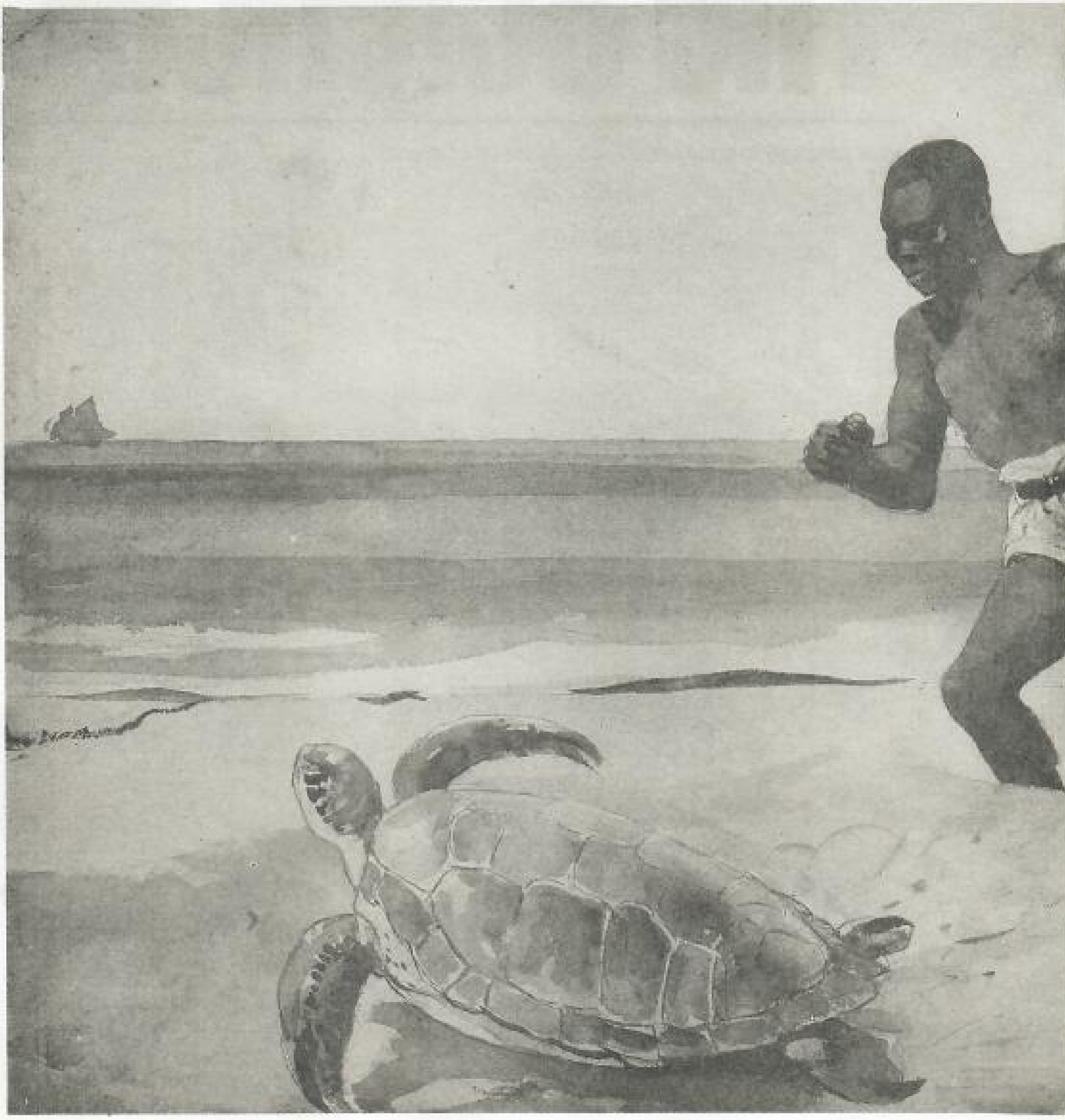
1984

Mystery of the Missing Year

Chasing sea turtles to their secret sanctuary

by Archie Carr

Winslow Homer, **Rum Cay,** *1898*



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ALONG THE WARM SHORES of the world's oceans, sea turtles are a familiar sight, rising to blow by a fishing boat or dragging themselves up on beaches to lay their eggs. But there was a time, not very long ago, when nobody had the vaguest idea where little turtles lived until they reached the age of a year or more and had grown to about the size of a dinner plate. Once a turtle hatched on a beach, scuttled down to the water, and crossed the breaker line, it seemed to disappear from the face of the earth. I have lived most of my life in sea turtle country, where fishing people ransack the inshore waters of coves and bays with cast nets, gill nets, stop nets, and shrimp trawls. But until recently I had never heard of anyone's catching a sea turtle from the missing year.

I first realized the extent of this mystery in the 1940s, while gathering information for a *Handbook of Turtles*. I read virtually everything in print on the natural history of sea turtles and found almost nothing about their first year of life. In the world's natural history museums, there were collections of newly emerged hatchlings preserved in jars of formaldehyde, but these were mostly taken from nests or caught with dip nets from boats anchored just off a nesting beach. (Sea turtles usually hatch at night or right before dawn, and they are attracted by a boat's riding lights and lit portholes.) Beside these, there were larger specimens, dried or stuffed, in the museums, but there were none from the missing year. When the handbook finally came out, all I could say about the beginnings of sea turtle life in the sea was this: "Once in the water young loggerheads are seldom seen, and their early activities remain a mystery." And it was the same with the young of the other species—green turtle, hawksbill, ridley, and leatherback. They all disappeared.

