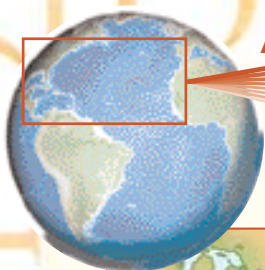


# ATLANTIC OCEAN: *The Atlantic's Wandering Turtles*



*Newborn loggerhead turtles embark on a transoceanic crossing of thousands of kilometers. Researchers are trying to determine where they go and how they survive in the featureless, blue expanse* by Thomas Dellinger

It is high noon. Around us, the sea is motionless under a clear, blue sky and a scorching sun. In the distance, Madeira Island is a reddish-brown mound emerging from the mirrorlike surface of the water.

On closer inspection, the mirror is dotted with cobbles here and there that disrupt the flat surface. We aim our orange, rubber inflatable boat toward the nearest one and try to make out the droplike silhouette.

These brownish bumps are juvenile loggerhead sea turtles, and they are fast asleep. As we approach the one we've spotted nearby, we attempt to figure out where the head should be. The idea is to come at it from behind, carefully, so as not to wake it.

We glide the last few meters, with the 40-horsepower motor idling. Notwithstanding the noise, the turtle continues its deep slumber. Only when my colleague Carla Freitas bends over the bow of the boat and grabs the shell firmly with both hands does the turtle paddle helplessly with its flippers.

After driving around in the boat for two hours, we have finally made our first capture of the

day. There is no time to make measurements of its shell—more properly known as a carapace—and head and flippers, because before long the sleeping turtles will all be gone. This basking behavior, as it is called, happens only around the middle of the day, and each turtle sleeps for only an hour or so. When they resume diving after their nap, we'll have almost no chance of spotting and capturing them. So for this first capture, and all the others that follow

it, we simply note the Global Positioning System coordinates, clip the turtle with little metal identifying tags on the inner rims of both foreflippers and leave it in the boat. A short distance away another turtle drowns and is next to be grabbed.

By three o'clock we have hauled in a total of 20 turtles, and there are no more to be seen on the surface. After measuring them, we clean their carapaces, removing the algae and barnacles for later analysis. At about 5:30 it is time to release them into their vast, blue lair. Stroking strongly away from the boat with its front flippers, our first capture appears to have suffered very little from its short time in captivity. After a couple of meters, it pauses and looks back, as though questioning whether the ordeal even took place.

