatman, attended them in a skiff. Three orange transmitters, with underwater microphones suspended from them to catch whale sounds, floated at the corners of a triangle of shallow sea 2,000 feet on a side.

I picked up earphones plugged into receiving equipment on the clifftop. Through them I could monitor the sounds of the whales, as well as the running report of whale action transmitted from the boat and from a Cessna 150 spotter plane circling overhead.

Suddenly a great shape breached and hurled itself in charcoal sleekness from the water to smack down on the surface with a boom like cannon fire. Moments later our spotter spoke from the plane: "I think it's Y-Spot's companion breaching. Y-Spot just rolled over on her back with her calf draped across her chest. Now she's patting it with a flipper." I brought my camera-telescope to bear on Y-Spot, named for a big white splotch on her back like piebalding.

Newfound Haven Proves Ideal for Whale-watchers

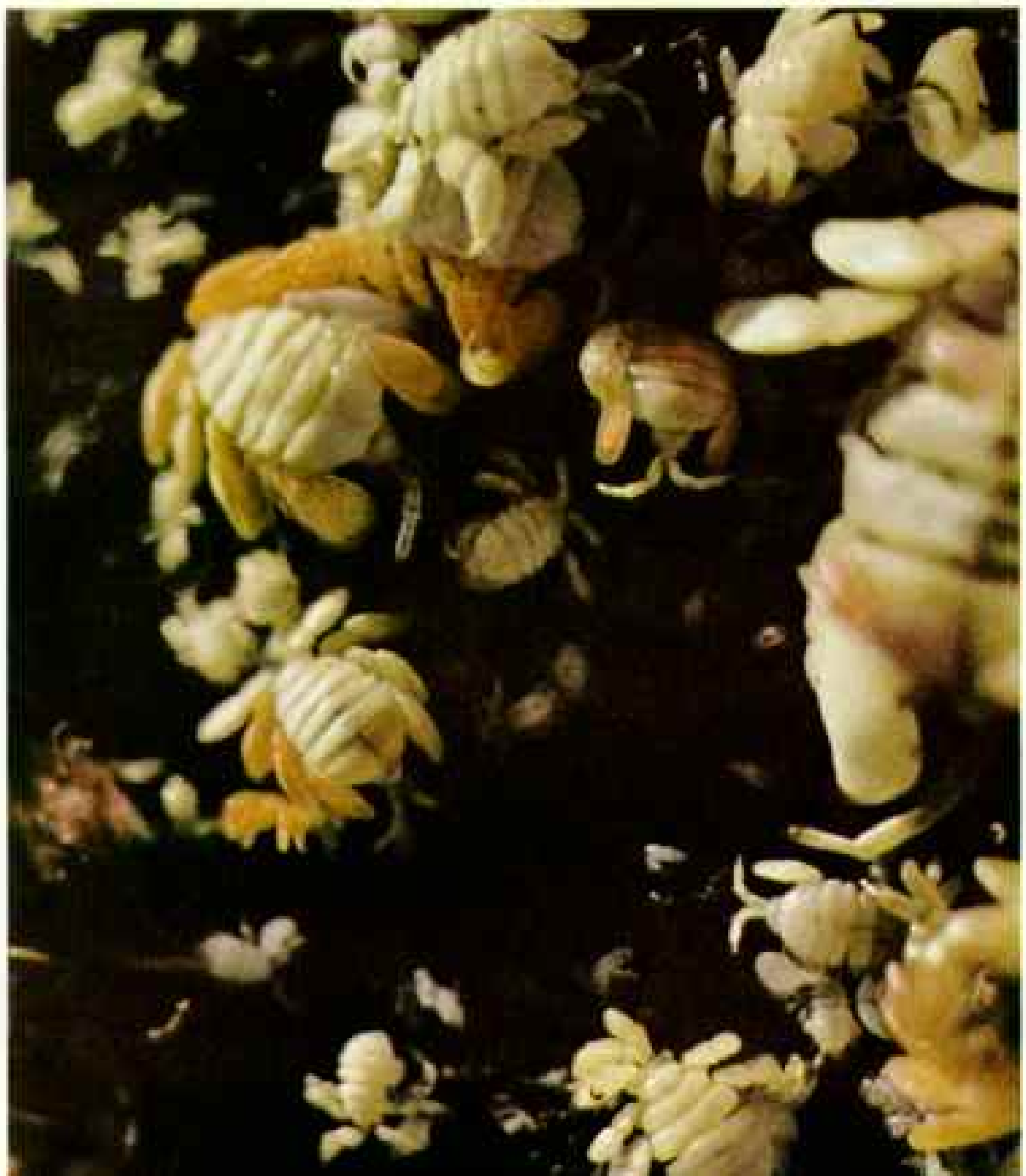
Only recently has this remote whale haven in the western South Atlantic become known to us. In 1969 the National Science Foundation research ship *Hero* came upon a herd of right whales off the coast of Patagonia. Residents of the area confirmed that the species visited the region each winter and spring.