In the Dark Ages, people believed that wild geese, which suddenly appeared in the European landscape each spring, hatched from goosenecked barnacles, whose long stems suggested the necks of geese. The goose was *Branta leucopsis*, which breeds in the Arctic and flies south to Europe. Its life has nothing to do with barnacles. The lost year of the sea turtle is a mystery with reverse English: we know where the little turtles come from, but until now we could not say where they go.

Looking back, it seems strange how slowly the explanation took shape. I ought to have figured that anything might be possible, since even the earlier stages of sea turtle life are astonishing. The female's custom of going ashore and depositing edible eggs in the sand seems a perverse evolutionary gesture, one likely to doom sea turtles to early extinction. But sea turtles have been doing it now for at least a hundred million years.

Most adult turtles either graze in shallow water on submarine pastures of eelgrass, as the green turtle does; prowl the bottom eating crabs, shrimps, and mollusks; or cruise along the edges of currents to forage on the jellyfish that congregate there. When the mating season arrives, they may swim as far as a thousand miles, sometimes across the open ocean, to ancestral breeding grounds. One of the best known of these is the beach at Tortuguero, in Costa Rica, where sea turtle research has been in progress for thirty years. When the turtles arrive there, they mate just offshore; then the female crawls inexpertly up the beach and, in a carefully chosen place above the reach of high tide, digs a hole and deposits her round, leathery eggs. After meticulously covering the nest and tamping down the filling, she conceals the site by slinging sand around and goes back to sea, never to see her progeny unless by some chance encounter a long time later.

The eggs are left buried in a chamber two or three feet down, where the permanently moist sand ensures a microclimate just right for incubation. This is one of the marvels in the sea turtle's instinctive equipment. If the female buried her eggs only inches deeper, they might be flooded by the tide, and the embryos would drown in their shells. A few inches less deep, they could dry out in the hot sand. The old turtles virtually always place the eggs just right, however, and after two months or so they hatch. Immediately, the little turtles face their first ecological hurdle—moving upward through a yard or so of sand.