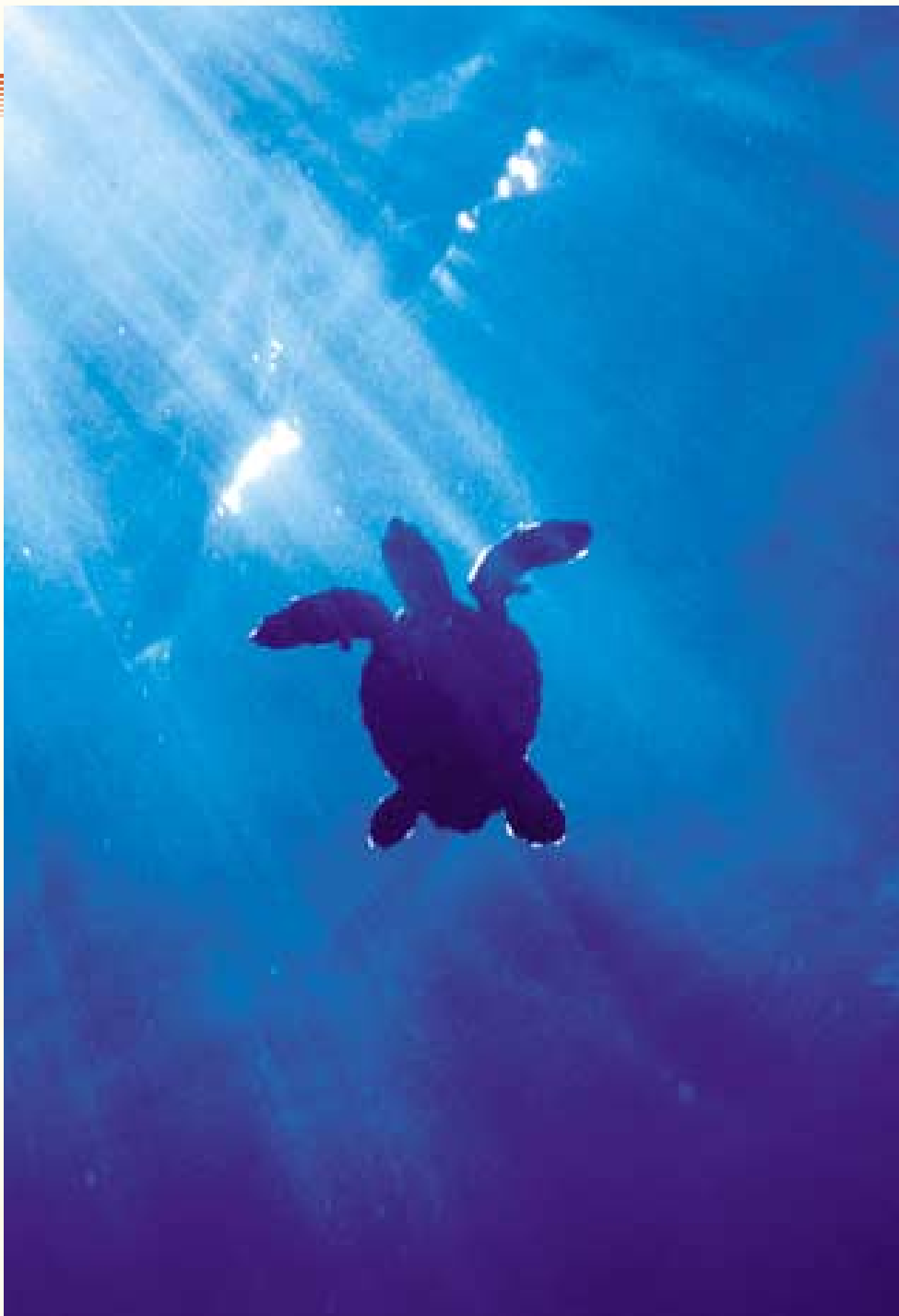
### Mystery of the Turtles

Where do these turtles come from, and what are they doing here? The first question was answered only recently after several decades of research; the second is the subject of our current work. There are a total of seven different species of sea turtles, all of which are endangered to some extent. Five of these species are seen in the sea surrounding Madeira, its sister island Porto Santo and the Azores. Practically all the turtles seen in these waters are loggerheads, but we are occasionally visited also by leatherbacks, the largest species of sea turtle, as well as by green, hawks-



YOUNG LOGGERHEAD sea turtle named Lidia was the first outfitted by the author's group with a small data collection and transmission unit, enabling her movements to be tracked in the open ocean. In June, she was between Madeira and the Azores.

CARLA FREITAS



PETER WIRTZ

**SWIMMING TURTLE** was photographed off Funchal, capital of the Madeira Islands in the North Atlantic. After hatching, typically on southeastern U.S. beaches, loggerhead turtles embark on a transatlantic journey that can take a decade or more.

bill and, very rarely, Kemp's ridley turtles.

The profusion of turtles around the Portuguese islands puzzled naturalists for many years. All species of sea turtles lay their eggs in nests dug into sandy beaches, which are in short supply on these islands. Madeira, for instance, has no sandy beaches whatsoever. Porto Santo, on the other hand, does boast a gorgeous, nine-kilometer-long stretch of uninterrupted, white sandy

beach—but has no record of turtle nesting.

The lack of turtle nests on Porto Santo was established back in the 1930s, when the island had only a small fishing village and the sandy beach was viewed as an obstacle to fishing rather than as a tourist bonanza. By interviewing fishers, Artur Sarmiento, a Madeiran naturalist, found that sea turtles did not nest on the beach.

