

CARIBBEAN GREEN TURTLE

Imperiled Gift of the Sea

By ARCHIE CARR, Ph.D.

Photographs by
ROBERT E. SCHROEDER, Ph.D.

THE BIG GREEN TURTLE stranded in the surf and rested there for a while, making up her mind. It was the end of her long nesting migration. She blinked and peered into the night, then nosed the wave-washed black sand, as if to smell for telltale signs of other generations of her kind. I crouched low beside a log, savoring the sight of a sea turtle coming in to the beach.

It is a stirring thing to see the ponderous water creature come ashore for her single nesting venture in two or three years. The first stages of her landing are not often seen by anyone. The turtle comes by night and is wild and skittish when she first touches shore. Even the flash of a match far up the beach may scare her back into the sea. For several minutes she may stay there in the wash, pushing her head this way and that in her first prospecting, with quick movements more like a lizard or snake than a 350-pound turtle.

Since that first time fifteen years ago, I have walked turtle beaches every summer. Only a few times, in strong moonlight or, eerily, on pitch-dark nights with the surf breaking phosphorescent like rolling fire, have I again seen this cautious first leaving of the sea.

Once a green turtle has dragged herself up onto the dry, wind-blown upper beach and has begun to nest, she loses her shyness. By the time the eggs start dropping, a dozen Indians drumming dance beats on her shell would not disrupt her ceremony.

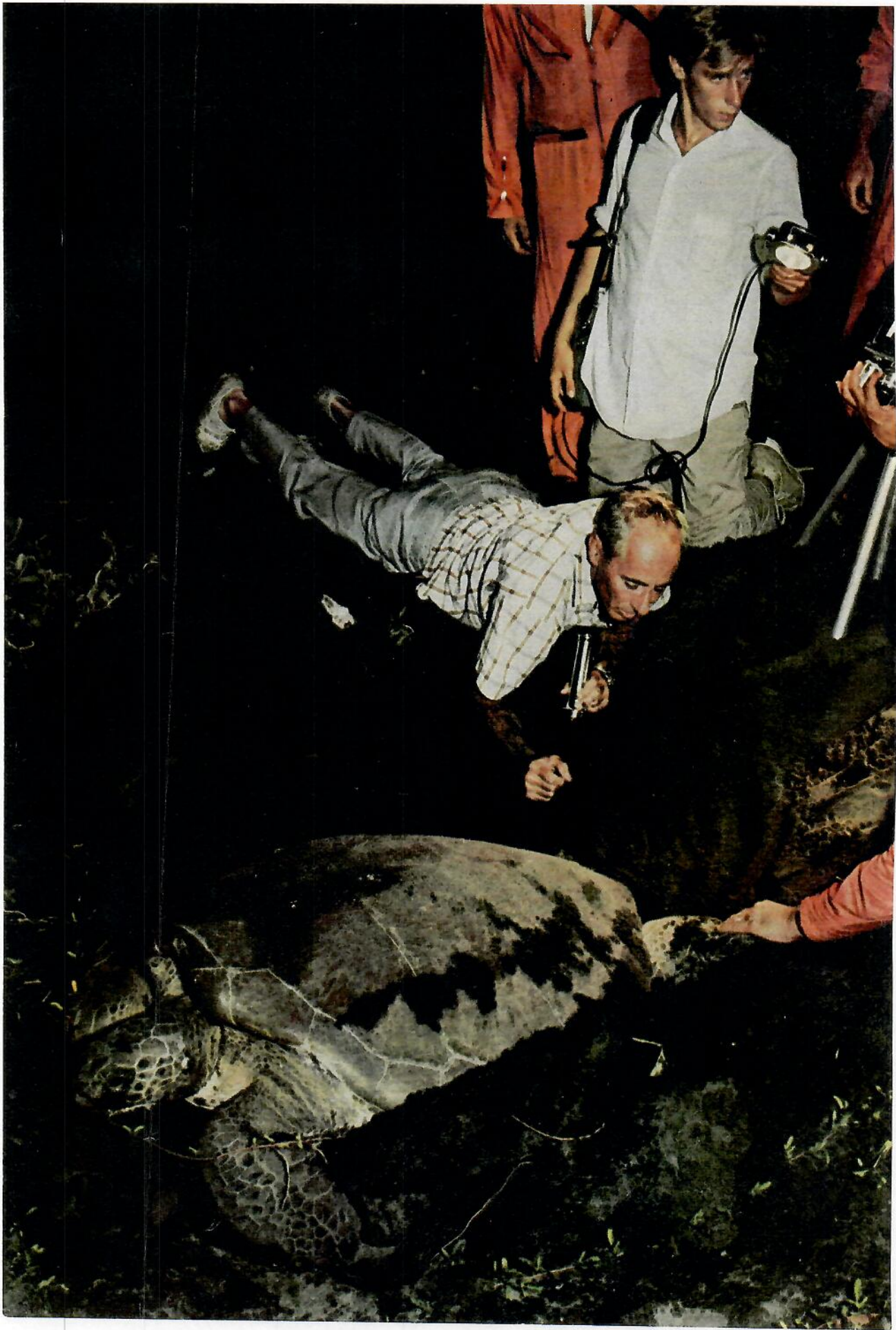
At the edge of the first vegetation, or beside the

The world pops into view when a minutes-old green turtle escapes from its leathery egg. Scientists hope to learn how the mature *Chelonia mydas*, heavier by 300 pounds than this silver-dollar-size hatchling, finds its way across trackless oceans to nesting beaches. They also hope to re-establish the once plentiful turtle as a valuable food resource in the Caribbean.





KODACHROME © NATIONAL GEOGRAPHIC SOCIETY





rise of a dune or log, she swipes at the sand with her front flippers, thrashing out a pit to rest in while laying. Delicately she shapes the urn of the nest hole, and into this drops a hundred-odd eggs, filling it to the neck (left and below). After that she covers the nest and throws sand about to conceal the site, then slowly makes her way back to the sea.

