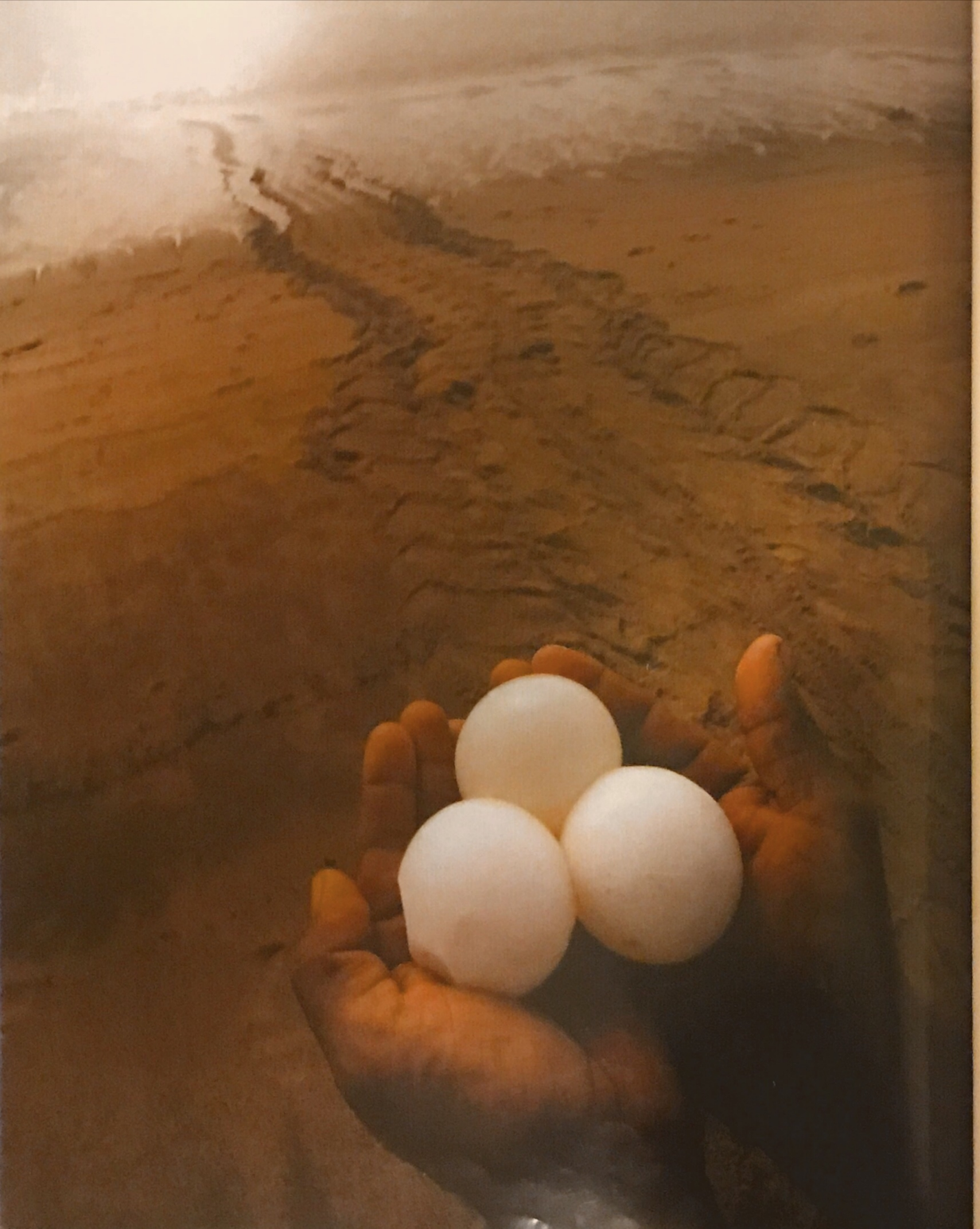
CHAPTER TWELVE

LEATHERBACKS

The Giant Mariner



THE LEATHERBACK, *DERMOCHELYS CORIACEA*, IS THE MOST EXTRAORDINARY of the shelled marine reptiles. Guillaume Rondelet, a French physician and naturalist, introduced the leatherback turtle to the scientific world in 1554. His book on sea creatures, *Libri de Piscibus Marinis, in quibus verae Piscium effigies expressae sunt* (translation: *Books on Marine Fish, in which True Figures of the Fish are Presented*), put many ocean animals into a more proper scientific context than had been the case, and it remained a standard reference for more than 100 years.

Before Rondelet, leatherbacks were placed in the same category as mythical sea serpents. Rondelet, however, descriptively called the leatherback "*coriaceam*," which is Latin for "leathery." He described a turtle with "the hide of an ox, tough and black, and which is used to produce bridles, saddles and other leather ornaments." He also called it "Mercury's turtle" because it resembled the shape of the lute that Mercury was thought to have fashioned from the shell of a turtle. Since the time of Rondelet the French have called leatherbacks *tortue luth*.

The leatherback is the largest turtle in the world and one of the largest living reptiles. It is also the deepest diving reptile, able to descend as deep as a whale—4,000 feet (1230 m) and deeper. Fastest of all sea turtles and incredibly maneuverable, the leatherback can swim circles around sharks when it needs to. Its streamlined shell creates very little drag in the water and its large body size and thick, fatty insulation allow it to control its body temperature in a way that makes a mockery of the term "cold-blooded reptile." In fact, it maintains a warm constant body temperature in the frigid North Atlantic. Other distinguishing characteristics of the leatherback include: specializes in eating jellyfish, lays the largest eggs of all the turtles, produces the heaviest clutches of eggs, produces the largest hatchlings, migrates the greatest distances, grows faster than any other reptile, and is among the widest ranging vertebrates on the planet.

Like the big whales, the leatherback swims from near the Arctic to the tropics and as far south as New Zealand and the Southern Ocean. However, it exceeds the distribution of whales by climbing out of the sea to lay its eggs on tropical beaches. The leatherback is a one of a kind, a sea turtle's sea turtle, and arguably one of the most unusual vertebrates in the world.

Previous pages: Leatherback turtle provides a ride to numerous remoras off the coast of Florida. The shape of the leatherback shell makes it hydrodynamic, helping it to swim rapidly. The remoras attach to the shell or ride in the slipstream flowing over it.