Because the spherical eggs occupied more space in the nest than the newborn turtles do, the hatchlings find themselves in a cell with an inch or so of headspace. To get to the surface, they don't merely decide that upward is the way out and start digging at the ceiling. Their approach is not so purposeful. I have watched the behavior of hatchlings of three different species, in both natural and simulated nests with a glass pane in one wall. The first turtles to hatch lie quietly, with only occasional spells of squirming. From time to time, however, the weight of the upper tiers of turtles irritates the lower and triggers frequent outbursts of squirming and flailing of flippers. These random writhings dislodge sand from the walls of the chamber, and bits of the ceiling collapse. Then, as the dislodged sand sifts down through the little turtles, it elevates the floor, and the thrashing hatchlings rise toward the surface.

Barring exceptionally heavy seas or outside interference from scavenging predators, a complement of hatchlings rarely fails to emerge on the beach by this wholly unpurposeful cooperation. On arriving just beneath the surface, with only an inch or so of sand over them, the hatchlings rest quietly, as if awaiting some signal to break out into the world. The signal generally comes in the hours before dawn; it is probably the lowered temperature of the sand that stimulates the breakout.

In any case, the hatchlings emerge en masse and then must find the sea. Sometimes it is in plain view, but often the nest is behind a dune or drift log or beach vegetation that blocks the view to seaward. They find the water all the same, without setbacks and with very little straying, moving across the dry sand of the upper beach by fits and starts, thrashing along with their long flippers, then resting and peering ahead briefly, then moving off again. As they arrive at wave-washed sand, their pace mounts. When the uppermost reach of a wave lifts a hatchling, its crawling instantly gives way to swimming.

Through the first period of overland travel, in a world just seen for the first time, the hatchlings are obviously guided toward the sea by some sensory beacon. Apparently, it is the character of the light over the open sea that guides them to the water. Whatever the sea-finding sense, the stimulus of being lifted in the first half-inch of wave-wash trips a switch and in an instant releases the inborn swimming talent. Then there comes the staggering obligation to get through the surf. For a flat, leggy, newborn creature weighing only an ounce or so to go barging through a breaker line is out of the question. The turtle's strategy is to pass through the breakers by diving as each crest flashes white, and to move out with the undertow. By repeating this straightforward process, it soon reaches fairly easy water beyond the combers. But then what? That is the abiding puzzle of the lost year.

Archie Carr is Graduate Research Professor in the department of zoology at the University of Florida, in Gainesville. Since 1955, he has directed the green turtle research program in Tortuguero, Costa Rica. His most recent book is So Excellent a Fishe, A Natural History of Sea Turtles.