Almost 40 years went by before someone

else took an active interest in the question. While studying stranded and accidentally caught turtles on European coasts, Leo Brongersma, a Dutch scientist, marveled at Madeira's plentiful supply. "I estimate that a thousand (and probably more) are taken each year," he wrote, based on interviews with local fishers and souvenir-shop owners who sold crudely stuffed and varnished turtle corpses to the tourists who poured out of the cruise ships in Funchal Harbor. In 1967 Brongersma noted that most turtles found in British and other European waters were, at 10 to 15 years old, fairly young. Loggerheads, for example, do not mature until they are at least 13 years old and perhaps as old as 30 years, and it is believed they can live from 60 to 90 years (no one knows for sure how long loggerheads can live in the wild). Brongersma proposed that the turtles came from the Gulf of Mexico and suggested that "migrations across the ocean may form part of their normal pattern of life."

On the other side of the Atlantic, meanwhile, the absence of turtles of a certain age and size was puzzling scientists. They saw adult turtles digging their nests on beaches in Florida, Georgia, the Carolinas and along the Gulf coast. They also saw the hatchlings run for their lives down to the sea and disappear into the rolling waves. Then they saw little or nothing of them for a period that American naturalist Archie Carr dubbed the "lost year."

Carr was the driving force behind American efforts to solve the mystery. He collaborated for years with Helen Martins of the University of the Azores, who had measured turtles in Azorean waters and found that their size distribution exactly fitted the gap in the Florida size distribution. Shortly before his death in 1987, Carr elaborated on Brongersma's hypothesis that ocean currents in the Atlantic carry the juvenile turtles from their southeastern U.S. birthplaces to the Portuguese islands and eventually return them to the U.S. later in life for nesting.

The idea that Atlantic currents could carry objects great distances to the east was not new. Even Christopher Columbus is said to have noticed strange objects on the beach at Porto Santo while pondering routes to what he believed to be the Indies (the flotsam helped to convince him that land lay somewhere over the horizon).

Like all other oceans, the North Atlantic has a large-scale, looping current system called a gyre. The North Atlantic gyre starts with the Gulf Stream, which flows northeastward from the Gulf of Mexico, the Caribbean and the waters off the south-



THOMAS DELLINGER

**BASKING BEHAVIOR**, in which sea turtles float for about an hour in a deep slumber, occurs around midday. To catch the turtles for tagging, researchers study the bobbing forms and then approach the creatures from what appears to be the rear.

eastern U.S. The Gulf Stream divides itself around the Azores into the northeastward-going North Atlantic Drift and the Canary Current. This latter current then circles around clockwise to the south and begins its return trip across the Atlantic as the North Equatorial Current. Finally, it flows back into the Caribbean and Gulf region as the Caribbean and Antilles currents. Thus, loggerhead turtles born along the U.S. Atlantic beaches are picked up by the Gulf Stream; once there they do not need to do anything except survive and make their way into the Canary Current [see “How Sea Turtles Navigate,” by Kenneth J. Lohmann; *SCIENTIFIC AMERICAN*, January 1992]. This way, they reach Portuguese waters both at the Azores and here at Madeira.

### A Mystery Solved

**D**uring his lifetime, Carr had access only to circumstantial evidence that the turtles in the Portuguese islands are the ones missing from Florida. Yet his former students and collaborators, Alan B. Bolten and Karen A. Bjorndal, worked with Martins in the mid-1980s to tag large numbers of turtles off the Azores; a few were later recovered off Florida.

We now know that loggerheads are found throughout the world’s tropical and subtropical waters. Most of the nesting sites of the large Atlantic population are on southeastern U.S. beaches. A smaller loggerhead population lives in the eastern Mediterranean and nests primarily in Greece and Turkey. For Pacific loggerheads, the major nesting areas seem to be

in Japan and, to a lesser extent, Australia.

