

Introduction



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The natural history of these islands is eminently curious, and well deserves attention.

—Charles Darwin, *Journal of Researches*¹

Darwin's Islands

Galápagos is a group of 13 islands and numerous smaller islets and rocks that straddle the equator 1000 kilometers west of South America.² Like a cluster of forgotten crumbs on a well-swept floor they are isolated, arid, and barely visible on the world map. But insignificant they are not. Together they form a surprisingly heterogeneous world of their own, occupied by an astonishing diversity of endemic plants and animals. Their story, from their volcanic birth under the sea, to their colonization by organisms from distant lands, and the transformation of these colonists into diverse new species as the islands themselves change and diverge, is the story of evolution itself.

Viewed in this light it is no wonder that Galápagos played a pivotal role in the development of Charles Robert Darwin's famous theory of evolution by means of natural selection. For when Charles Darwin (referred to hereafter as Darwin) visited Galápagos for five short weeks in 1835 his experiences and observations there transformed his way of thinking about the natural world. They revolutionized our understanding of life on Earth.

Galápagos inspired Darwin, and both the place and the man have inspired us. It was Darwin and his theory of evolution that brought each of us to Galápagos in the first place. I arrived in 1973 with my parents, Drs. Peter and Rosemary Grant, at the start of their famous long-term study of evolution in Darwin's finches. Greg arrived nine years later as leader of the 1982 Cambridge Darwin Centenary Galápagos Expedition. Over the years we pursued university degrees in biology, conducted independent ecological research on various Galápagos species, and worked as naturalists in the islands. Our fascination with Galápagos and Darwin swelled. Then one day in early 1996, atop the most active and pristine volcano in the Galápagos archipelago, it took on a new form. The two of us were on the summit of Isla Fernandina (Narborough Island), making field observations on Darwin's finches and pledging a lifetime of adventure together. Wouldn't it be extraordinary, we agreed, to retrace Darwin's footsteps through Galápagos, to see the places he observed, to compare the wildlife he described with what can be found at the same sites today, and to investigate how else the archipelago has changed. We had little idea, at that point, of how closely we would be able to follow his path. How much physical detail had he recorded of the sites he had explored? Was it enough to reveal the treks he had taken, define the paths he had walked? Would we gain insights into the development of his ideas by following in his footsteps? The possibility was beguiling, the challenge irresistible.

We took our brainchild to England and nourished it with literature. Today Darwin's published works and transcriptions of some of his unpublished notes and manuscripts are accessible on the World Wide Web (www.darwin-online.org.uk and darwinlibrary.amnh.org), but this service did not exist at the time of our expedition. At the Cambridge University Library (CUL) we paged through volume after volume of published and unpublished Darwiniana. We feasted most heavily on Darwin's original manuscripts in the CUL Darwin Archive, for we guessed that Darwin's first-hand notes, and especially those pertaining to the geology of the islands, would contain the greatest number of clues to where he had landed and explored. We were astonished to find that Darwin's Galápagos geology notes had gone virtually unnoticed. A full transcription of those 115 man-

uscript pages became our first-priority assignment. We also transcribed the Galápagos portion of Captain Robert FitzRoy's log of the *Beagle* in the Public Records Office at Kew, and scoured his charts of Galápagos in the United Kingdom Hydrographic Office (UKHO) at Taunton. Back in Galápagos, at the Charles Darwin Research Station, we prepped and primed and plotted our course through the archipelago, based on all we had learned in England. Then, on October 19, 1996, one hundred and sixty-five years after HMS *Beagle* graced the waters of Galápagos, we found ourselves flying over a choppy ocean between our home island of Santa Cruz (Indefatigable) in the center of the archipelago and Darwin's starting point of Isla San Cristóbal (Chatham Island) on the eastern perimeter. Our dream was literally taking flight, with the two of us happily on board in search of what it meant to be Darwin in Galápagos.

Why Darwin?