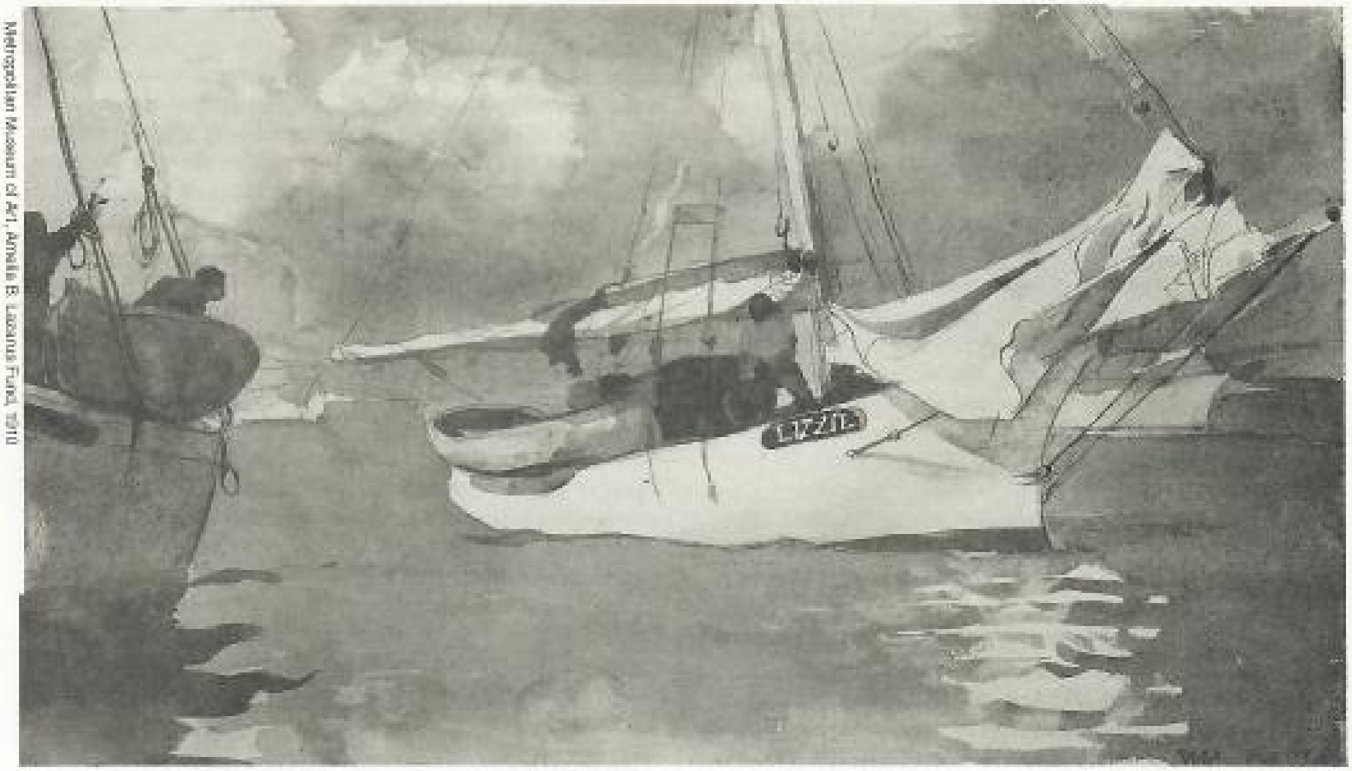
For years, I talked about this with zoologists and with fishing people along the coasts of North and Central America. Nobody had a solution. Anyone who had ever kept newly hatched turtles in tanks, however, had noticed their strong swimming urge and their enormous energy. Hatchlings swim furiously against the walls of a confining tank, sometimes for days. It is not that they are scared or starving, or that the water is too hot or too cold. The hatchlings just seem in a passion to get somewhere. They paddle so frantically against the tank wall that, in the case of little leatherbacks especially, they often rub the skin off their noses. This powerful swimming urge, combined with a residual supply of nourishing yolk in the bellies of the hatchlings, seems clearly to be an adaptation to carry the turtles somewhere far off.

Most people who stopped to wonder where the turtles go assumed they must just head somewhere up or down the coast. The swimming frenzy must serve to distribute them along a shoreline, scattering the hatchlings into estuaries, coves, and bays. It seemed obvious that the mysterious destination ought to be shallow water, because sea turtles feed on the bottom. Even the largest adult turtles forage mostly in inshore waters, where their food is concentrated.

There was another possibility, of course, but it seemed farfetched. It was that the baby turtles, small as they are, headed out into the open ocean. Although most of the many local fishermen I interviewed had no theory to account for the lost first year, a few had concluded that the hatchlings do in fact swim straight out to sea. "They go into the berry grass," several fishermen told me, berry grass being floating masses of seaweed called sargassum. This idea was most often advanced by dolphin fishermen, who frequent the edges of offshore currents where sargassum collects, because dolphins regularly lurk beneath the mats. Quite often "weed line" fishermen I spoke with on the Florida coast south of Cape Canaveral had seen little turtles either in sargassum or in the stomachs of fish they had caught there.