Opposite: Leatherback turtle eggs collected by conservationists in Surinam who will incubate them in a hatchery for protection. The large eggs are dimpled when they are laid but will take up water from the ground after being placed into the sand and swell to a perfectly round shape.

Distribution

Leatherbacks are distributed around the globe throughout the tropical and temperate oceans and even edge into subarctic waters. In the Atlantic Ocean they live as far north as Newfoundland and Labrador and visit the waters of Great Britain and Norway. They range as far south as Argentina and the tip of South Africa.

Occasionally these turtles swim from the Indian Ocean to the Atlantic and vice versa. This allows for mating between different populations and may be why there is little genetic difference among leatherbacks around the world. Leatherbacks range throughout the Indian Ocean and the Pacific Ocean, and periodically are reported off Tasmania and New Zealand. One leatherback found in Prince William Sound, Alaska, some 20 years ago is now mounted in a museum in Cordova.

The largest nesting colony is in South America, along the coast of French Guiana. More than 7,000 female leatherbacks laid as many as 50,000 nests there in 1988 and again in 1992. Over the last few years the number of nests has fluctuated and may be declining. It is difficult to assess this population because leatherbacks that nest in French Guiana also nest on the nearby beaches of Suriname, Guyana, and probably in Trinidad, as well. Because Guinean beach sand shifts, leatherbacks change their nesting beaches to follow the areas of shifting sand. These changing sand conditions may account for recent declines in the number of nesting leatherbacks in French Guiana and an increase in Suriname and Trinidad. At the very least we should strongly consider the possibility that leatherbacks form a regional colony, in this case a colony of 13,800 mature female leatherbacks that stretches from Trinidad to French Guiana. The second largest colony is in Gabon, West Africa, where 4,300 females nested in the 1999-2000 nesting season.

The largest colony of Pacific leatherbacks nests in Parque Marino Las Baulas (Las Baulas National Park) in Guanacaste, Costa Rica. Between 59 and 435 leatherbacks nest there each year depending upon the El Niño–La Niña cycle in the Pacific Ocean. Other large colonies visit the beaches of Papua New Guinea, where about 100-200 leatherbacks nest each year. As many as several hundred leatherbacks nest on the Andaman and Nicobar Islands off Thailand. Small colonies of leatherbacks nest in the United States, primarily on St. Croix in the U.S. Virgin Islands and in Puerto Rico and Florida. These populations are increasing in numbers.

Leatherbacks are primarily pelagic (open ocean) animals and migrate great distances from their nesting beaches to their feeding grounds. A number of leatherbacks tagged in French Guiana have been found along the east coast of North America as far north as Newfoundland. New World leatherbacks also migrate to Spain, France, and Morocco. Leatherbacks from St. Croix are known to feed in the north Atlantic and the Gulf of Mexico. One tagged female swam from St. Croix to the resort town of Atlantic City, New Jersey, a trip that spanned some 85 days. The waters of the Grand Banks in the north Atlantic and the Georges Banks off Nova Scotia and

Leatherback turtle returns to the sea after nesting on a beach on Huon Gulf, Papua New Guinea. Leatherbacks heat up when nesting, and the skin along their neck often looks pink due to increased blood flow.

Newfoundland are major feeding areas for leatherbacks because of their abundant jellyfish populations during the summer.

My colleagues Ed Standora, Frank Paladino, Steve Morreale, and I once placed satellite transmitters on leatherbacks on the Caribbean coast of Costa Rica and found that they traveled across the Caribbean to the Gulf of Mexico and the Atlantic Ocean. One of those animals made it to the island of St. Kitts where it died in a local fisherman's gill net. Ed later tracked the still-working transmitter to a home on the island. It was hanging on the living room wall, still attached to the rear tip of the carapace, all the while beaming its location to orbiting satellites.

Leatherbacks that nest on the Pacific coast of Mexico and Costa Rica migrate south to feeding grounds off the coasts of Peru and Chile. Our satellite transmitter studies revealed a "biological corridor" running from Costa Rica to Cocos Island and

Major Nesting Colonies of Leatherback Turtles around the World Today

Location	Nesting Females per Year	Female Population Size
Western Atlantic		
French Guiana	2,200	
Suriname	1,575	
Trinidad	2,000	
Guyana	200	
Brazil	20	
Subtotal	5,995	13,800
Eastern Atlantic		
Gabon	4,300	
Subtotal	4,300	9,890
Caribbean		
Costa Rica		
Tortuguero-Limon	400	
Gandoca/Manzanillo	300	
Panama, Bocas del Toro	200	
Columbia	250	
Dominican Republic	300	
St. Croix, USVI	120	
Isla Culebra	30	
Puerto Rico	30	
Florida, Atlantic coast	40	
Subtotal	1,670	3,840
Indian Ocean		
South Africa, KwaZulu Natal	120	
Sri Lanka	20	
Andaman and Nicobar Islands	1,000	
Subtotal	1,140	3,420
East Pacific		
Costa Rica	180	
Mexico	60	
Subtotal	240	910
West Pacific		
Irian Jaya, Bird's Head Peninsula	650	
Papua New Guinea	300	
Solomon Islands	100	
Malaysia	0-2	
Subtotal	1,052	4,000
		Total: 35,860

on to the Galapagos Islands. Leatherbacks swam in a straight line, essentially, within the corridor, making the long trip to the Galapagos in 60 days. Biologist Scott Eckert and his colleagues found that turtles equipped with satellite transmitters in Mexico swim southwest and then south to the Galapagos and the waters off South America. Across the Pacific, leatherbacks from Papua New Guinea swim northeast and travel to Monterrey Bay, California, where they feed on abundant jellyfish in the upwelling waters.

Life History

Each nesting season, female leatherbacks lay 1-10 clutches (7 on average) of 50-100 eggs that weigh 2.7 oz (77 g) each. Turtles nesting for the first time lay subsequent clutches 10 days apart, while females that have nested at the beach in previous years

return every 9 days. It takes about 1.5-2 hours for a leatherback to complete her nesting process. She will return to nest after 2-7 years, usually every 2-4.