Darwin is one of the most celebrated naturalists and influential persons in the history of mankind. Born a naturalist and an ambitious one, he spent his life seeking to explain the great diversity of life that exists in all its colors all around us, and to solve what contemporary luminary Sir John Herschel called the “mystery of mysteries”—how new species come into being.³ Through his keen powers of observation, his interest in all aspects of the natural world, his ability to reason, and his rigorous approach to study, Darwin came up with answers that “shook the world.”⁴ His theory of evolution by means of natural selection not only restructured the entire science of biology, it revolutionized the way people perceive themselves. It created a whole new world of understanding.

Darwin will forever be credited with evolution, but no one pretends he was the first to think up the idea. Author Loren Eiseley, in his prize-winning book *Darwin's Century*, likens the discovery of evolution to “a new continent” that was glimpsed through lifting fogs by “master mariners” well before voyager–naturalist Darwin finally established its reality.⁵ The first of these known “mariners” was

Anaximander, a 6th-century Greek philosopher who suggested that man had sprung from some form of aquatic animal.⁶ The germ of an evolutionary idea may well have entered the minds of acute observers of nature even before this, in preliterate civilizations. What is known is that, in the western world, evolutionary speculations took off during the 18th century's Age of Enlightenment, when learning from nature began to replace unquestioning acceptance of dogma and myth. Darwin's own grandfather Erasmus contributed to this movement. There was even a theory of evolution when Darwin arrived on the scene, but the chief explanation for how it worked—Jean-Baptiste Lamarck's idea of the inheritance of acquired characteristics—failed to gain widespread acceptance at the time.

Darwin changed all that. By marshalling evidence in support of evolution, and coming up with a new and ultimately convincing explanation for how it works—natural selection—Darwin demonstrated the fact of evolution. He transformed evolution from a radical, somewhat illusory idea into a coherent scientific theory of consequence.

First published in 1859, Darwin's masterwork *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (hereafter referred to as *The Origin of Species*) is Darwin's argument for evolution. In it he proclaims that all species are modified and diversified descendants of a single common ancestor and reasons that species change because of the following natural laws:⁷

1. Heritable variation exists among the individuals that comprise populations of species.
2. There is a struggle to survive and reproduce, in which individuals compete for limited resources.
3. More individuals are born than survive this struggle for existence.
4. Those individuals with variations that help them survive the conditions of their local environment are the ones most likely to reproduce and pass on their winning traits to the next generation.

As environments are neither uniform nor static it logically follows that as populations move into new environments, whether through

time or space, they change. They form new species that diverge and diversify in an ever-branching tree of life.

As asserted by evolutionist Julian Huxley, Darwin's epochal book, "altered the substance and the direction of human thought more profoundly than any other publication of the age of print."⁸ It transformed the prevailing view of the world as a static, biblical place inhabited by species created by God according to His will and design, into a dynamic landscape run by nature and subject to the rules of change. Ernst Mayr, another great evolutionist, goes as far as to say publication of *The Origin of Species* "almost single-handedly effected the secularization of science."⁹

This is not to say that Darwin's theory was accepted overnight. Darwin encountered major objections from scientists who doubted the validity of natural selection as an explanation for evolution. Over the 15 years following the first publication of *The Origin of Species*, Darwin revised his book five times to answer criticisms and clarify his arguments.¹⁰ It took another 65 years for biologists to fully come to terms with natural selection as a cause of evolution.¹¹ Nonetheless, during his lifetime Darwin succeeded in bringing about a scientific movement that changed research programs and transformed the direction of science. In the words of science historian Peter Bowler, Darwin's "great achievement was to force the majority of contemporaries to reconsider their attitude towards the basic idea of evolution . . . despite the fact that many found natural selection unconvincing."¹²

The Origin of Species also made a huge, divisive impact outside the scientific community. The working classes, eager to "wrest control . . . from the old landed interests" hailed Darwinian evolution (or "Darwinism" as Darwin's theory and corrupted interpretations of it became known) as an endorsement for social progress and reform.¹³ Members of the ruling class, those whose social and political position depended on maintaining the status quo, felt threatened. And because Darwin's theory offered secular answers for sacred questions—What is life? Who are we? Where do we come from?—it kicked up a storm of outrage among religious traditionalists. Even today, Darwin's theory of evolution remains contentious in society for its religious, social, and cultural implications.