Making a reconnaissance trip in 1970, sponsored by the New York Zoological Society, I found the place ideally suited for behavioral studies. The animals congregated in a small bay and along a stretch of coastal shallows, promising relatively easy approach.

During that first season we uncovered extraordinary evidence of right whales' restraint toward humans.

One day Katy was out in our skiff with an Argentine diver, Adalberto Sosa. A whale approached and circled the boat closely, almost touching it several times with its head. But then it turned its flukes to the skiff, swished them strongly from side to side, backed up and placed them under the stern and raised the whole boat, passengers and all, about six inches in the air.

Katy kept cool. On the radio she told us what was happening, and simply asked, "Do you have any suggestions?" At the time, a



Bumps of identity, the calluslike growths that sprout in varying shapes on the head of each right whale help in the recognition and tracking of individual animals. Communities of whale lice (**left**), some of them half an inch long, cling to the growths. Gathering specimens of these hitchhiking crustaceans, photographer Curtsinger (**above**) eases his rubber raft up to a lounging giant. The inquisitive mammal views the intrusion with ponderous calm. Notes Curtsinger: "The whales seemed as curious about us as we were about them."

Lolling sea monsters provide dramatic close-ups. Only once did a whale seem to react aggressively, advancing to within three feet of submerged lensman Curtsinger and violently thrashing its great head. "I think it was just telling me to scram," recalls the photographer, who calmly continued shooting pictures.

Whales a-courting go: Two males pursue a coy female (**left**). To evade unwanted suitors, cows sometimes surface and float on their backs.

stony dune obstructed my view of the action. I was uneasy, but Katy's voice was unalarmed, and a similar thing had occurred to me the previous day, so I didn't worry.

The whale let the captive craft hang there for a long minute, then lowered its flukes slowly without tipping the boat. Over the next five minutes Sosa and Katy made no attempt to free the skiff, and the whale lifted and set it down two more times with utmost control and deliberation. Two whales with calves loafed nearby. Maybe this was a mild threat by which the animal intended to ease the boat out of the area. Finally, Katy and Sosa took the hint.

Next day Sosa swam within ten feet of a mother and calf without incident. We had become convinced that the true disposition of a right whale is at variance with its centuries-old reputation for smashing boats and men. That violent action only followed harpooning and lancing, with the whale writhing in agony.

Don't Those Leviathans Ever Sleep?

Our major study took place in 1971, when we returned to Patagonia with support from the New York Zoological Society and the National Geographic Society. For almost three months we camped beside the bay, and right whales became a part of our daily lives.

We could watch them while we were cooking or eating or doing the dishes. At night their breathing and out-of-water sounds often awoke us. Sometimes it was as if we heard wind blowing across an open pipe; at other times the sounds were loud, high trumpet calls.

In hundreds of encounters with dozens of right whales, we confirmed that they are by nature placid and gentle. Only once did a whale behave in a way that seemed to threaten violence.