One of the turtle's unique characteristics is its "yolkless egg." Leatherbacks produce 10-40 small egg-like structures that tend to drop at the end of each clutch of eggs. For years called "yolkless eggs," recently biologist Paul Sotherland verified that these false eggs contain neither yolk nor embryo. He calls them "shelled albumin gobs," or SAGs, the result of excess albumin production in the oviduct.

Leatherbacks nest on open beaches that are often exposed to considerable erosion. This is especially true in the Caribbean on St. Croix, along the coast of Costa Rica, and on Suriname and French Guiana. Formerly remote and undeveloped, most nesting beaches are now threatened by humans.

The leatherback uses its large rear flippers to dig a nest on the beach, laying its eggs about 3 feet (1 m) deep in the sand. It covers the eggs gently and finishes by throwing sand over the area.

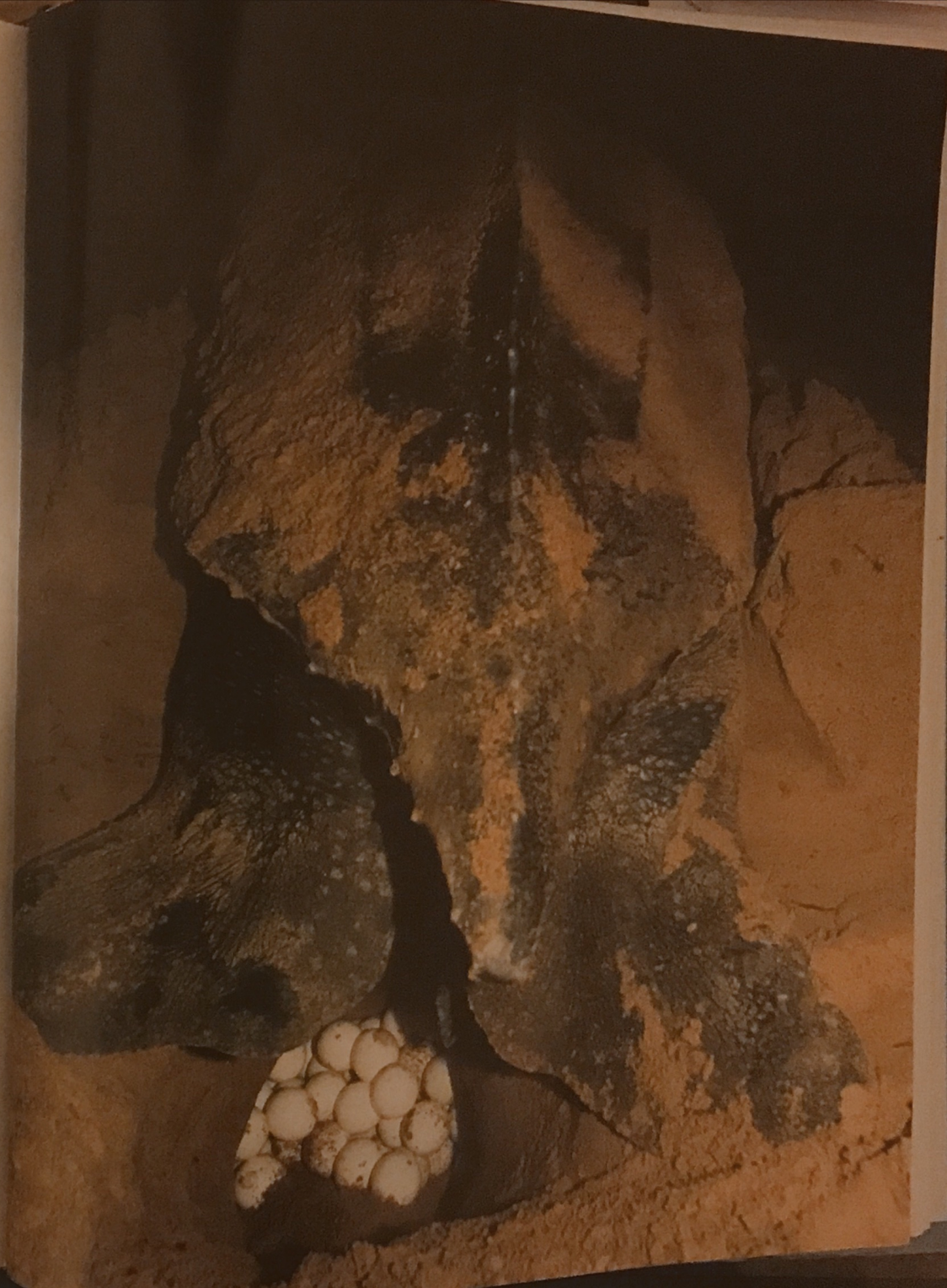
In the Caribbean leatherbacks emerge from March to June to nest throughout the night. Some in French Guiana remain onshore after sunrise. On the Pacific coasts of Mexico and Costa Rica leatherbacks nest between October and March. If the high tide is at night the turtles emerge two hours before the high tide to about four hours after. If the high tides occur within about two hours of dawn and dusk the turtles emerge all through the night.

Mating may take place along the migration route to the nesting beach but we know that it also takes place right off the nesting beach. The ingenious National Geographic explorer Greg Marshall found this out when he put video cameras (he calls them "crittercams") on the backs of nesting females. Marshall and my post-doctoral assistant Richard Reina recorded the behavior of females after they left the nesting beach. Males chased them, bit them on the head, bit other males on the shell and flippers, and continuously tried to mount the females. They also bit the camera, much to Greg's displeasure.

Hatching success of clutches in undisturbed nests is only about 50 percent, and on some beaches predators such as raccoons, coatis, and dogs destroy many nests. The low hatching success is yet another sea turtle mystery. It cannot be explained by infertility or nest depth (30-39 in/75-100 cm). Neither do we believe the answer is low oxygen or high carbon dioxide levels in the nest because these values are not as extreme as in other sea turtle nests. The presence or absence of SAGs appears to have no effect. Some have suggested that the eggs may be laden with toxins that increase embryo mortality, but definitive studies have yet to be conducted.

Like with other sea turtles, nest temperature determines hatchling sex, with a 50-50 ratio produced at 85°F (29.5°C). A nesting beach's sex ratio varies with the season but is typically biased toward females. At Playa Grande in Las Baulas National Park, eggs laid in October produce males primarily but eggs laid during most of the nesting season produce females, so the beach produces about 95 percent females during a typical year.