In an area of the Atlantic near Bermuda, sargassum floats on the surface in such abundance that the place has been given the name Sargasso Sea. Christopher Columbus was the first European to encounter it, on his maiden voyage across the Atlantic, in 1492, and since it seemed a sign of land it encouraged his near-mutinous crew to sail on. Sargassum rafts are home to crabs, shrimps, mollusks, and small fish. Some of these creatures are so closely adapted to life in the rafts that they can live nowhere else. Thus, if turtles hid in sargassum, they would find food and a place to hide from predatory birds and fish.

Because sargassum is dispersed over such a vast expanse of ocean, the idea that hatchlings might be hiding out in drifting rafts of the weed was exceedingly difficult to test. There are myriad sargassum mats in the waters of the world; the odds against finding little turtles by simply cruising among the rafts made the project, for logistic reasons, out of the question. Information had to come from beach strandings of weed rafts, from volunteers, from interviews with saltwater people in propitious places, and from "platforms of opportunity," as the jargon of marine research has it—vessels cruising with other



Winslow Homer,* Fishing Boats, Key West, *1903

aims, but willing to look out for hatchlings. In the past few decades, I have recorded more than a hundred such observations, none conclusive in itself but all pointing in the same direction. We can now say a good deal about the sea turtles' lost year. But the discovery has shown us that their way of life is not without its hazards.

MOST OF THE EVIDENCE for the turtles' hideaways is circumstantial, and is persuasive only when taken as a whole. In 1966, for instance, I received a letter from Edward M. Cook, of Eau Gallie, Florida:

> As a matter of interest, I wish to report to you the following observation:
>
> On Thursday, August 18, at approximately 2:00 P.M., I sighted two loggerhead hatchlings floating in a substantial patch of sargassum weed on the edge of the Gulf Stream approximately twenty-six miles east-northeast of the Sebastian Inlet, or twenty-four miles east of the coast. One hatchling was approximately the size of a half-dollar, and the other approximately double that size. The weather was hot, with a smooth sea and a slight southeast breeze, and the current very strong. There was much other life of all forms and sizes in the water. Our position was at the edge of the stream or within a half mile into it. I thought you might be interested in this.

In 1978, during a cruise of the research vessel *Alpha Helix* in the western Caribbean, we found little green turtles in the weed line off Colón, Panama, more than a hundred miles south of the big breeding ground at Tortuguero, where they had almost certainly hatched. And in 1981, a research vessel of the Skidaway Institute of Oceanography had a remarkable encounter with a large group of loggerhead hatchlings at the inner border of the Gulf Stream, about seventy-five miles off St. Augustine, Florida. According to a graduate student at Skidaway, Phil McGillivary, who told me about the observation, dozens of hatchlings were seen in a short stretch of weed line. These turtles must have come from a beach somewhere between Cape Canaveral and Cape Florida and been carried south in the longshore current before being transported into the Gulf Stream somewhere near Cape Florida, and then being carried back northward.

In the early 1970s, inspired in part by such sightings, Jane Frick, a devoted student of sea turtles and an exceptionally good swimmer, simply got in the water and followed hatchlings. By snorkeling along behind them after they passed through the surf, she was able to follow at a distance of five or six feet and, in the clear water of Bermuda, keep them constantly in view for miles. The turtles appeared unconcerned by her presence and traveled on in the same direction, even if she moved up alongside. Frick herself was followed at a distance of a few hundred feet by a boat from which assistants plotted her course.

Those simple tracking tests indicated that the hatchlings traveled for distances of at least several miles, and that even after the shoreline had receded and all landmarks had disappeared from their horizon, their courses were directly away from land and toward open ocean. Later on, Frick tracked hatchlings off the breeding ground in Tortuguero. Swimming is out of the question down there; the sea is usually rough and often turbid, and sharks abound. So the Caribbean hatchlings were followed by boat—a dugout with an old diesel engine—with assistants from the Caribbean Conservation Corporation research station and from Tortuguero village. As in the Bermuda trials, the presence of a boat, even close alongside, did not distract the turtles, and the observers stayed just near enough to keep their subjects in view.