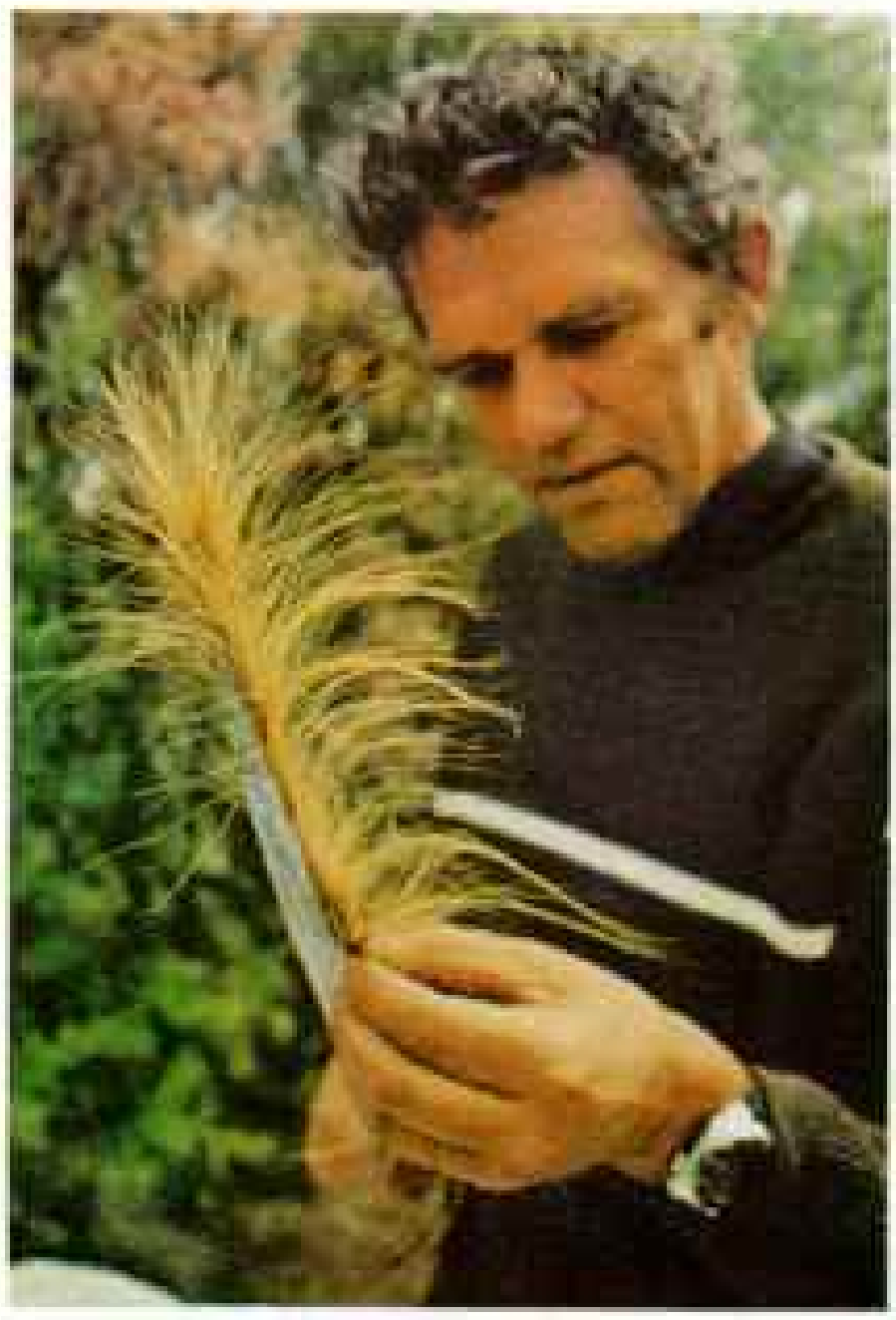
I had assured Bill Curtsinger that it was perfectly safe to swim

Too close for a close-up—or for comfort—movie photographer Pruna keeps his

camera out of harm's way as he gently pushes off from a nosy whale.

No Jonah-swallower, a right whale could never gulp down a man; the mammoth's throat is too small. Instead of teeth, it wears a comblike set of horny baleen plates, popularly called whalebone. With this immense strainer, it filters small organisms from seawater.

Wet-suited author Roger Payne (**above**) examines the giant wraparound grin of a beached right whale, dead of undetermined cause. Dr. Payne wins continuing support for his whale studies from the New York Zoological Society, where he is a research zoologist, and from the National Geographic Society.



Feather or bone? Baleen bears superficial resemblance to both. Photographer Nicklin (**right**) examines the fibrous, ruggedly flexible material, which once buttressed ladies' corsets and made the hourglass figure painfully possible.

among the whales. Bill had no more than slipped from the boat when a whale turned to face him. At a distance of only about three feet, it began slamming its head from side to side and up and down, churning and battering the shallow water into explosions of flying spray in an awesome display of raw power. Throughout this tempestuous exhibition Bill held his ground.

When the whale's frenzy had subsided, Bill swam slowly back to the boat, passed his camera carefully over the gunwale, pulled himself over the side, and said simply, "That was fascinating."

Our most ambitious project, correlating whale sounds with behavior, was especially difficult because whales apparently make no special motions of their mouths or bodies while vocalizing. That's where the need for an array of underwater microphones came in. By measuring delays in arrival time of a whale's voice at each one, we hoped to determine the position of the sound source.