The tiny hatchlings weigh only 1.6 oz (45 g) and quickly become bird food if they try to enter the ocean in the daytime. Early in the morning, frigate birds and pelicans patrol the sea and eat any hatchling entering the water as well as many that have not made it far from the beach.



Surface sand temperature provides the cue that prevents hatchlings from emerging at the wrong time. When hatchlings heat up to 93°F (34°C) they lose the ability to coordinate their movements. Another four degrees renders them immobile. So when hatchlings are climbing up from the nest after hatching and reach the sand near the surface they will be immobilized if the sand is hot. They remain stiff until the sun goes down and the sand cools somewhat. Then they wiggle around and crawl to the surface. This temperature cue ensures that the hatchlings emerge only at night—unless it rains. Of course leatherbacks tend to nest during the dry season so rain usually does not present a problem. When it does, the birds are there and the fate of the hatchlings is sealed.

Once the hatchlings enter the ocean they swim vigorously for at least six nights and days. They can orient in the earth's magnetic field like loggerheads but are usually carried by the prevailing currents to convergence zones away from shore. Small leatherbacks have to eat their weight in jellyfish each day to support their rapid growth rates. Juveniles appear in areas of coastal jellyfish concentrations when their shells are about 43 in (110 cm) long. Thereafter they seem to exhibit the same migration and feeding habits as adults. Leatherbacks appear in large numbers off Florida in February, off southern Virginia in late April, and in the Gulf of Maine along the Canadian coast during the summer. They appear to follow or anticipate the arrival of large schools of jellyfish.

As the fastest growing reptile, leatherbacks reach adult size in 7-13 years. The largest adult females are in South Africa where shell length averages 63 in (160 cm). The smallest adult females are in the Pacific, averaging 57 in (145 cm), whereas in the Atlantic they average 60 in (153 cm).

Leatherbacks forage for food from the surface down to great depths, preying on jellyfish, colonial siphonophores like the Portuguese man-of-war, tunicates, and other soft-bodied animals. In the Mediterranean leatherbacks feed on the deep-water siphonophore *Apolomia uvaria*. In the Atlantic they feed on jellyfish such as *Cyanea capillata arctica*, *Cyanea lamarckii*, *Rhizostoma octopus*, *Rhizostoma pulma*, *Aurelia aurita*, *Pelagia noctiluca*, and *Chrysaora hysoscella*. Leatherbacks also eat the colonial hydroid *Obelia dichotoma*, the jellyfish *Catostylus mosaicus* in Australia, the tunicates *Pyrosoma* (gelatinous colonies that can grow to six feet in length), crabs (*Libinia spinosa*), and amphipods (*Hyperia medusarium* and *Hyperia galba*). Some prey may be consumed accidentally if they live close to jellyfish.

The largely jellyfish diet not only spurs rapid growth but also fuels the turtles' long-distance migrations and high reproductive output. Jellyfish are made up largely of water but they contain some protein, a small amount of fat, iron, and a variety of vitamins and minerals. Still, the water content is so high that they pose an interesting digestive question: How do leatherbacks eat enough jellyfish and efficiently extract the small amount of energy they contain to feed such a large, active reptile?

The answer is that hatchlings and adults have evolved an extraordinarily long esophagus. From the mouth it extends all the way to the rear of the body before looping back up the side to enter the stomach about a quarter of the way from the front of the body. It can expand to hold a tremendous amount of food and is lined with very large, very strong and stiff papillae that point backward. Papillae are also found in other sea turtles but they are much more pronounced in leatherbacks. These cone-shaped papillae are made of cartilage and are sharply pointed.

Leatherbacks swallow jellyfish whole or bite off large pieces with their pointed beaks and sharp jaws. As it swallows the gelatinous mass the leatherback contracts its throat to expel any ingested seawater through its mouth. The papillae prevent the jellyfish from washing out with the water. Then the turtle literally stuffs the food down the esophagus. In this way it can eat huge amounts of food and push it into the stomach as the earlier portions of its meal are being digested.

The leatherback's digestive system is analogous to putting logs into a fireplace. As the first logs burn, new logs are added. Because protein is easy to digest, leatherbacks efficiently convert the jellyfish into leatherback energy, mass, or eggs.

Leatherback hatchlings are covered with tiny scales and are counter-shaded dark above and white below. They row themselves down the beach with their large flippers and swim for days after entering the ocean.

Anatomy and Physiology

The leatherback's skeleton has long fascinated anatomists. Taxonomist, anatomist, and orthopedic surgeon Anders Rhodin spent many years studying the leatherback skeleton and has discovered that the ends of their bones contain thick cartilage filled with blood vessels. This characteristic is unique among all other turtles, the bones of which have thin cartilages containing no blood vessels. Leatherbacks' special cartilage permits their skeletons to grow quickly because the blood vessels flood the developing bone with nutrients.

Another fascinating aspect of the leatherback skeleton is, of course, a softer, leathery shell that is unique among modern sea turtles. We do not know why they evolved this shell but it could be because it compresses at the great depths to which leatherbacks are known to dive. A hard shell might snap. Leatherback shells are composed of numerous small "dermal bones" that lie above the distinct ribs and just beneath the skin surface. The skin itself is a flexible covering that may excrete compounds that keep the shell clean and discourage ocean plants and animals from attaching themselves.

The muscles of leatherbacks exhibit unusual adaptations. Contrary to what happens in most other animal muscles, the metabolic rate of the leatherback's muscle tissue is high and fairly constant over a wide range of temperatures. Therefore leatherbacks feeding in cold waters can maintain their energy level despite low temperatures.

Leatherbacks swimming off Nova Scotia and Newfoundland, Canada, have a body temperature of 60-78°F (15-25°C) when the ocean is as cold as 40°F (5°C). Should we call them warm-blooded given their ability to keep their bodies warmer than the environment? Not exactly, in the sense we usually use the term, because leatherbacks do not have a high metabolic rate like birds and mammals.

Yet adult leatherbacks have unusual adaptations that keep them warm. An adult leatherback's great size, weighing in at 550-2,000 pounds (250-900 kg), ensures that metabolic heat is slow to leave its body. It can also control its body temperature by shuttling between warm and cold water and using its great mass as a buffer, dampening the rate of heating and cooling.