Brilliant, ingenious, audacious, Darwin is loved and revered by many, hated by others. Above all he fascinates. As Ernst Mayr once said, “no biologist has been responsible for more—and for more drastic—modifications of the average person’s worldview than Charles Darwin. . . . Almost every component in modern man’s belief system is somehow affected by Darwinian principles.”¹⁴ Indeed, Darwin matters so much to human thought that he has been, and continues to be, the subject of intense scrutiny by scientists, historians of science, philosophers, psychologists, and theologians alike.

A substantial body of work has been written on Darwin and his life and seemingly no stone has been left unturned in an effort to understand the man who redefined the science of biology and the path he took to do so. In addition to a perennial supply of scientific and historical papers produced by members of this “Darwin Industry,” several outstanding books have been written by some of these same scholars. They include Janet Browne’s comprehensive two-volume biography¹⁵ that describes Darwin’s life, analyzes his achievements, and illuminates how his environment made him who he was; Adrian Desmond and James Moore’s work of similar scope;¹⁶ and the more concise, but insightful overviews of Richard Keynes,¹⁷ Randal Keynes,¹⁸ Niles Eldredge,¹⁹ and David Quammen.²⁰ These books examine parts or all of Darwin’s life—his childhood, his famous voyage round the world on HMS *Beagle*, his return to England, and the subsequent steps that led him to become the most influential scientist of the century—in the illuminating context of the Victorian era, the social circles in which he moved, and the scientists with whom he corresponded. Other authors adopt more oblique but equally revealing perspectives from which to explore the subject of Darwin and his intellectual journey, angles that reflect their own particular interests and expertise. For instance, Sandra Herbert investigates the key role that geology played in Darwin’s thinking.²¹ Edward Larson²² and Peter Bowler²³ choose the history of evolutionary thought as the platform from which to examine Darwin and his theory.

By looking at Darwin’s life from historical, philosophical, and scientific points of view, these authors paint a detailed picture of Darwin’s development as he changed from an ordinary creationist to an

extraordinary evolutionist. They vary on interpretation and the degree to which various moments in Darwin's life were important to his theory. Yet all agree on one thing; Galápagos was key to Darwin's conception of evolution.

Why Galápagos?

Darwin spent only 5 weeks in Galápagos, a minute fraction of the 248-week voyage of HMS *Beagle*, yet his experiences in the archipelago were of disproportionate importance to the development of his scientific thinking. Quite simply Galápagos convinced Darwin of evolution.²⁴ It did not happen overnight. Rather, it took several years for Darwin to fully recognize the significance of his Galápagos observations. Nonetheless, his appreciation of three fundamental features of Galápagos—its isolation, the geographical distribution of its organisms, and the affinities of these organisms to species on the South American continent and between the islands themselves—ultimately persuaded him that species could change. When he first began putting his ideas on transmutation to paper in 1837, Darwin declared the “S. American fossils —& species on Galapagos Archipelago . . . [are the] origin (especially latter) of all my views.”²⁵ He maintained his emphasis on the importance of Galápagos, declaring to fellow evolutionist Alfred Russel Wallace 22 years later, while preparing for publication *The Origin of Species*, that the “Geographical Distrib[ution] & Geographical relations of extinct to recent inhabitants of S. America first led me to [the] subject [of evolution]. Especially case of Galapagos Isl^{ds}.”²⁶