Meanwhile, from the airplane, our spotter photographed the whales' activity and radioed a blow-by-blow account of their behavior. Later, we would try to unscramble the information and sort out which whale said what to whom in what situation.

What makes up the "talk" of right whales? They revealed a complex vocabulary of strangely haunting grunts and groans. But it may take years for us to interpret the sounds—if, indeed, we ever can. Right whales' hearing apparently is keen: When we would knock on the side of the boat, they would dive.

To determine the sex of whales, we usually had to rely upon their behavior. One part of our study area seemed primarily a mating ground, another a nursery where, as spring progressed, mothers with calves predominated. Few females with calves stayed in the mating territory, where a great many males were always competing for partners. Mating appeared entirely promiscuous—the whales displayed no noticeable pair bond.

Whale of a tail juts from the surface in a cetacean activity called lobtailing. Repeatedly, the massive flukes clap against the water with thunderous impact. One whale's lobtailing sometimes appears to cue others nearby to follow suit. The author's team hopes to learn the meaning of this and other forms of right whale behavior, including still-undeciphered noises, or "speech."

We found that courtship involved much stroking and hugging of a female by the males competing for her. She would avoid her suitors by rolling onto her back and lying at the surface. But eventually she had to right herself to breathe, and then the males would grab hasty breaths and dive beneath her, swimming upside down and pushing and shoving each other.

With only one male present, however, the female normally was quiet and tender in her acceptance. The pair would hold each other with their flippers, belly to belly, while mating.

Whales Stand at Ease—on Their Heads

Another notable activity had nothing to do with courtship. Frequently, we would see a whale assume a vertical posture, tail out of the water and nose down, its mouth inches off the bottom. One observer reported this as a possible feeding attitude. But I suspect that it is a rest posture, for whales would maintain the position, eyes closed, for about 20 minutes at a time before surfacing to breathe. Normally they blow every two to three minutes.

It was delightful to watch the young whales at play. Strands of seaweed dislodged by storms were the toys. I watched one calf swim up beneath a clump of kelp, draping the green ribbony stuff over its head like a bizarre hat. Swimming ahead, it let the strands slip free and stroke along its back and flanks all the way to the tail. With a swirl, the calf rolled on its side and used its tail to scoop the seaweed within reach for patting with its flippers.

Newborn calves liked to play with their mothers' tails. They would slide off first one fluke and then the other. Usually the mothers patiently absorbed all the jostling. Once, though, we saw a big female deftly roll onto her back just as her mischievous calf was about to ram her. She grabbed the youngster by clamping the small of his tail to her side with a flipper. He wriggled and struggled and spluttered. When he had calmed down, she slowly let him go.

To document right whale social structure fully will require much more fieldwork. Yet a shadow hangs over our hopes. The few known herds often concentrate near shore where they make easy targets for outlaw whalers or for whalers from nations not bound by international agreement. Even though declared a protected species for the past 37 years, right whales have made little, if any, recovery.

In late spring Patagonian right whales leave their breeding area—an area protected by the Argentine Government—and head south to summer feeding grounds. But where do they go? Will they evade the guns of whalers who are party to no restrictions?

Far-reaching undersea topographies that reverberated formerly with the shouts of whales now echo only the monotonous hiss and surge of sea-surface waves set against the dull, numbing roar of shipping. The once-vast host of right whales now is reduced to a few roving bands—harassed, divided, and dispersed. □

Spouting cow escorts her calf along a surf-fringed strand. The youngster—weighing perhaps three tons at two months—stays within an easy sidelong glance of its mother. In shallow water she keeps the calf on her landward side. They spend hours playing together, occasionally resting and drifting with the tide. Mother elephant seals and their newborn pups, bottom, also find haven during the southern winter and spring on this mild-weathered Patagonian shore. Undisturbed by man, it provides a rare sanctuary for many marine species.