The Caribbean green turtle (*Chelonia mydas*) matures at about 250 pounds, but often grows to twice that size. In the warm, clear edges of the Caribbean, schools of them move placidly across submarine pastures, grazing the waving turtle grass like flat-backed cows.

Green Turtles Fed Colonial Navies

The green turtle is probably the most valuable reptile in the world and offers an expansible food resource for the future. But increased hunting pressure has taken heavy toll of its once-great numbers. There is a ready market for frozen turtle meat, a growing demand for clear green turtle soup, and a rising commerce in turtle hides for leather. Also, sales of stuffed young sea turtles are brisk in curio shops. The price on *Chelonia's* head is therefore steadily mounting, and the species could soon be wiped out.

Big, succulent, and easy to catch, the green turtle was an important factor in the colonization of the American tropics. It was abundant and easily kept alive for months with a minimum of care. It went into the pots of salt-water peasantry and the tureens of flagship chefs alike. The British Navy victualled its ships with green turtle to extend cruises in the New World, and Spanish fleets took on turtle for the long voyage back home to Cádiz.

The only flaw in the green turtle resource is that the females have to come ashore to lay eggs. They leave the safety of the sea—where their size makes them almost immune to danger—and expose themselves

Sighing and weeping salty tears, a green turtle deposits her eggs on a Costa Rican beach; the tears wash sand from her eyes and rid her system of excess salt. The turtle, usually shy but unmoved by anything while laying, ignores the author (prone), other scientists, and orange-suited U. S. Navy flyers who help film the drama. She drops about 100 golf-ball-size eggs into a flipper-scooped pit (below) and covers them before ambling seaward. Greens breed every two or three years, digging three to seven nests each time.

Dr. Carr, a University of Florida zoologist, cooperates in a study sponsored by his university, the National Science Foundation, Caribbean Conservation Corporation, and Costa Rican Government. The U. S. Navy, interested in the green's ability to navigate, also assists and ferries baby turtles throughout the Caribbean.



EKTACHROME (OPPOSITE) AND KODACHROME © N.G.S.

and their offspring to the hazards of the land. Still, turtle populations held their own so long as the dangers on shore remained natural ones: jaguars, pumas, and Indians for the mature turtles; gulls, vultures, coatimundis, and other predators for the eggs and young.

It is not possible to say how widely the green turtle nested in colonial days, though certainly there were several rookeries in the western Caribbean, and probably many.

Life Begins at Turtle Bogue

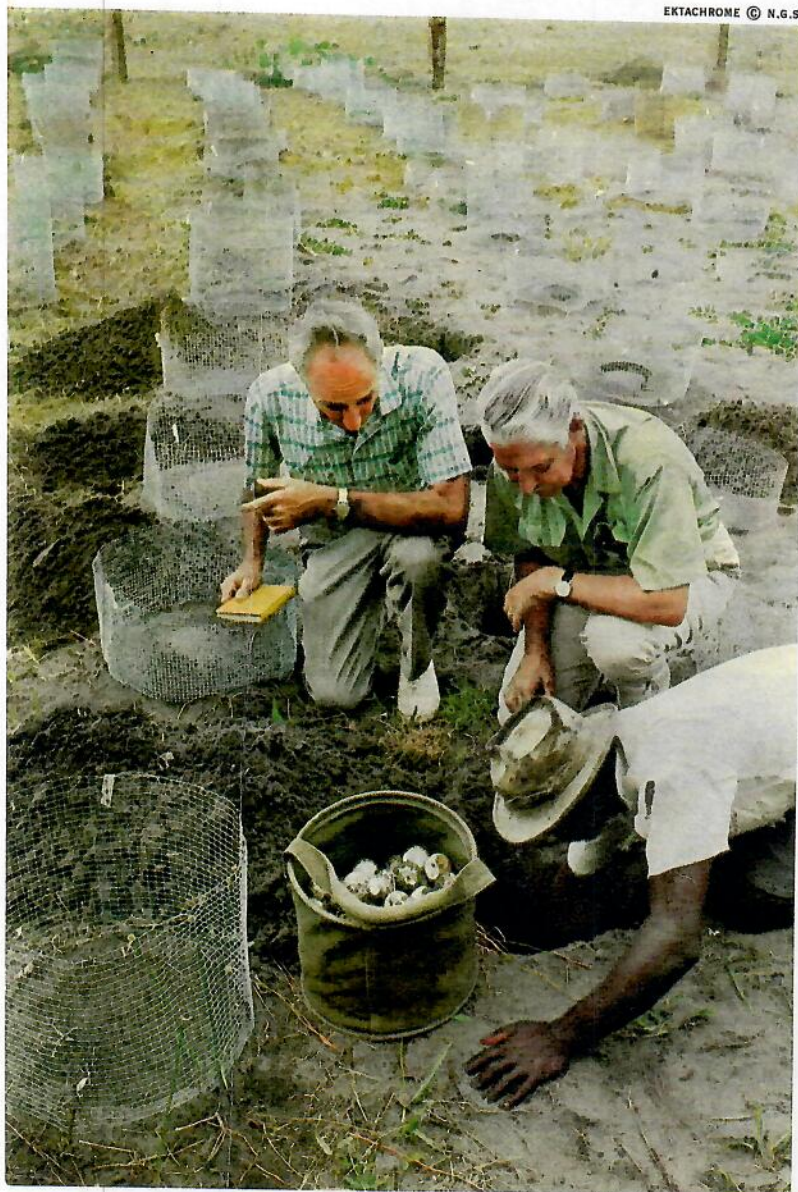
Today most of the green turtles of the western Caribbean nest on Tortuguero Beach—Turtle Bogue, the English-speaking Creoles call it—a 22-mile strip of Costa Rica's eastern shore. Elsewhere in the Caribbean, and occasionally in Florida and the Bahamas, they nest singly or in little bands (map, page 883).

Tortuguero remained a turtle breeding

ground because of its isolation. The Río Tortuguero comes down from the mountains and runs behind the shoreline. Swamps and forests also cut it off from the hinterland.