Adult leatherbacks have other advantages, including a thick layer of fat under their shells and fat under the skin of their shoulders and necks. This offers excellent insulation to prevent heat loss. In addition, they a have a unique arrangement of blood vessels in their flippers where arteries and veins lie next to one another. This provides a counter-current blood-flow heat exchanger that helps retain heat.

One would think that these adaptations would pose a problem for leatherbacks when they are swimming in warm water or nesting on a tropical beach. However, another adaptation prevents them from overheating. When leatherbacks get hot they can pump blood from deep within their body past the layer of fat to the soft skin above it. That is why the skin of a leatherback turns pink when it is nesting. The leatherback is dumping heat by pumping lots of blood to its outer surfaces. Conversely, when leatherbacks enter cold water they can constrict their blood vessels to remain insulated. This combination of large body size, thick insulation, and blood-flow control allows leatherbacks to control their body temperature, staying warm in a cold ocean and cool on a hot beach.

Diving Experts

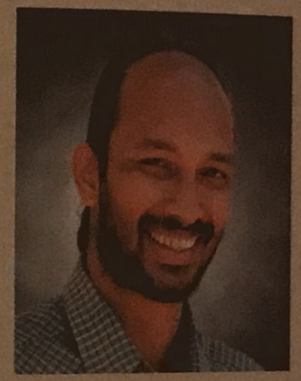
Our "crittercam" videos show that when a leatherback dives down to 90 ft (28 m) the plastron starts to compress inward. In a deep dive the shell will compress even more so that the lungs collapse, forcing air out of the alveoli and into the respiratory passages. This repositioning of air prevents the turtle from getting nitrogen narcosis—"the bends"—from nitrogen that dissolves into the blood stream from the lungs during a deep dive.

Leatherback lung and respiratory features are similar to those of deep-diving mammals. Like them, leatherbacks probably regulate the amount of blood flow to the lungs during diving and inhale just before diving to maximize their supply of oxygen. Thus they may be able to use the oxygen during the initial phases of deep dives, before they reach depths at which the lungs collapse. When a leatherback returns to the surface it quickly exhales and inhales to replenish its oxygen supply. After a long or deep dive a leatherback may take several big breaths in sequence, dipping its head under water between them before submerging for another dive.

Kartik Shanker: A Leader in India's Sea Turtle Community

Kartik Shanker is a Fellow of the Ashoka Trust for Research in Ecology and Environment in Bangalore, India. He has taken the Indian turtle conservation movement to a higher level by the quality of his scientific research and the effectiveness of his community outreach. Kartik began his sea turtle work as a founding member of the Students' Sea Turtle Conservation Network during 1988 in the southern Indian state of Madras. He led volunteer programs at zoos, education programs at schools and a sea turtle hatchery on the beach. Many of those who participated in his efforts have gone on to become wildlife biologists, and in 1990 a group of fishermen in the adjacent state of Kerala started a sea turtle conservation program modeled after his efforts.

Kartik completed his Ph.D. ten years after founding the student conservation network. After completing his studies he carried out research on the population genetics of olive ridleys on the mainland of India and the ecology of leatherbacks in the Andaman and Nicobar Islands in the Bay of Bengal. From 2000 to 2002 he helped coordinate a national project



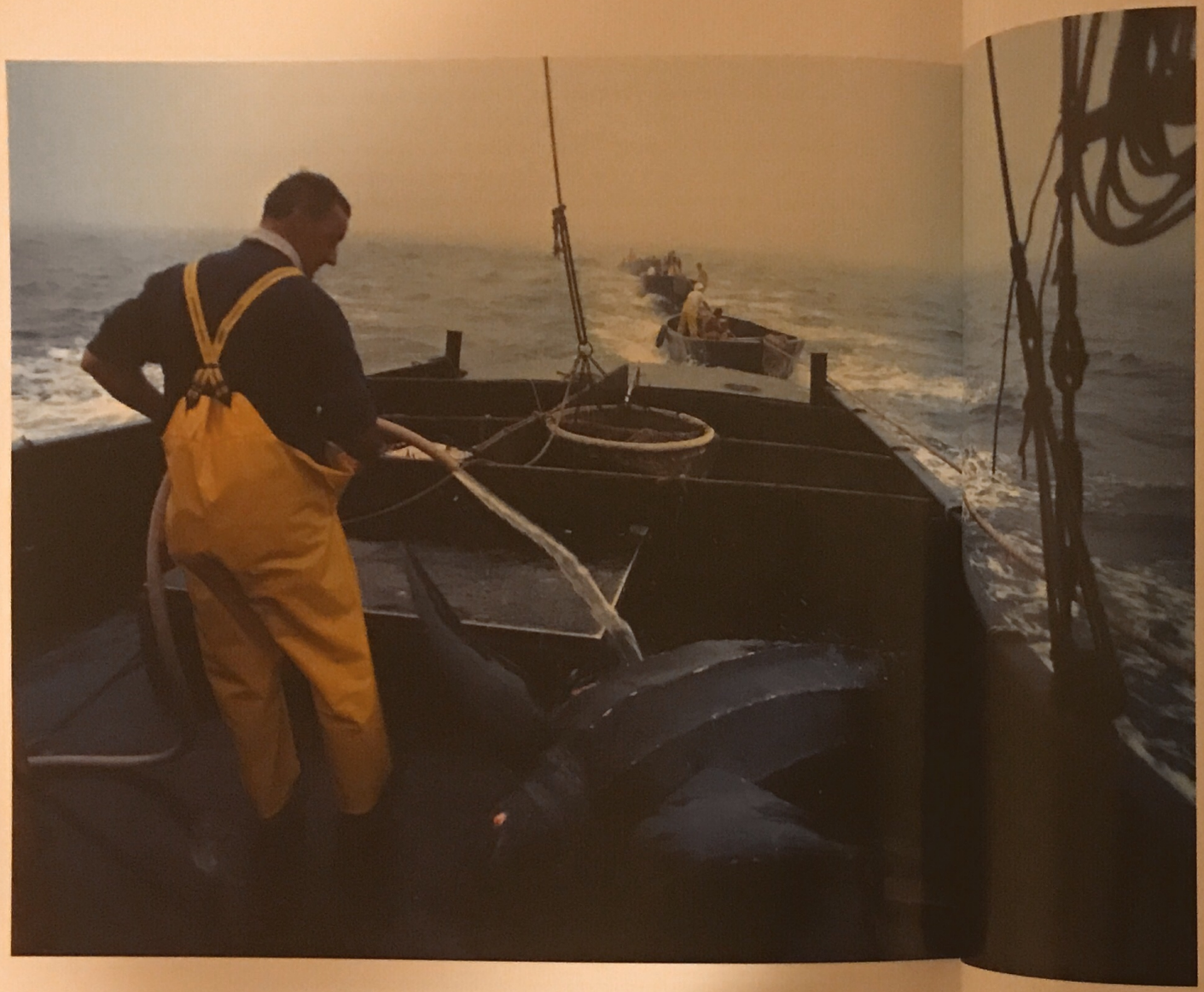
on sea turtles for the Government. The latter project involved surveys of nesting beaches, training and capacity-building workshops for local workers, and satellite telemetry of olive ridleys.