The hatchlings in these tracking experiments had been picked up on the beach as they crawled down to the sea. A few dozen of them were brought aboard the boat and put into a darkened container; a number of others were released at the breakers' edge. When Frick and company, waiting just past the breaking surf, spotted a swimming hatchling, they cruised along behind the turtle, dead slow. If a shark or a kingfish or a frigate bird grabbed the turtle they were following, the observers immediately took out another hatchling from the container on board and dropped it into the water. Though each of these replacement turtles had been in a covered bucket, it always assumed a course directly away from shore, even after the land was long out of sight, and moved away on a bearing consistently within a few degrees of those taken by preceding turtles.

Out at the edge of the north equatorial current, a line of sargassum rafts stretched out of sight in both directions. The remaining captive hatchlings were released there, where they disappeared into the floating mats of seaweed; and the big dugout with the old diesel plodded slowly home, arriving after dark.

Working in this way, Frick was the first person to prove that little turtles travel constantly on courses directly away from shore for many miles and to see them clamber onto sargassum rafts.

DURING THE PAST THREE YEARS, observations of hatchlings in or near sargassum rafts have multiplied, and each has been a cause for minor celebration for those who have long pondered the lost-year puzzle. One day last year, my secretary came hurrying down the hall to tell me I had a long-distance call. "It's a call from a yawl," she said. The summons was auspicious because I knew only one yawl, the research vessel *Geronimo*, operated as a sailing classroom by St. George's School, in Newport, Rhode Island. Bob Hueter, the biologist on board, had been on a cruise with me the year before, searching for little turtles off Florida at the eastern edge of the Gulf Stream, southwest of Bermuda. He had promised to look out for them during the *Geronimo* cruise. It was Bob on the telephone. "We found them!" he said. "Little loggerheads, two of them, about five inches long. They were in a bloom of blue-green alga. No big weed rafts—only scattered patches of sargassum." Those little turtles were a long way in space and time from their native shore.

From such observations, it is now abundantly proved that hatchling loggerheads of the huge breeding colony on Florida's east coast regularly take refuge in sargassum and drift for long distances. There is growing evidence that hawksbill and green turtle hatchlings do the same. Since they have no control over their destinations, their lives are by definition planktonic—at the mercy of the currents. In one way, it seems absurd to speak of such furious swimmers as plankton; but the swimming frenzy is merely a launching adaptation, an initial short-lived interlude of strong self-propulsion to get the hatchlings away from the tumultuous and predator-ridden inshore waters. From the moment they enter the water, the little turtles have a very specialized problem, and the adaptive equipment to cope with it. The infantile swimming frenzy, the several days' worth of residual yolk that fuels their frenzy, and the orientation sense that guides it are all adaptations for getting away from land and into the open sea. Once there, though their long-range travels are passive, their life in and around the sargassum is by no means inactive. They swim around and under the mats, crawl across their tops, move from one mat to another, and dive to considerable depths to feed—or to escape a dip net.

Just how long they remain in the rafts is still not known. Many more very young turtles have been found than older ones—simply because older turtles, having drifted longer, are far more widely dispersed. However, growing numbers of older sea turtles have been recovered many months after hatching season, and at great distances from all known nesting shores, as in the *Geronimo* discovery. Moreover, sargassum leaves and floats, and invertebrates known to be habitués of sargassum rafts, are often found in the stomachs of turtles many months old that have been thrown ashore in weed wrack by storms.

To predict the routes taken by hatchlings as they drift away from their natal beaches is complicated, because different sets of hatchlings leaving the same breeding shore may get caught in different eddies and currents and take different paths. For example, at the nesting ground of both the Florida loggerheads and the green turtles at Tortuguero, a south-trending current shoreward of the north-trending main current is created by eddies generated when the Gulf Stream strikes Cape Canaveral and when the north equatorial current moves past the Nicaraguan cape. Thus, Tortuguero hatchlings might either circle in the local eddy and stay in Central American waters or be carried by the north equatorial current through the Yucatán Channel, travel in the loop current through the Gulf of Mexico, then enter the Gulf Stream and move past the east coast of Florida and out to Bermuda, and perhaps finally be carried toward the Caribbean again. The Florida turtles, similarly, may get carried away by the main Gulf Stream or circle locally between Cape Canaveral and Miami in the opposing longshore and Gulf Stream currents. There is now evidence that lost-year turtles drift along all these routes.