At the north end of the beach rises 450-foot Cerro Tortuguero—Turtle Mountain—a forest-covered volcanic rock which the shore people believe is a beacon for flotillas of homing turtles. It is just a folk belief, of course. But, as a zoologist, I learned long ago not to discount all folk notions as empty talk.

I went to Tortuguero in 1954, with the first of a series of National Science Foundation research grants, to study the natural history and migrations of green turtles. For one thing, I wanted to test the stories of fishermen and turtle hunters who spoke of the green turtle as a far-ranging migrant and "a better navigator than man." Another goal was to restore former rookeries to old-time levels of



EKTACHROME © N.G.S.

Planting eggs by the bucketful, Dr. Carr, left, and associates safeguard the harvest from natural nests by reburying the eggs at the protected Turtle Bogue hatchery in Costa Rica. After two months' incubation in the warm sand, the hatchlings squirm around within the egg until they tear ragged exits in the shells. Then the young use what Dr. Carr calls "a witless collaboration that is really a loose sort of division of labor" to reach daylight.

With bursts of frenzied wriggling they collapse the nest's walls and ceiling. As sand showers down in an ever-growing pile, it builds the nest floor upward, elevating the young until they reach beach level. Here wire corrals thwart the hatchlings, seen life-size (right), in their instinctive attempt to reach the sea.

The Turtle Bogue hatchery raises turtles for research and produces hatchlings for airlift to 28 beaches where greens once nested in Central and South America, Mexico, the West Indies, the Bahamas, Florida, and Texas. By transplanting the turtles, the Caribbean Conservation Corporation hopes to save the species from possible extinction, a threat that comes mainly from the mushrooming market for hides and calipee, or under-shell cartilage, a prime ingredient of turtle soup.

abundance, stocking them with Tortuguero hatchlings. I set up a tagging camp on a two-mile stretch of the Bogue that the Costa Rican Ministry of Agriculture had allotted me. It was manned by graduate students from the University of Florida.

Navy Ferries Turtle Hatchlings

So far we have marked some 4,200 nesting green turtles at Tortuguero. Each metal tag offers a reward for its return to the university. To date we have recovered 175 tags, all from outside Costa Rican waters—some from more than a thousand miles away.

In 1958, a group of philanthropists formed the Brotherhood of the Green Turtle, which gave rise to the nonprofit Caribbean Conservation Corporation to save biological resources in the Caribbean. Since then we have operated a green turtle hatchery at Tortu-

guero. Additional help came from the Office of Naval Research. Long concerned with the navigational feats of migratory animals, the U. S. Navy began airlifting our hatchlings—and Operation Green Turtle was born.

In the past decade we have sent more than 100,000 baby turtles to 28 different localities in Central and South America, Mexico, the West Indies, the Bahamas, and southernmost Florida and Texas.

The study and conservation of the green turtle has drawn me back to the Bogue year after year. When I first went there, it was being worked intensively by turtle hunters—*veladores* (stayers awake), they called themselves. All night they patrolled the beach to intercept turtles that came ashore, flipping them on their backs. Over each they built a palm-thatch shed to shield the turtles from the broiling sun until boats came to pick them up.

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EKTACHROME © NATIONAL GEOGRAPHIC SOCIETY





Beating flippers like wings, green turtles can swim nearly as fast as a man runs. Comparatively sluggish on land, young turtles flip-flop across a Cape Sable, Florida, beach (left). At water's edge frantic paddling begins as hatchlings start to swim.

Although found principally in the tropics, Atlantic greens wander sporadically from New England to Argentina; they nest prolifically at Turtle Bogue and Ascension Island. Those hatched on Ascension—midway between Africa and South America—ride the South Equatorial Current to Brazil, where they mature. Tagging indicates that the nesting urge drives them back to Ascension. To find the seven-mile-long island across 1,400 miles of unbroken ocean, the greens must rely on an unknown, inborn navigation system.

In those days the end seemed near for the Tortuguero turtle colony. Today, however, the whole Costa Rican shore is legally protected from turtling. It is against the law to dig up eggs or to disturb any turtle on land.

In spite of restrictions, the inroads continue. The law permits the harpooning of turtles beyond the breaker line. A man good with the iron can often harpoon both the male and female of a mating pair. Boats go back to Limón loaded down with turtles (map, opposite).

Poachers Endanger Green Colonies

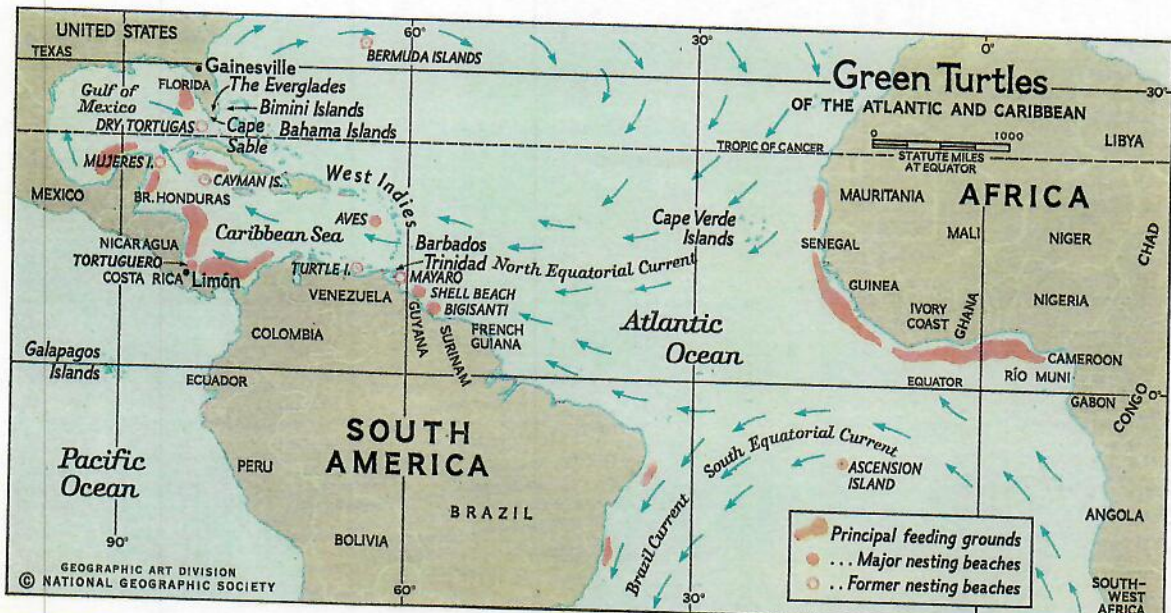
Even on the beach the killing has not stopped completely. Poachers find it easy to move in behind the thin-spread guards.