During 2003 Kartik started to organize a nationwide network of non-government organizations to monitor sea turtle populations, raise awareness about sea turtles, and implement conservation programs with local governments and community groups. He also launched a sea turtle newsletter, called *Kachhapa*, which is distributed twice a year to over 1000 subscribers in government organizations, agencies, nongovernment organizations, academic institutions as well as to conservationists and international subscribers. He also produced a series of sea turtle manuals, is completing a book on sea turtles of the Indian subcontinent and regularly turns out popular articles about sea turtles. Kartik's tremendous impact on sea turtle conservation in India cannot be overestimated. He has become a role model for those seeking to transform themselves from student to conservation leader.

Learning to Do Lamaze

Leatherbacks appear to practice Lamaze breathing during egg laying. The pain of childbirth causes human females, like other mammals, to increase their breathing rate and sometimes hyperventilate during labor and delivery. The increased volume of air passing through their lungs flushes out carbon dioxide and makes their blood more alkaline, causing medical complications from a condition known as respiratory alkalosis.

To counteract this tendency women learn Lamaze breathing techniques—rapid, shallow breaths that reduce the volume of air that passes through the lungs. Leatherbacks breathe the same way when delivering their eggs. They reduce the amount of air they take in to 44 percent of resting levels and increase their breathing rate 1.8



Fisherman Ernest Carlisle cools a leatherback caught in a trap net (also called a weir or pound net) off Rhode Island. This type of fishing gear is turtle-friendly because turtles can come up to breathe in the open-top net box. The fisherman was helping with a research study. After being measured and examined, this turtle was released back into the ocean unharmed.

times normal. This helps to maintain normal levels of oxygen and carbon dioxide in their blood and helps maintain a high level of metabolism while they are covering the nest, throwing sand, and crawling back to the sea.

Genetics Tales

Modern genetics has provided important insights into the biology of all sea turtle species, and the leatherback is no exception. Because leatherbacks have declined exponentially in the Pacific Ocean we thought that the low hatchling success could be a fertility problem. One of my students, Barbara Bell, examined developing eggs under the microscope and found that this was not the case. More than 90 percent of the eggs contained cells of developing embryos, indicating that they were indeed fertile. The leatherback's low hatching rate is still a mystery.

Jennifer Crim, another of my students, made an even more amazing discovery. She examined the DNA from blood samples obtained from 1,000 hatchlings from 20 leatherback mothers on Playa Grande, Costa Rica. Every pattern of mating seemed to be evident. At least two and perhaps eight females had eggs fertilized by multiple males. Twelve of the females seemed content to have the entire clutch fathered by one male. Three of the 12 "monogamous" females, however, seemed to have shared the same male, as the DNA pattern for the father indicated it was the same turtle for the trio of clutches.

For many years scientists have been unable to find any genetic differences among leatherbacks around the world. Recently scientist Peter Dutton used the latest genetic techniques to examine both mitochondrial and nuclear microsatellite DNA to determine that leatherbacks that nest in the eastern and western Pacific are genetically distinct populations. This is a critical discovery because it suggests that it is not sufficient for us to save the leatherbacks in New Guinea or some other western colony to save the genetic diversity of the Pacific populations.

Dutton also discovered that leatherbacks from the western Pacific nesting colonies of Papua New Guinea and the Solomon Islands migrate to the north Pacific and west coast of the United States to feed. Leatherbacks from the eastern Pacific nesting colonies tend to migrate south to the waters off South America. This information could help us understand how to manage these populations and emphasizes the importance of international cooperation and local conservation efforts in saving the leatherbacks in the Pacific.

Leatherback Extinction?

Some years ago, my students and I began to wonder how many leatherbacks there were in the world. We counted up all of the records of nesting females and were astonished to learn that they were declining at an alarming rate. In 1980 Peter Pritchard estimated that there were 115,000 nesting female leatherbacks world-

wide, and with many colonies still unknown at that time there were probably even more. In 1994 we estimated that there were fewer than 50,000 female leatherbacks left. We raised an alarm but it is hard to attract attention in a world with many environmental crises.

In 1996 our results were published in a prestigious scientific journal. We reported that there were about 34,500 mature female leatherbacks worldwide. Colleagues raised doubts because the numbers were, at best, estimates. I felt fairly certain the grim news was correct but at that time there was a small possibility that we had erred. Sadly, we soon had yet more data supporting the decline. The number of nesting leatherbacks at Las Baulas National Park in Costa Rica varies from year to year but our best estimate is that the number of nesting females has declined from almost 1,400 in 1988 to about 160 in 2003-2004.

The news from other places supports this grave situation. The 90,000 leatherbacks on the Pacific coast of Mexico in 1980 have virtually disappeared. Leatherbacks in India are essentially extinct and in Malaysia they declined from about 10,000 nests in 1956 to just a pair in 2003. However, recent discoveries have added more turtles to the known population in Gabon and the Indian Ocean. In short, today there are about 35,800 adult female leatherbacks in the world, but fewer than 1,000 in the eastern Pacific.

My conclusion is that unless something is done quickly Pacific leatherbacks (like loggerheads) are headed for extinction. Indian Ocean leatherbacks are in grave danger but will likely outlast their Pacific counterparts. In the Atlantic things are better but only by comparison. Some Atlantic nesting colonies seem stable; others are probably in decline, although the data are not conclusive because year-to-year fluctuations make it difficult to detect trends.