Galápagos was not the only factor in Darwin's conception of evolution. As Darwin pointed out in the quotes above, his recognition of the significance of Galápagos was influenced by his earlier observations on the mainland of South America and especially by his study of geographical barriers as they relate to species distributions. Nor was Galápagos central to the development of Darwin's theory of evolution. Three years after his visit to Galápagos Darwin hit upon the idea of natural selection as an explanation for evolution, not from

contemplating Galápagos organisms but primarily from studying domestic breeds and reading Thomas Malthus's essay on human population theory.²⁷ He advanced his theory by spending decades conducting original research and gathering facts on various groups of organisms outside Galápagos, most notably on domestic pigeons, barnacles, orchids, bees, and worms. Nevertheless, Galápagos was the keystone of his conversion and the foundation for his understanding of evolution. It was the Galápagos organisms he observed and collected, and his recognition of their affinity to organisms found on the South American continent and their representation as similar but distinct species on the different islands of Galápagos, that persuaded Darwin of the mutability of species and against their miraculous creation. As one author avows, "It cannot be maintained that without Darwin the theory of evolution would not have come into being, but it can be insisted that had Darwin not taken the voyage of the *Beagle* to the Galápagos, it would have been seriously delayed."²⁸

That Galápagos was important to Darwin is a well-accepted fact. The particulars—what about the islands stimulated Darwin, and how, when, and why they influenced his ideas on evolution—are generally not so well known. Indeed, they are the subject of ongoing study and exciting debate. Like a pendulum the question of whether Darwin was thinking in evolutionary terms while he was in Galápagos swings back and forth, each oscillation provoking new investigations and providing fresh insights into Darwin's Galápagos experience. In 1966 Julian Huxley wrote, "It was on the Galápagos in the early autumn of 1835 that Darwin took the first step out of the fairyland of creationism into the coherent and comprehensible world of modern biology, for it was here that he became fully convinced that species are not immutable—in other words, that evolution is a fact."²⁹

While correct in essence, Huxley's words (and similar statements from other authors³⁰) oversimplify the process of Darwin's conversion to evolution, and misleadingly suggest a eureka-like moment taking place in Galápagos. This has since been shown not to be the case. By using Darwin's spelling mistakes and changing orthography as a means of dating his notes, historian Frank Sulloway has mapped Darwin's evolving attitudes. He has shown that Darwin first wrote

about the instability of species nine months after leaving Galápagos and has argued that Darwin did not become convinced of the mutability of species until he was back in England.³¹ Sulloway has made great strides in elucidating the role Galápagos played in Darwin's thinking, and in debunking the myths of what Darwin did and did not do in the islands.³²

Yet the pendulum swings. While it is no longer contended that Darwin reached an evolutionary standpoint while he was in Galápagos, just how close he got, and how important Galápagos was, is still under scrutiny. Darwin historian Sandra Herbert puts it this way: "[A]t first Darwin's experience in the Galápagos Islands was over-emphasized as the turning point in his arrival at a transmutationist position. Now that most readers have learned that Darwin did not become an evolutionist until 1837, the Galápagos experience is possibly credited with too little."³³ After all, she reminds us, it was in Galápagos that Darwin "recorded patterns of variation among species on the islands . . . and that, ultimately, pushed him across the line to a transmutationist position."³⁴

Darwin's Galápagos experience was multifaceted and the effects it had on his thinking multitiered. Thanks to the continued research of scientists and Darwin historians, there is a widening appreciation of what Galápagos meant to Darwin, and when it did so. The efforts of biologist Richard Keynes³⁵ and botanist Duncan Porter³⁶ have been particularly constructive. By examining Darwin's zoological and botanical notes and specimens they have identified the many Galápagos species that influenced Darwin's developing ideas and have shed light on how they did so. Paul Pearson³⁷ and Sandra Herbert³⁸ have helped expose one of Darwin's greatest geological discoveries in Galápagos, and have suggested that Darwin's developing ideas on evolution were closely tied to his concurrent theorizing on the origin and diversity of rocks. Darwin historian David Kohn and colleagues have recently elucidated the early origins of Darwin's interest in variation (a key element of evolution by means of natural selection) and have suggested that Darwin's collecting activities in Galápagos were influenced accordingly. They also suggest that although Darwin was not thinking in evolutionary terms while he was

in Galápagos, he was operating within an intellectual framework to allow him to recognize varieties as incipient species, and to appreciate transmutation, soon after.³⁹