I saw a sample of their work on a recent flight from Limón to Tortuguero. It was my first visit to the camp that year, and I asked the pilot, who flew regularly along the beach, how the green turtle crop seemed that season.

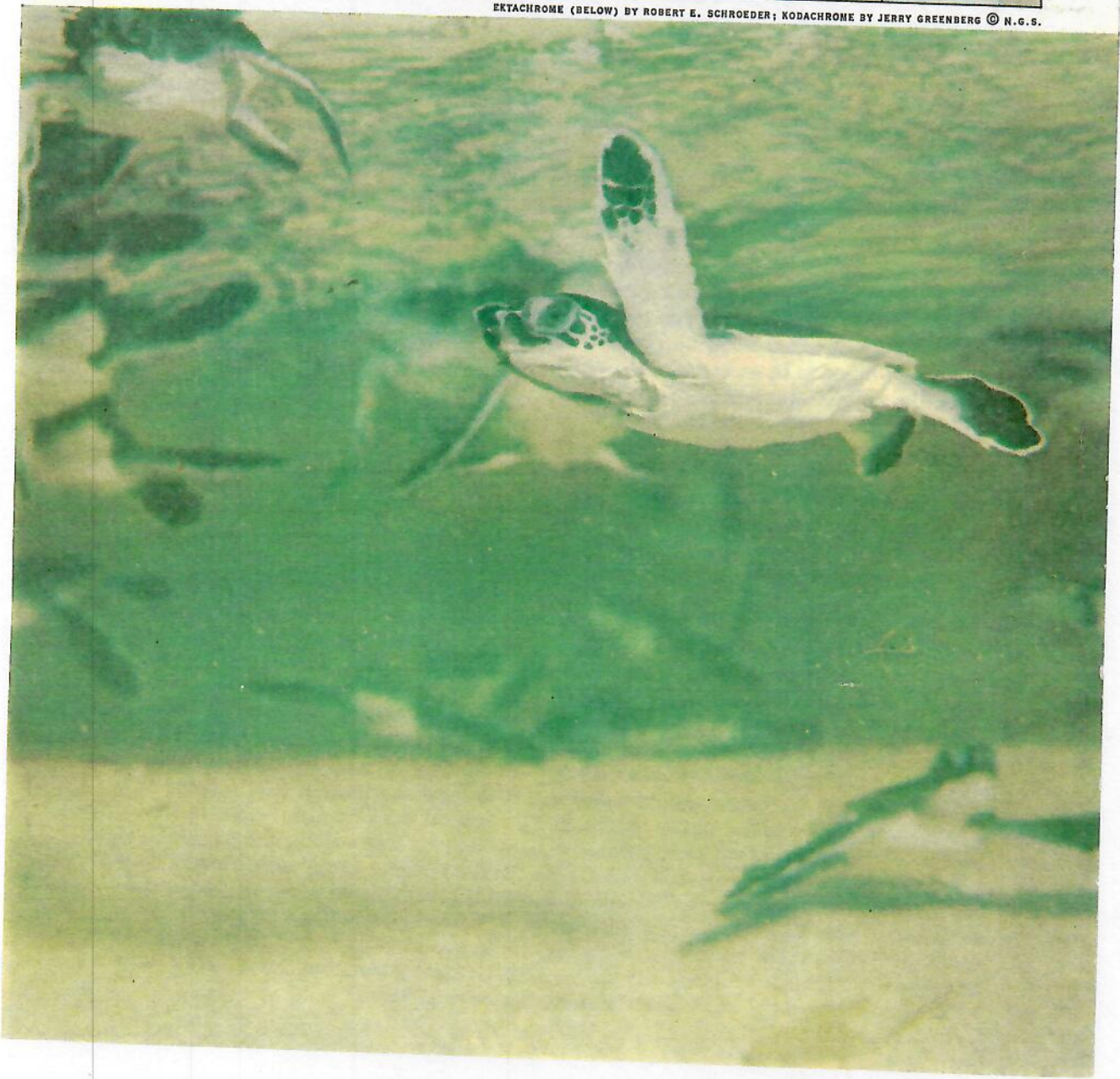
"*Hay muchas,*" he said. "Plenty of them. But the poachers are many, too."

He banked seaward and flew along just over the edge of the forest, so I could look down on the Bogue. In a broad zone between high-tide reach and the beach scrub, patches of what looked like torn-up white paper littered the dark obsidian sand.





EKTACHROME (BELOW) BY ROBERT E. SCHROEDER; KODACHROME BY JERRY GREENBERG © N.G.S.





"Turtle bones," the pilot called out. He nosed the airplane, down to a hundred feet and, looking closely, I could see the white patches were bleached shells and bones left by calipee hunters. In most cases they had taken the calipee—the cartilaginous part of the under shell—leaving the turtle to die.

Calipee is the most important ingredient of the famous English clear green turtle soup. It gives the soup its characteristic consistency. Some connoisseurs will reject turtle soup that fails to make their lips stick together. Calipee produces this quality.

Natural Sanctuaries Invaded

The demand for it has had an alarming effect on green turtle populations. Light, easy to conceal, and practically indestructible when sun-dried to the texture of rawhide, the three or four pounds of calipee from one turtle brings as much as \$5—more than the whole turtle brought a few years ago. As a result, hunters are killing green turtles in remote places where they were not molested before.

An increasing trade in turtle hides for leather adds cause for concern. This spring a fashionable New York store advertised a new "status" handbag of sea-turtle skin: "Only the underside of the turtle's flippers will do."