The cause of the leatherback's impending extinction across vast parts of its range is quite clear. First, 50 years of harvesting nearly all of the eggs from many beaches have limited the supply of new turtles. Second, killing adults on the beaches of Mexico, Panama, and other places eliminated many nesting females.

Third, and most significant, is the great slaughter taking place in the oceans. In the Pacific in the 1980s, giant drift nets that stretched for hundreds of miles and hundreds of feet deep decimated turtle populations (and caused harm to dolphin and whale populations). Now that most of those nets are gone, leatherbacks still have to evade coastal gill nets, which are smaller but more focused on the turtles' feeding grounds. Chile's swordfish gill net fishery killed thousands of leatherbacks in the 1990s. Nevertheless, the greater threat is longline fishing.

Biologist and demographer Larry Crowder and his students recently compiled data on the number of longline hooks set for swordfish and tuna in the world's oceans. Pelagic longlines stretch as far as a hundred miles and dangle thousands of hooks from each line. Fishing fleets from 40 nations now set an astounding 3.8

million hooks each day—1.4 billion hooks per year. Their numbers are probably underestimates because they did not count unreported fishing in some nations and the many illegal fishing boats.

Scientists who work onboard fishing boats indicate that the probability of a turtle being caught on a longline is small, perhaps seven loggerheads and one leatherback per 1,000 hooks. However, with all the hooks set each year one can extrapolate that about 220,000-250,000 loggerheads and 50,000-60,000 leatherbacks are caught each year. Of the estimated 32,000 juvenile and adult leatherbacks in the Pacific, it is believed that 20,000, or 63 percent, were caught on longlines in the year 2000. That means that

A fishermen harpooned this 1,150 pound (522 kg) leatherback off Montauk Point, Long Island, in 1951. After bringing it to shore in Connecticut the fisherman hung it up for all to see. The skeleton was later put on display in Yale's Peabody Museum, exhibited next to the dinosaurs.

an individual leatherback is likely to be caught on a longline once every two years.

Even if the mortality from longline capture is as low as the 16 percent estimated by fisheries biologists, the death rate from longlines would drive these turtles to extinction over a relatively short period of time. This is seen in our data from Las Baulas, where the annual rate of apparent mortality (never returning to nest again) for nesting females tagged the first time on those beaches is 25-30 percent.

There is hope, however, despite these numbers. Twenty-two years of conservation efforts at Sandy Point on St. Croix and a 40-year campaign on the beaches of KwaZulu-Natal Province in South Africa have succeeded in building up the leatherback populations on those beaches from about 20 to more than 100 animals nesting per year. These remarkable achievements resulted from protecting the integrity of the physical beach, the nests, and the nesting females.

Similar programs in French Guiana and Suriname may be responsible for leatherbacks having expanded their nesting to other areas in the Caribbean and Florida in

recent years. They may also be responsible for the survival of the Atlantic leatherback population in the face of heavy fishing pressure. Nevertheless, it is difficult to see how leatherbacks will survive in the Pacific unless something is done quickly about longline fishing and nesting beach protection.

International Protection

Leatherback turtles are considered "critically endangered" internationally by the World Conservation Union (IUCN) and are protected in Appendix I of CITES (Convention on International Trade in Endangered Species) and Appendices I and II of the Convention on Migratory Species (CMS). They are similarly listed by the United States and by many other nations as "protected" in national legislation (for example, the U.S. Endangered Species Act).

The recently ratified Inter-American Convention for the Protection and Conservation of Sea Turtles, which protects all sea turtles, is a boon for leatherbacks. Leatherbacks are also protected by the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA), the Memorandum of Understanding on ASEAN Sea Turtle Conservation and Protection, and the Memorandum of Agreement on the Turtle Islands Heritage Protected Area (TIHPA). These measures may help save the populations nesting in Papua New Guinea and Indonesia. The Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa is beginning to have an effect and may help to save the leatherbacks that nest in Gabon.

The use of turtle excluder devices helps to save green turtles, loggerheads, and ridleys, especially in the United States, Mexico, and South and Central America, but TEDs need to be modified to accommodate the much larger leatherbacks. In addition, the relentless pursuit of fish by the industrial fishing enterprises of Japan, Taiwan, Korea, Spain, and other nations threatens to eliminate the leatherback from the world's oceans. Longline and gill net fishing must be controlled or stopped. We can continue to catch fish without exterminating sea turtles in the process.

Although nesting beaches in places like Las Baulas Park in Costa Rica and on the Pacific coast of Mexico have received protection, these beaches and others are being threatened by development. If these beaches are developed it won't matter if we get the fishing problem under control. There are many beaches in these countries where hotels can be built but only a few on which leatherbacks can nest successfully. In the worst-case scenario, the turtles can tolerate low-density development back away from the beach. That means building structures away from the beach, keeping lights off at night, keeping people off the beach at night except under the leadership of trained guides, and controlling activities on the beach that could disrupt the turtles and their eggs and hatchlings.

This leatherback, entering the surf after nesting, will face a gauntlet of long lines, gill nets, shrimp trawls, and other fishing gear. Its large flippers, streamlined shell, and protective coloration are no defense against modern fishing techniques.

The lessons from Malaysia are clear. Developers built hotels and cottages right on the nesting beaches to accommodate as many as 1,000 people a night who came to see the leatherbacks nest. In addition, Malaysians continued to take the eggs. The result was near-extinction for Malaysian leatherbacks.

People can make a difference by assisting in efforts to oppose development on leatherback beaches and by demanding that their governments get industrial fishing under control. This will be a continuing struggle, but one worthy of our best efforts.

The Future

Our goal should be to restore global leatherback populations so that they can fulfill the ecological roles into which they evolved. We may not be able to accomplish this in countries like India and Malaysia during our lifetimes. However, we must work hard to preserve the genetic diversity that still exists in populations that nest on Pacific beaches. This is a reasonable goal because we know that protection in St. Croix and South Africa has made a big difference in the numbers of turtles nesting in those locations. Progress is possible in other locations as well. We either take the steps necessary to save the leatherbacks today or we lose them forever.