In this book we take this rich cornerstone of Darwin's career as an evolutionist and put it under the magnifying glass. We examine Darwin's physical journey through Galápagos in unprecedented detail. By taking a step-by-step tour of his visit we demonstrate just how influential and inspirational it was. Using new facts drawn from Darwin's original unpublished notes, fresh insights from his sketches and publications, the studies of modern-day scientists, the analyses of Darwin historians, and our own intimate knowledge of the place, we explore how Galápagos shaped Darwin and his theory and how it defined the legacy he left behind. We show how Darwin's Galápagos experiences catalyzed his thoughts on evolution, how his Galápagos collections provided him with persuasive evidence to support his theory, and how his Galápagos observations fueled his speculations and motivated some of his later experiments. In doing so we shed light on the whole canvas of Darwin's life and work.

Into the Wild

It has been said that the love of the chase [sic] is an inherent delight in man,—a relic of an instinctive passion. —if so, I am sure the pleasure of living in the open air, with the sky for a roof, and the ground for a table, is part of the same feeling. It is the savage returning to his wild and native habits. I always look back to our boat cruizes [sic] & my land journeys, when through unfrequented countries, with a kind of extreme delight, which no scenes of civilization could create. —I do not doubt every traveller [sic] must remember the glowing sense of happiness, from the simple consciousness of breathing in a foreign clime, where the civilized man has seldom or never trod.

—Charles Darwin, *Beagle Diary*⁴⁰

Our *Beagle* on the first day of our own voyage of discovery was a five-passenger Piper Aztec air ferry, but it metamorphosed over the

following weeks into whatever means of transport we could find and afford: a fishing boat, the crews quarters of a cruise ship, a municipal launch, a dinghy, our legs for walking, our arms for swimming. At one point we really did travel on the *Beagle*. It was the current research vessel of the Charles Darwin Research Station, and the sixth vessel of that name to grace the waters of Galápagos since HMS *Beagle*. Darwin was our constant companion, speaking through his field notes,⁴¹ geology notes,⁴² zoology notes,⁴³ ornithology notes,⁴⁴ plant notes,⁴⁵ diary,⁴⁶ and specimen lists,⁴⁷ copies of which we had obtained and, in some cases (most notably the geology notes), transcribed in England. Captain FitzRoy was also a commanding presence, showing us, from the bearings and anchorages identified in his logs⁴⁸ and charts,⁴⁹ where to hit the shore and strike inland. Instead of spirit bottles and collecting bags we carried cameras, a GPS (Global Positioning System) receiver⁵⁰ and compass, and a stack of photocopies.

It was already known, from published accounts of the voyage, which four islands Darwin visited—San Cristóbal (Chatham), Floreana (Charles), Isabela (Albemarle), and Santiago (James)—and roughly where on each he explored. Frank Sulloway published a rough outline of Darwin's course through the islands but the details of where Darwin landed and explored remained vague.⁵¹ Each island is topographically and ecologically heterogeneous, its habitats varied, and the distribution of its organisms uneven. Where Darwin walked determined what he saw and what he saw influenced what he thought. For the purposes of our study it was important to determine as closely as possible where Darwin stepped ashore and to define his movements inland and along the coast. Only in this way could we compare the natural history Darwin observed with what can be found in the same sites today. We could identify the sources of his geological insights, the exact features that triggered his understanding of the physical processes governing evolution in Galápagos.