The first I saw of the traffic in turtle skins

was at a fishermen's camp just across the pass from our research station. As I walked into the cluster of thatched shacks, I noticed a man carefully salting and rolling the skin of the shoulders, neck, and upper foreflippers of a green turtle.

"What are you doing with the turtle skin?" I asked him.

"Saltin' it," he said. "Eduardo Sung instruct me how you roll dem to send away."

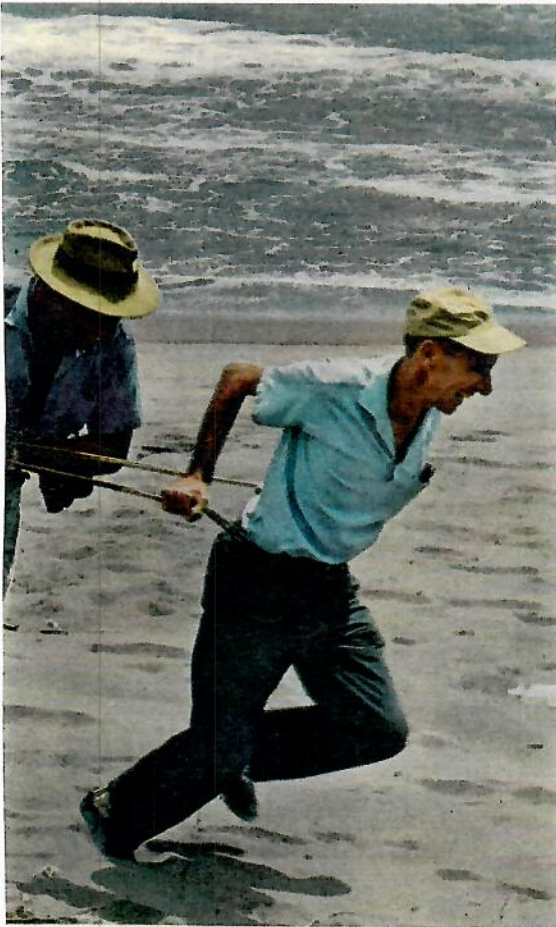
Sung was a buyer of shark fins, calipee, and tortoise shell. He operated from a little settlement up the coast.

I sat down and watched the workman make a neat parcel of the irregular rag of hide, stow it in a box under a layer of salt, and pick up another skin from a pile. I plied him with questions about the market for skins and learned enough to increase my misgivings over the future of the green turtle. Each new by-product increases the zeal of the hunters, both legal and illegal.

Several seasons ago, before turtling was outlawed, I was walking the Bogue one night without a light, as the turtle hunters do. Suddenly a voice came out of the darkness:

"Está poniendo [she's laying]."

It was Eligio, a spry Nicaraguan who had been turning turtles at Tortuguero every season for 35 years.



"I was letting her lay," Eligio told me. "But come over and see what a curiosity."

Most of the veladores never take time to let turtles finish nesting, simply because the wait cuts down the number they can turn in a night. But Eligio was a friend of mine, and we had had long talks about the plight of the turtles.

We walked quietly up the turtle track to where it met the coco plum bushes. There, barely discernible in a pit as deep as the depth of her shell, the turtle lay quietly.

I turned on my flashlight, reached down and pulled one of her back flippers aside, and exposed the neat egg cavity beneath them. As I watched, the turtle heaved slightly and two more golf-ball-size eggs bounced together on top of the growing pile.

"What's the curiosity you had to show me?" I asked Eligio.

"Look here," he said. "She came up with cargo besides the eggs."

He leaned over and picked up a three-foot length of wood that dangled a rope at one end. Eligio pulled gently on the rope and I could see

that it was fastened to the upper part of one of the turtle's foreflippers. The chunk of wood was a buoy. Some velador had caught the female coming ashore, attached the marker, then skidded her on her back down to the surf.

He had expected that, after righting herself, she would swim out to sea, where she could be hauled aboard a collecting launch. Eligio's turtle had been overlooked and had come back to finish her nesting.

Greens mate near the shore during nesting season. Males do not venture on land. Females lay eggs three to seven times, at 13-day intervals.

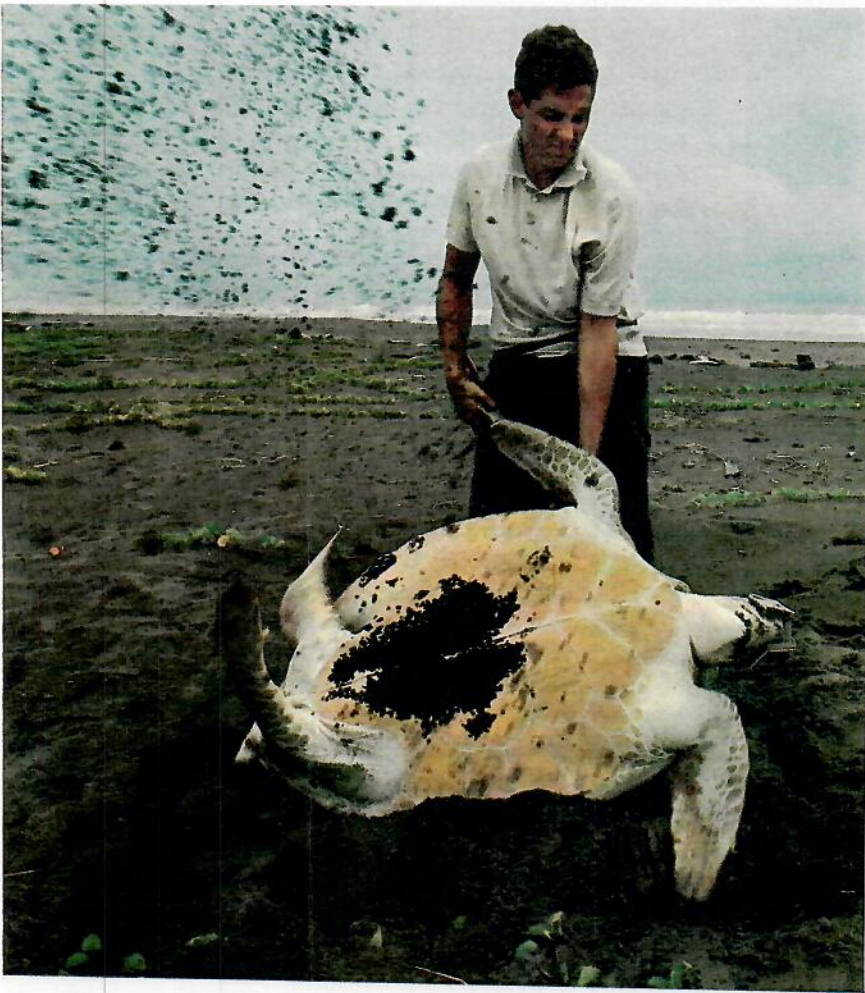
From July to November we gather eggs from Tortuguero nests and rebury them in our hatchery, a chicken-wire enclosure where the eggs can incubate undisturbed. A little circular wire fence surrounds each nest to keep out crabs (page 880). This also makes it easy to harvest the hatchlings and to keep track of unhatched nests. The peak of the hatching season, September and October, is a hectic time.