Irrefutable proof for the long, strange trip of the Atlantic loggerheads awaited the genetic-identification techniques that became available in the 1990s. Female turtles generally nest on the same beaches where they were born and therefore have a distinct DNA identity from females born elsewhere. In a project led by Bolten, now at the University of Florida, Martins, Bjorndal, four other researchers and I compared the DNA of female loggerheads taken from Madeira and the Azores with that of females at nesting beaches in the North Atlantic and Mediterranean. Our finding, published earlier this year, was that between 88.1 and 91.9 percent of the turtles at the Azores and Madeira were born on Florida beaches (the rest are probably from Georgia, South Carolina and Cuba). We also showed that the loggerheads found in Madeira and those in the Azores are genetically indistinguishable and therefore are part of the same population.

The so-called lost year of the Atlantic loggerhead is actually not just one year but more like 10 to 15 years. During this time, the hatching loggerheads are believed to drift for a few months in the Sargasso Sea, sheltered within enormous mats of

sargassum seaweed. Then, as juveniles, it seems that they search for and inhabit open-ocean eddies and frontal systems, where their favored foods—jellyfish, squid, various floating dead sea creatures—accumulate. In this stage they are truly “pelagic,” living far from the nearest landmasses.

Still, astonishingly little is known for certain about these lost years of the loggerheads. As Carr wrote in 1984, “It is frustrating not to know where the Azores migrants are spending the years it takes them to grow from saucers and dinner plates to the heft of the Florida subadults.” The statement remains true to this day.

Understanding more about this stage in the sea turtle’s life cycle is the aim of our program, Projecto Tartaruga Madeira. As we accumulate information about juvenile pelagic-stage sea turtles, one of our most important priorities will be using the knowledge to protect them more effectively in the future.

As their numbers declined worldwide



PHOTOGRAPHS BY THOMAS DELLINGER

**DATA COLLECTOR** and transmitter was attached to the sea turtle Lidia with fiberglass resin. The 380-gram unit will drop off the loggerhead after about a year.

over the past half a century, sea turtles became a “poster species” for animal conservation efforts because they are so defenseless to human encroachment and destruction. In many parts of the world, sea turtles face mortal threats throughout their lives: nesting habitat is being destroyed, eggs are being eaten or trampled, and adults are being caught and sold for their meat and carapaces. In their pelagic habitat, innumerable creatures are killed by longline hooks. Ordinary plastic bags, mistaken for jellyfish and swallowed, bring sea turtles a slow and painful death.

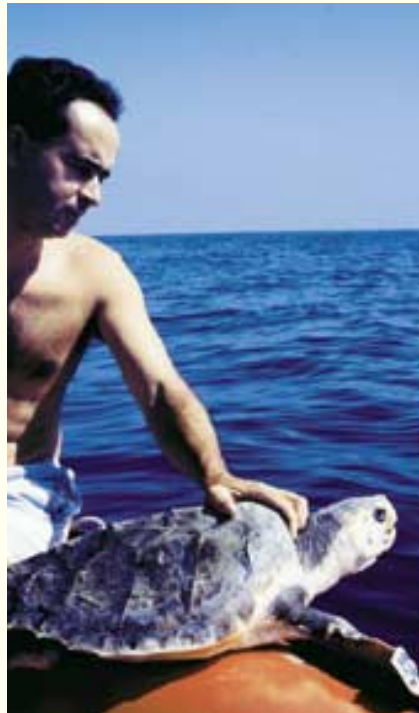
Madeira has been turtle-friendly since 1985, when its parliament proclaimed the first Portuguese law protecting a reptile. Nevertheless, the precarious state of sea turtle populations worldwide is apparent in Madeira, where, according to fishers, turtles are not nearly as numerous now as they have been in the past.

Part of the problem is well-meaning but poorly conceived conservation efforts. Most such activities concentrate on nesting habitat, even though eggs and hatchlings suffer high mortality naturally. Thus, recovery efforts would be more profitably concentrated on the other life stages. Madeira and the Azores are among the very few places right in the middle of the pelagic sea turtle habitat. Concentrating efforts here would probably have the largest effect on the future of breeding populations.