By gleaning clues from Darwin's original notes, time and again we were able to figure out where Darwin walked, the land formations he examined, and the route he took to reach them. Indeed, on the very first day of the expedition, from clues in Darwin's forgotten geology notes and the *Beagle* logs, we identified the cove at Cerro Tijeretas

(Frigatebird Hill) as Darwin's first Galápagos landfall.⁵² For 165 years this doormat of the most famous stopover on the voyage of the *Beagle* and in the history of evolutionary thought had remained unidentified. And now we had elucidated its location. Never again would Darwin's first landing spot be known only vaguely as somewhere on the southern end of Isla San Cristóbal (Chatham Island). It was a confident start to our expedition, and one that gave us no modest feeling of accomplishment. But not all the sites were so easy.

Despite traveling far faster than the *Beagle*, we took eight weeks to cover the area Darwin did in five. To determine the limits of Darwin's excursions we explored widely. As we pushed our way through thickets, tripped over knife-like lava, trod sun-scorched beaches, and clambered up crater after crater, we marveled constantly at Darwin's stamina. Not only were his hikes often long, some of the terrain was exceedingly rough. If he ever fell he never complained. We, on the other hand, went home sporting a few new scars. Of course, Darwin was only 26, and in fine form from his recent treks through South America!

One of the fascinating things about Darwin was his extraordinary power of observation and reasoning. He noticed "things which easily escape attention," questioned them, and endeavored to understand them.⁵³ Fortunately for us, he wrote down such thoughts, albeit in note form. Retracing his footsteps was like taking a guided walk through the countryside "to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth."⁵⁴ Only instead of worms it was reptiles and instead of through damp earth, it was over arid lava.

In the prologue of his book *Fossils, Finches and Fuegians*, author Richard Keynes wrote, "When you have transcribed several hundred thousand words of [Darwin's] writings, concerned with places . . . not too greatly changed 160 years later, you may once in a while almost feel that you are talking to him."⁵⁵ Compared to Darwin's great-grandson we have transcribed but few words (and thank goodness, for Keynes's transcriptions made our footwork that much easier), but we have certainly read and relived many. How many times did I not look at Greg as he crouched to identify a plant, reach up to measure

the thickness of an ancient stream of lava visible in a cliff face, or hike off toward a distant hill, and imagine, with allowances for costume, I was seeing Darwin himself. Nine years later I was awarded a sense of déjà vu when the British Broadcasting Corporation (BBC) filmed Greg acting as Darwin's double while we were working as on-site script consultants for their three-part television series, *Galápagos*. This time Greg was dressed for the part, with straw hat, waistcoat, and hob-nailed boots, but because of his dark hair, brown eyes, and beard—Darwin was fairer, blue-eyed, and possibly clean shaven in 1835—Greg was filmed from behind and at a distance, while another man played Darwin close up.

During the expedition, we often caught ourselves asking Darwin's ghost out loud which way he had gone, and admonishing (to put it mildly) the great man for not having made it clearer in his notes. For not all the sites were named in Darwin's day as they are today, and some were not named at all. We had to feel our way along by matching up landmarks with Darwin's imagery. While our task was helped enormously by the fact that Darwin was a geologist and generous in his descriptions of land formations, his footsteps became faint wherever outstanding geological features were lacking. Retracing Darwin's route, from hint to sometimes ambiguous or inconsistent hint, became a veritable treasure hunt, frustrating at times, but infinitely rewarding in the process. Nor did we limit ourselves to walking in Darwin's own footsteps; we readily branched out to explore formations that Darwin, having lacked the time and means to examine himself, had nonetheless described from the decks of the *Beagle*. Isote Tortuga (Brattle Islet) and Punta Cristóbal (Point Christopher) on Isla Isabela (Albemarle Island) are two such places.