Four-man tow party just manages to move a green to the scales at Turtle Bogue. Biggest green ever recorded weighed 850 pounds; most adults range between 200 and 300 pounds. After measuring the reptile, hatchery workers attach a metal tag to one of her flippers. From among the 4,200 *Chelonia* thus far marked, 175 tags of captured turtles have been returned to Dr. Carr. His tagging system has revealed widespread travels—one specimen marked at Turtle Bogue turned up at Trinidad, 1,500 miles away. Tagging also shows that females rarely change nesting beaches.

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KODACHROME (ABOVE LEFT) BY KIP ROSS; EKTACHROME BY ROBERT E. SCHROEDER © N.G.S.





After incubating for about 60 days, baby turtles break out of their leathery eggshells and wriggle up through the sand, usually in the early morning hours. They burst out in flurries of little paddle-footed creatures, each the size of a silver dollar, and all with an inborn frenzy to scramble toward the sea (pages 881-2).

Early Habits Remain a Mystery

Every day we find them on the seaward side of their pens, put them in wooden tanks, and feed them chopped fish. When the turtles are about a year old and weigh from two to five pounds, their jaws are strong enough to crop turtle grass. From then on, they are mainly herbivorous. We still don't know what young turtles eat or where they go during their first year in the sea.

The thousands of Tortuguero hatchlings we airlift to other areas may rejuvenate extinct rookeries. We hope that the young turtles, imprinted by the smell, taste, or feel of such release sites as Bimini, or Cape Sable in Everglades National Park, will instinctively return there to breed when they mature.

On a recent Operation Green Turtle stop at Barbados, a ring of spectators watched as we opened six crates and freed 1,200 little turtles on the beach. All scurried across the snow-white sand toward the surf.

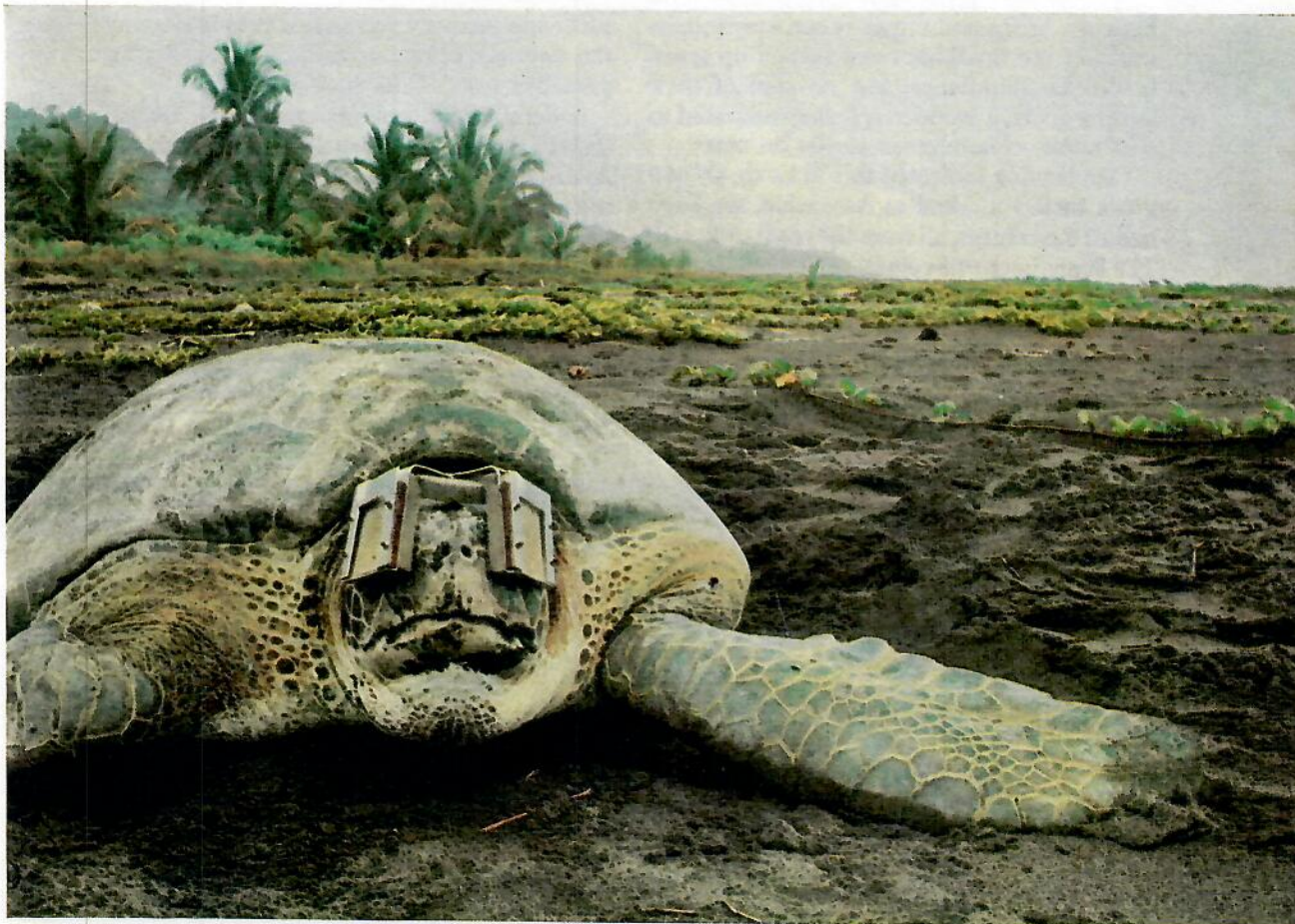
"They headin' fo' Tettel Bogue," a young Barbadian yelled.