Projecto Tartaruga Madeira started in 1993 as a tagging program. Indeed, we still go out regularly to catch and tag turtles, and whenever I am stuck sifting through piles of paper on my desk I am generally looking forward to another day out at sea. So, luckily for me, tagging still plays an important role in our work. We use metal tags a few centimeters long bearing a unique identifying number, the name and address of the Archie Carr Center for Sea Turtle Research at the University of Florida, and the promise of a small reward for the return of the turtle and tag. The main objective of the tagging program is to measure how much a given creature has grown between taggings. The secondary objective is simply to record where it went.

Though useful and economical, tagging cannot answer many of the most pressing questions about these animals, whose home is the vast, open ocean. For example, we need to know if turtles prefer certain areas within this vastness and, if so, how they use them. Exactly where do they feed, and where do they rest? Do they form groups or lead essentially soli-

tary existences, like humans in big cities? We need this information so that we can evaluate it in terms of what we know about the threats to sea turtles. Once we have the data on the turtles’ feeding grounds and other preferred habitats, for instance, we can begin comparing them with the areas frequented by fishing trawlers. And when we know how long the



**TAGGED LOGGERHEAD** is about to be released by Renato Barradas, a technician at the University of Madeira.

turtles stay near densely populated islands, with their constant output of plastic and other rubbish, we can get a better idea of the extent of the threat posed by the trash.

Only satellite-based tracking can provide this kind of detailed geographic information. So last spring, with funding from the European Union’s Life Program, we began a new initiative in which we are affixing small data recorder–satellite transmitting units to the carapaces of sea turtles. The units, which weigh only 380 grams, are affixed to the carapace with a fiberglass resin in such a way that as the carapace grows, after about a year it eventually forces the unit to drop off (the same resin is used to repair broken carapaces of sea turtles).

Each unit has a depth sensor that records data on the creature’s vertical movements in the water. Twice a day, when the turtle is on the surface, signals are beamed to satellites operated by the U.S. National

Oceanic and Atmospheric Administration. Under a tracking service that uses the satellite and is run by a joint French–U.S. venture called Argos, we can download updates over the Internet two hours after information is beamed from a turtle. We outfitted our first turtle, a loggerhead we named Lidia, on April 1 and released her just off Funchal. Freitas and I and another colleague, Idoya Cabrera, attached the satellite transmitter and covered it with a glass-fiber protective coating, with the help of Bolten.

Every day Freitas and I connect to the space center in Toulouse, France, and excitedly type the commands and passwords to find out what Lidia has done in the past 24 hours. The little technical wonder on her back not only reports Lidia’s position every day but also tells us how often, for how long and how deep she dived during the previous day, and how often she rested. Such information has never before been collected on sea turtles. We found that Lidia had spent the first month with her transmitter swimming and diving in the waters off Madeira. Then she headed north, in the direction of the Azores; as of early June, she was in open ocean roughly midway between Madeira and the Azores.

Within three weeks of Lidia’s release, another four creatures had been outfitted with the units and released off Funchal. They all headed in a more westerly direction than did Lidia. Our plans are to similarly equip and track a total of 10 sea turtles.

We hope this excitement will translate soon into knowledge that can be put to use in protecting not only turtles but a variety of other pelagic creatures, such as the American wreckfish, that migrate in the open ocean. As Madeirans, we would be especially proud if, in this International Year of the Ocean, our budding project leads eventually to methods of bolstering pelagic populations. EXPO ’98, the centerpiece exposition of International Year of the Ocean activities, is being held in Lisbon, where the Madeira Pavilion is showing a film in which our turtles appear.

We Portuguese boast that we have given new worlds to the world. It would therefore be fitting for us if our work on pelagic-stage sea turtles helps to conserve the open-ocean habitat—a world in its own right, which only true international cooperation can save.

*THOMAS DELLINGER is assistant professor of biology at the University of Madeira in Portugal.*