In 1996, the same year as our own expedition, an attempt was made to follow Darwin's route through mainland South America on horseback. "All over the continent," the rider wrote, "I found that urban growth made following Darwin's precise routes dangerous and sometimes impossible, it being no joke to ride a fairly wild horse along main roads or through urban sprawls."⁵⁶ Other places had been "swallowed" up by resorts. Fortunately Galápagos has been largely spared this development. Several of the sites that Darwin visited now

have a National Park trail running through or near them, but the only settlement from Darwin's day (on Isla Floreana/Charles Island) actually has fewer residents today than it did then. Unfortunately, this does not mean that Galápagos has been left untouched. Humans, and the plants and animals brought with them, have wreaked havoc on many of the islands, causing the local extinction of several endemic species. In many places we came across invasive plants choking out the native vegetation and saw the vandalistic signs of introduced insects and mammals. Nowhere was the destruction more apparent than in the highlands of Isla Santiago (James Island). Forests of endemic *Scalesia* trees (*Scalesia pedunculata*) that once covered the summits had been transformed into vast meadows by feral goats. We saw herds of hundreds of them running about the hills. In stark contrast, the native herbivores—the Galápagos tortoises that Darwin had reported swarming through the damp undergrowth of the highlands—were few and far between. Since our expedition, and over the first few years of the 21st century, the goats (and introduced pigs and donkeys) have been eradicated from the island, and the native vegetation has started to reinvade. Although there are now new alien contenders on Santiago—noticeably the invasive hill raspberry (*Rubus niveus*) and the aggressive paper wasp (*Polistes versicolor*)—there is much to rejoice about the natural state of Galápagos as a whole, for most of the wildlife described by Darwin is still there, albeit in reduced population numbers. Despite the increasing threats of a growing human population, “Darwin's Islands”⁵⁷ are still, for now, worthy of their epithet.

Darwin's Legacies

*The mind is its own place, and in it self [sic]
Can make a Heav'n of Hell, a Hell of Heav'n.*
—John Milton, *Paradise Lost*⁵⁸

Darwin lives on in Galápagos as nowhere else. The archipelago's unique plants, animals, and landscapes are responsible for its modern ranking

as a Natural World Heritage Site, a Biosphere Reserve, and a National Park, but it is Darwin's association with this same fauna, flora, and geology that gives Galápagos its iconic status. Darwin's importance to the islands is reflected in the numerous species and places in Galápagos that bear his name (see appendix 2). It is also advertised in the titles of a local research institution (Charles Darwin Research Station), a road (Avenida Charles Darwin), a tour boat (M/V Darwin), and various other businesses (Darwin Hotel and Charles Darwin Travel Agency, for example) that operate in Galápagos. Indeed, the prominence of Darwin's name in Galápagos attests to the fact that the islands are "inexorably linked to the evolutionary views of Charles Darwin."⁵⁹

Darwin revolutionized not only science and the way we perceive ourselves but also the way we view Galápagos. In the early days of its discovery the archipelago was commonly regarded (or at least portrayed) as a "monstrous" heap of islands upon which "God had showered stones"⁶⁰ in some places, "brimstone"⁶¹ in others. They were inhabited by "creatures . . . the ugliest in Nature,"⁶² "deformed fiends" and "devils"⁶³ and "imps of darkness,"⁶⁴ all readily sacrificed by the only men who dared frequent Galápagos waters—blood thirsty pirates, whalers, sealers, convicts, and men of war. American novelist and mariner Herman Melville summed up the gloomy impression of these early visitors when he wrote:

Take five-and-twenty heaps of cinders dumped here and there in an outside city lot, imagine some of them magnified into mountains, and the vacant lot the sea, and you will have a fit idea of the general aspect of the Encantadas, or Enchanted Isles . . . Man and wolf alike disown them. Little but reptile life is here found: tortoises, lizards, immense spiders, snakes, and that strangest anomaly of outlandish nature, the *iguana*. No voice, no low, no howl is heard; the chief sound of life here is a hiss.⁶⁵

Darwin began exploring the islands with some of the same prejudice. But as he traveled through the archipelago, then reflected on all he had seen, he realized that far from being dismal dumps of dust, the islands had a fascinating tale to tell. Using the language of science Darwin revealed the beauty of the archipelago's youthful landscapes

and unique organisms. He lifted the veil of ignorance that had cursed Galápagos for the past three hundred years, and exhibited them in a new, secular light. In so doing he reclaimed the islands and their inhabitants from human condemnation and bequeathed them long-lasting fame and a life-saving future.