It is a worrisome thought that the boy could have been right.

To date there is no clear evidence of renewed nesting at former breeding grounds we have stocked. Two important uncertainties trouble the restoration program. One is that nobody

Fitted with goggles that filter sky color, a female kicks up sand (top, left) as Dr. David Ehrenfeld of the University of Florida struggles to right her for a sea-finding experiment at Turtle Bogue. Spread-eagled like a sun-worshiper (above), she wears goggles whose interchangeable lenses depolarize the light or, alternately, let through red, infrared, green, blue, or ultraviolet rays. Blundering off, she eventually finds the water but her zigzag track reveals confusion (right).

Sight rather than sound, smell, or vibration guides females and hatchlings to the sea. This experiment tests a theory that sky coloration steers them. But results from turtles goggled day and night proved to Dr. Ehrenfeld that the brightness of the sea's horizon, not sky color, leads turtles to the water.



knows how long it takes green turtles to reach maturity. They have not been observed under natural conditions long enough for them to grow from hatchlings into breeding adults.

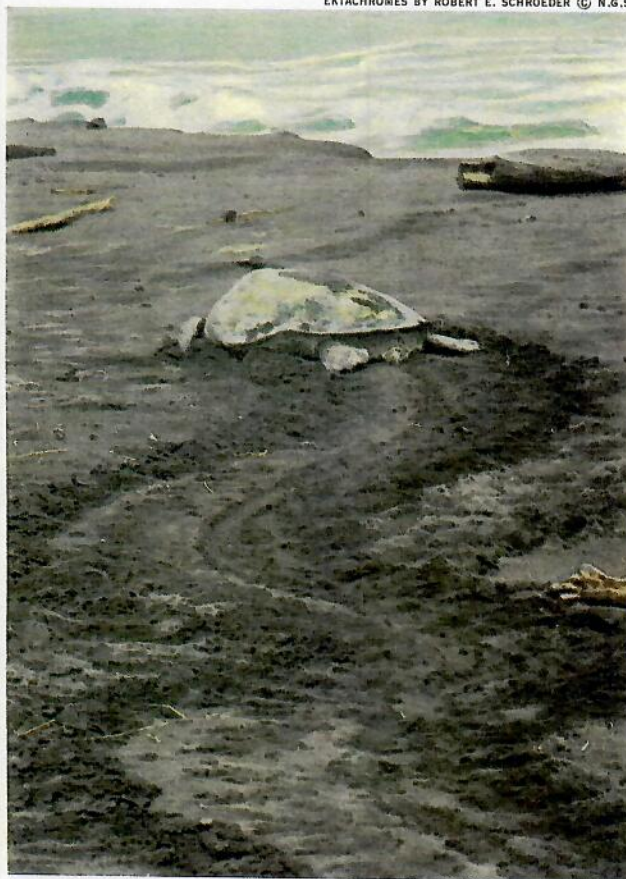
The other uncertainty is whether the transported hatchlings, when mature, will have the urge to go back to where we released them.

Another aspect of sea turtle behavior that is hard to investigate is the creature's ability to navigate in the open ocean. Our tagging studies have shown that the green turtle has a strong homing urge and navigational ability.

So far the process by which they hold courses and make pinpoint landfalls at the end of long journeys is not known. The most likely explanation is that smells of certain localities are carried by ocean currents, and that a sun-compass sense is used to help point the way.

Evidence of navigation has been reinforced by a supplementary tagging program we conducted at Ascension Island, a seven-mile-long speck on the submerged Mid-Atlantic Ridge, about equidistant

ENTACHROMES BY ROBERT E. SCHROEDER © N.G.S.



between Africa and Brazil. When a reconnaissance of the Brazilian coast turned up green turtles in abundance, but no sign of their nesting there, I wondered if they migrated to Ascension—where green turtles do nest.

Our tagging indicated this to be so. Of 556 green turtles marked at Ascension, we have had 10 tag returns, all from the coast of Brazil. The Brazilian turtle colony of *Chelonia* swims at least 1,400 miles to nest on the little cove beaches of the island—without a firm guidepost in all the watery way.

Considering the problems of direction-finding and position-finding that the green

turtle instinctively solves, it is easy to see why the animal excites anybody concerned with guidance systems, as the Navy is.

Several years ago Dr. Sidney R. Galler, then of the Office of Naval Research and now Assistant Secretary for Science at the Smithsonian Institution, asked me if a turtle would tolerate an apparatus bolted to its shell. I said I was pretty sure it would if the device was not too bulky. He was thinking of miniaturized tracking radios.*

*One use of such instruments was described by Frank and John Craighead in "Trailing Yellowstone's Grizzlies by Radio," NATIONAL GEOGRAPHIC, August, 1966.



EKTACHROME (CENTER) AND KODACHROMES © N.G.S.

Blimp bobs above a turtle to aid scientists tracking its course at Turtle Bogue. Tethered to a plastic-foam buoy tied to the turtle's shell, the balloon provides a target for trackers who follow the green from triangulation towers (above). Observers thus learned that the reptiles loaf offshore between trips to the nesting beach.

Scientists have also discovered that mature green turtles surface to breathe every few minutes, and rarely dive deeper than 70 feet.