Las Baulas Park, Costa Rica, is the focal point of one of the best-known struggles to save the leatherback turtle from extinction and may provide a capsule view of the future of leatherback conservation. In the past poachers took all of the eggs from the beaches of Playa Grande, Playa Langosta, and Playa Ventanas. Peter Pritchard discovered the beaches there for science and wrote a management plan for the Costa Rican government that provided a basis for protection. Then the president of Costa Rica declared the beaches a national park.

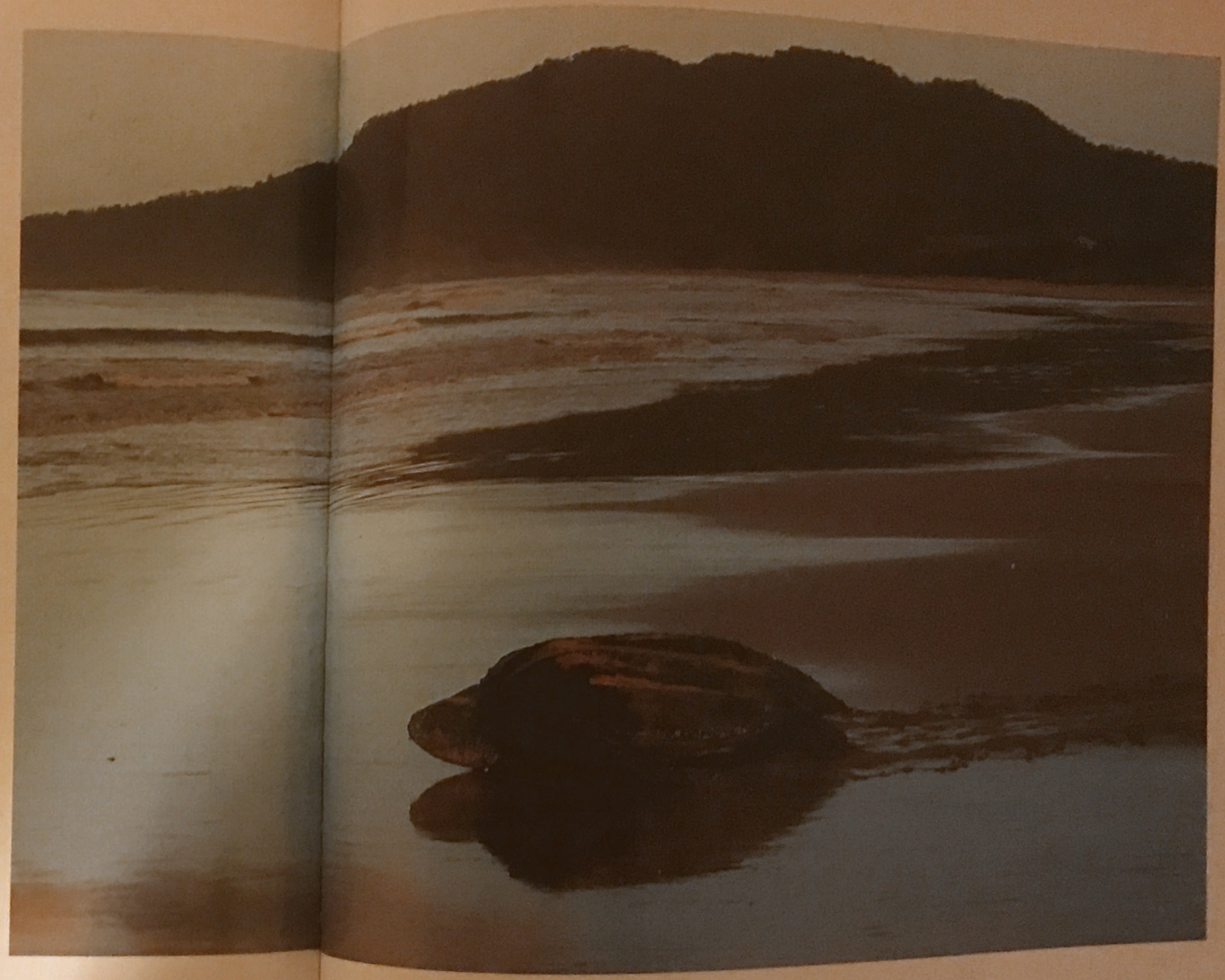
Local expatriate landowners tried to overturn the decree but in 1995 the national Congress passed a law that made the park permanent. Years of struggle led to the formation of a guides association that takes tourists to see the turtles, helps protect the beaches, and promotes economic development among the local people. A series of park directors worked to improve protection and the current director, Rodney Piedra, has not only protected the turtles but built strong ties in the local communities.

For Las Baulas, forming a U.S. non-governmental organization, the Leatherback Trust, played a key role in providing increased resources for protecting and consolidating the park. The Trust raised more than $850,000 in support of conservation, education, and research at Las Baulas. This provided for legal action to enforce national laws, developing a new management plan, and hiring and training rangers and biologists for the park. Frank Paladino provided the intellectual underpinning and the personal strength to focus research and conservation efforts at the park. Scientists, students, and volunteers supported by the Earthwatch Institute came to the park to provide basic protection and to carry out sophisticated research on leatherback biology.

This combination of international support for research, conservation, and capacity building in the park and local community has made Las Baulas National Park a model for leatherback protection. The struggle there continues, however, as developers continue to launch attacks against the park. But over the last 12 years hundreds of volunteers have come to save the leatherback turtle, scientists and students have come from many countries to conduct conservation and research, and local people have been empowered. The turtle is beginning to win.

Despite all of this effort the leatherback turtle is still in imminent danger of extinction in the Pacific Ocean. Las Baulas represents the leatherback's Guadalcanal or Valley Forge. It is either the last stand for the leatherback or the first step back from the road to extinction.

This model can be expanded to other locations. We can take the beaches back one at a time. Friends of the leatherback are working in Mexico, Papua New Guinea, French Guiana, Gabon, Trinidad, and elsewhere. Fishing practices can be changed. Attention can be focused on the leatherback until the glaring light of public opinion forces nations and corporations to change the practices that are driving this species to extinction before our very eyes. The road back will be long and hard but there is still hope that the leatherback, the Giant Mariner, will prevail.



A leatherback turtle heads for the sea at Playa Grande, Costa Rica, at dawn after a long night of nesting. The beach is protected as a national park, but real estate developers are constantly trying to change its status.