FINDING THE LOST TURTLES has led to further ecological insight: the importance of shears and convergences in condensing food and shelter in the open sea. Convection at current borders and under strong and continuous winds often sweeps seaweed and flotsam into rows on the surface of the sea. The Gulf Stream, for instance, passing the east coast of Florida at distances ranging from two to eighty miles, is a great, warm, steady current fifty miles wide, traveling north at about four miles an hour. As it passes the coast, it slides against—shears—the still water near shore. This shearing action creates convection along the border between the current and the still water, and sargassum mats frequently line up there in more or less continuous bands. For loggerhead hatchlings swimming seaward from the big nesting colonies on Florida's east-coast beaches, this alignment greatly increases the likelihood that they will promptly lodge in the sargassum. And time is of the essence, since they have only a small store of fuel for travel, and if sargassum were harder to find they would likely starve. The north equatorial current passes near the Caribbean coast of Costa Rica, and the sargassum lines that form along its inner edges are a similar boon for the green turtle hatchlings of Tortuguero.

There are other causes of drift lines, as sailors call aligned flotsam. In flying above the Florida coast, one often sees the surface of the sea striated with drift lines, parallel and evenly spaced. These are smaller than the great weed lines at the edge of the Gulf Stream, and in any case they are too far inshore to have been caused by the current itself. Here the aligning force is the wind, which, by a complex process known as the Langmuir effect, deploys flotsam in evenly spaced lines parallel with the wind direction. The same arrangement of the sargassum rafts is often seen in the Sargasso Sea.

Thus, convergences make the open sea a much more livable environment, creating linear habitats in which opportunities for shelter and food are multiplied and the abundance and diversity of life are markedly increased. Whether or not the convergence zone contains sargassum, it concentrates the organisms on which little turtles feed. Off some nesting beaches—those off the Pacific coasts of Mexico and Costa Rica, for instance, and in the islands of the Pacific and Indian oceans—there is no sargassum weed. In at least some of these places, however, convergences do occur not far offshore and concentrate macroplankton that hatchlings can eat.

Our slowly growing understanding of the hatchlings' habitats is a satisfaction. But it is marred by the realization that as the seas are loaded with more and more of the offal of civilization, the drift lines become less a refuge and more a trap. The same shears and down-wellings that cause sargassum and plankton to accumulate in bands concentrate every other kind of flotsam. Little turtles are peculiarly indiscriminate feeders; they tend to pick up all particles of bite size that they find in the weed lines. One frequent element is tar balls, from distant oil spills. Another is plastic debris, either broken-up Styrofoam or the industrial pellets, two or three millimeters in diameter, from which plastics are made. Both kinds of plastic abound in the ocean, and both are often found in the stomachs of lost-year turtles. Along the Florida coast almost every autumn, waves throw ashore dead young turtles of lost-year size in bundles of sargassum. Their jaws or throats are often occluded by tar.

Usually, the better one understands the life of an animal, the more one can do to protect it. But the sargassum rafts and convergence zones pose an intractable problem. You can stop people from building condominiums too close to the good turtle beaches, and keep them from driving cars on the sand during nesting season. But can the spilling of oil in the oceans be stopped? The same forces that bring life to the convergence zones are concentrating trash and poison there. The sargassum rafts and drift lines that shelter and feed the little turtles are now killing them off. ■

The Brooklyn Museum, Sustaining Membership Fund, A. T. White Memorial Fund, and A. Augustus Healy Fund

Winslow Homer, **The Turtle Pound,** ***1898***