We have fitted turtles with such radios, but found that the curvature of the earth imposes limitations on transmission. We may soon overcome this problem, however, for NASA has suggested that the facilities of a satellite might become available. Signals from a transistorized turtle could be picked up by a satellite in orbit hundreds of miles above the earth.*

One of our experiments has offered encouraging evidence about the prospects for tracking turtles by satellite. That evidence arrived

*See "Telephone a Star: the Story of Communications Satellites," by Rowe Findley, *GEOGRAPHIC*, May, 1962.

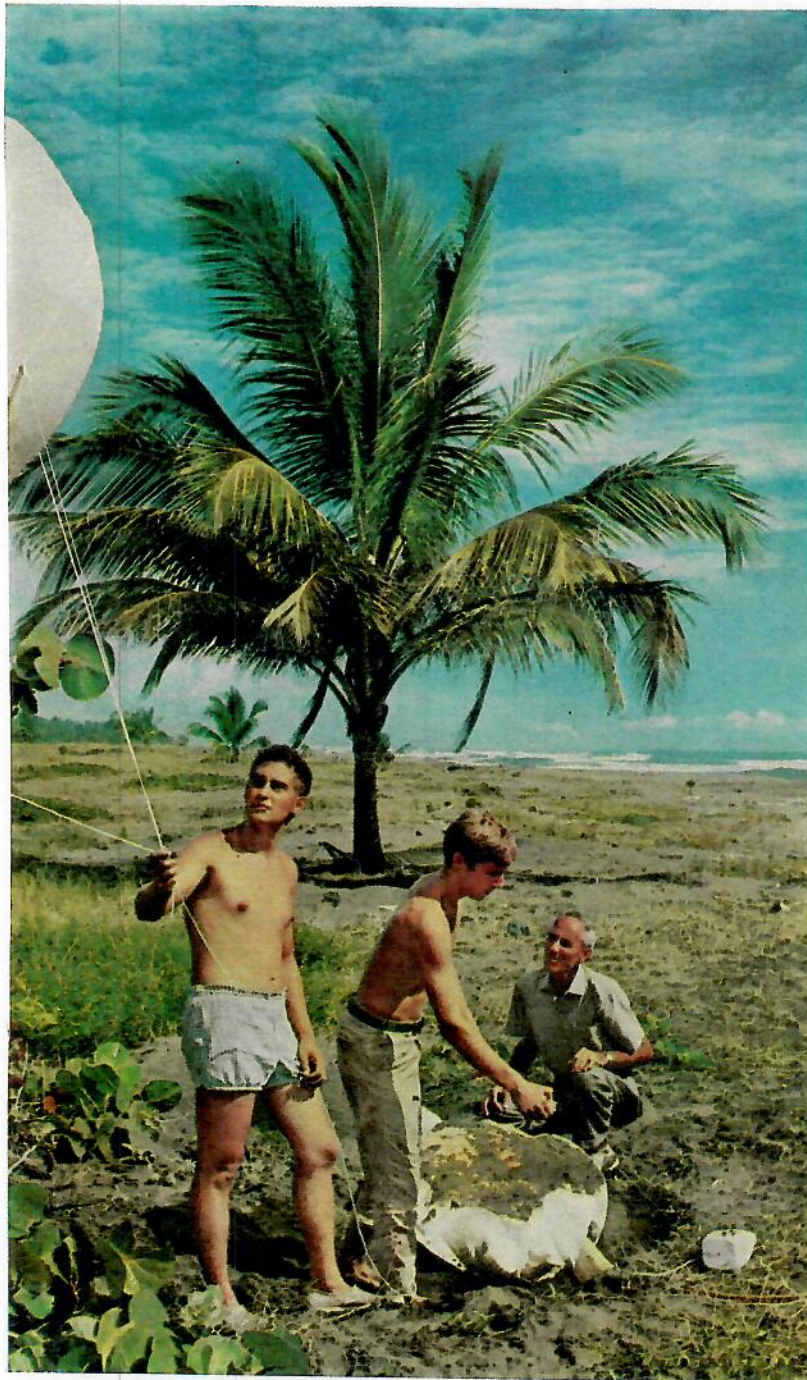
one evening at Turtle Bogue, while I was dozing in a hammock. Suddenly I heard a voice out toward the beach say, "3903..."

I jumped to my feet and yelled, "What about 3903?"

"She's back," replied Shefton Martinez. "She came out a little way up toward the pass."

Shefton cooks our meals and doubles as research assistant at the green turtle station. He had been on a routine patrol of the beach that night when he came upon a big green turtle busily covering her nest of freshly laid eggs. A Monel-metal tag on her left front flipper bore the number 3903.

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The turtle had been caught several days earlier on the beach before she could dig her nest. We had coupled to her a plastic-foam float; from the float a big blimp-shaped helium balloon rose on a 100-foot line. The day before she returned to shore she had cruised off the Bogue, towing the apparatus.

In this case the turtle had stayed in sight of land. We tracked her by taking continuous compass bearings from the second-floor porch of the green turtle station and from a tracking tower a mile down the shore.

Significantly, the rig the turtle carried was just as cumbersome as any we would need for electronic tracking. Her return meant that the load had neither killed her nesting

instinct nor interfered with her urge to go back to a specific section of the shore.

This experiment told us that in navigation tests a green turtle can be expected to travel with a load of instruments and go to places we could predict.

There is no telling what the future holds for green turtles. Someday, perhaps only a few years hence, new nesting colonies of them may flourish where they were wiped out long ago. Someday our tagging studies may help solve mysteries of animal migratory guidance, a phenomenon that still is far from being clearly understood. Until that day comes, nobody at Tortuguero expects to get much rest at turtle-nesting time.

890 **ON A STRAIGHT LINE TO THE SEA, a turtle digs a rut that resembles a tractor's track; no goggles now hamper her sight (page 887). Once, the reptiles provided fresh meat for sailing ships' crews, including those of Columbus. Now, if allowed to breed and graze in peace, a replenished tribe could help feed Caribbean peoples.**

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