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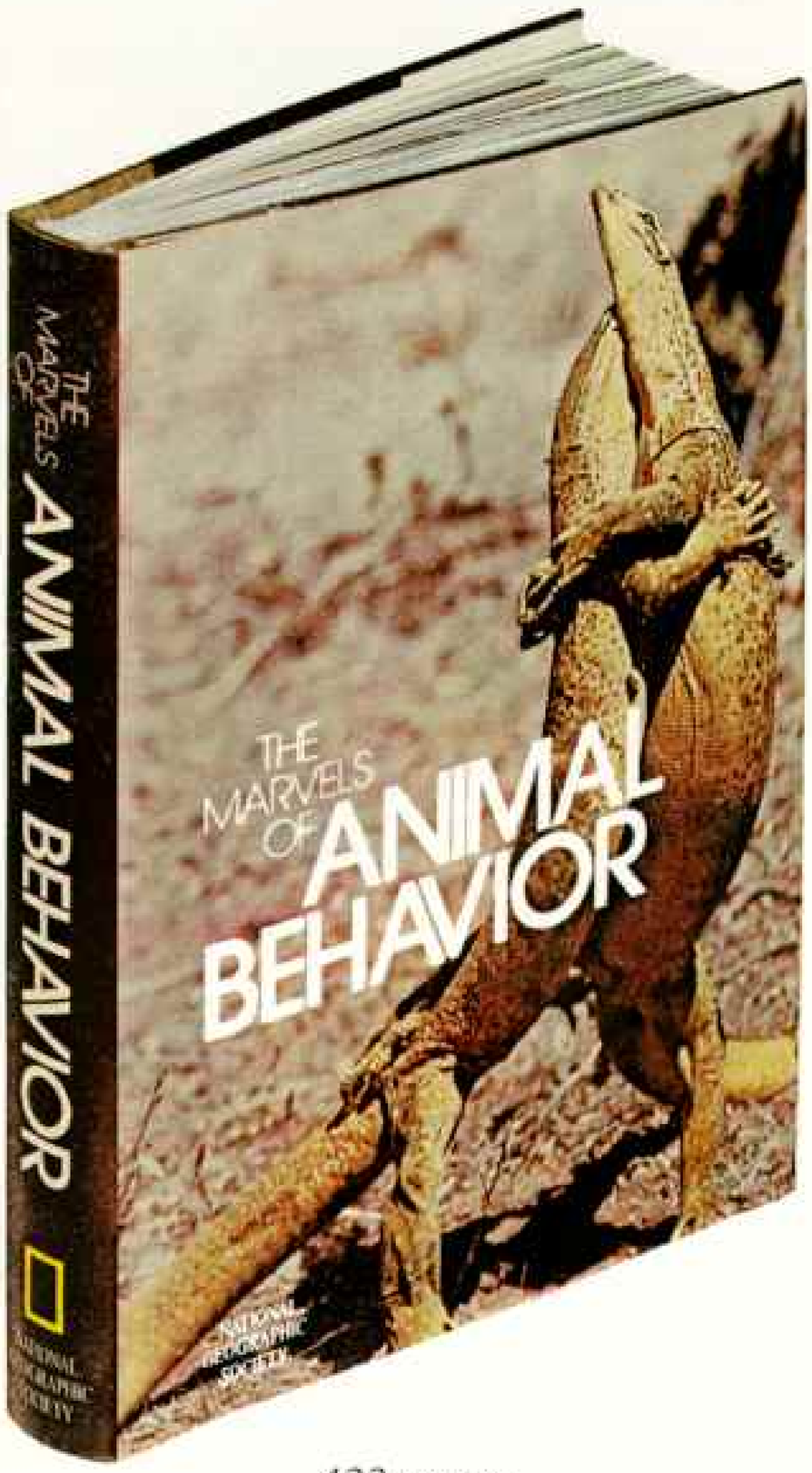

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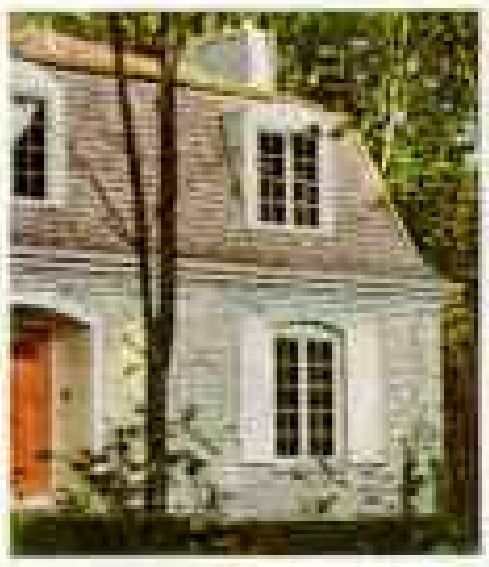

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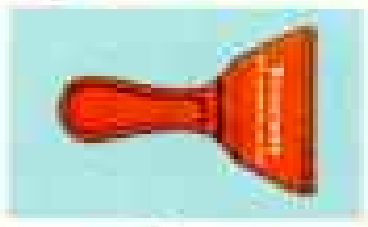

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