He did this in two ways. First, he revealed that the different islands of Galápagos are tenanted by different organisms of common ancestry adapted to different geographically isolated niches, and then issued a challenge for future scientists to “determine to what extent the fact holds good.”⁶⁶ Numerous scientists picked up the gauntlet, expanding on Darwin’s baseline collection and carrying out field studies to further understand the biodiversity of the archipelago.⁶⁷ Galápagos has now become a magnet for evolutionary biologists who, thanks to modern genetics, continue to reveal a greater amount of diversity in the islands than Darwin could ever have imagined. It is thanks to Darwin that Galápagos is now world famous and treasured as a “living laboratory.”

Secondly, Darwin did the eminent service of inspiring the conservation of the islands. For he anticipated “what havoc the introduction of any new beast of prey must cause in [Galápagos], before the instincts of the aborigines become adapted to the stranger’s craft or power.”⁶⁸ His words were heeded by a handful of scientists who, on the centenary of Darwin’s 1835 visit, initiated one of the first moves to protect the wildlife of Galápagos.⁶⁹ By 1959, one hundred years after the first publication of *The Origin of Species*, two organizations committed to conserving the Galápagos ecosystems were up and running. The Charles Darwin Foundation was founded to promote scientific research and environmental education about conservation and natural resource management in the archipelago. The Galápagos National Park Service dedicated itself to the protection by law of 97 percent of the landmass of the archipelago.

The efforts of these two institutions, with the support of various auxiliary conservation organizations,⁷⁰ have, to date, successfully managed to keep Galápagos one of the most pristine oceanic archipelagos in the world. It has not been easy. Tightly regulated nature-oriented tourism, introduced in 1967 with the hopes of it being a sustainable

economy compatible with Darwin's legacy of science and conservation, now (2009) brings more than 150,000 visitors to the islands every year. The sheer volume threatens the wildlife that the scheme was designed to protect, for along with visitors and an increased awareness of the importance of Galápagos, comes development, immigration, invasive species and exploitation. Conservation measures struggle to keep the threats in check by restricting access to and activities on the uninhabited islands, prohibiting the harming and exportation of native wildlife, limiting the introduction of non-native plants and animals, conducting eradication programs to eliminate feral animals, and controlling fishing activities. However, the magnitude of the problem is such that on July 26, 2007, the United Nations Educational, Scientific and Cultural Organization (UNESCO) added Galápagos to their "World Heritage Site in danger" list. Now, with mounting pressures from a spiraling human population, vigilance and understanding are needed more than ever to ensure that Darwin's islands are not destroyed. It was through Darwin that people have come to appreciate Galápagos, and it is through intimate recollection of his visit—what he did, what he saw, what he interpreted—that its cherished worth can hope to be maintained. It is to this end that this book is dedicated.

Two Tales in One

In the year 2000, after making repeated field trips to fine-tune Darwin's paths in the islands, Greg and I published the results of our expedition as a scientific paper.⁷¹ We lectured on the subject, continued with literature and field research, and designed an educational tour of the islands based on the *Beagle's* route through the archipelago. We knew, however, that there was more to tell than where Darwin explored in Galápagos and a comparative analysis of what he saw there. The significance of Darwin's visit to Galápagos stretches beyond the geographical boundaries of the archipelago and the temporal limits of Darwin's time there. The repercussions of his visit encompass the world and exceed Darwin's lifetime. The story of Darwin in Galápagos was fabric for a book.

Darwin in Galápagos: Footsteps to a New World is primarily a tale of two expeditions woven into one. Darwin's visit to Galápagos on the voyage of the *Beagle* provides the warp and our revisit provides the weft. For without the second, and the research that made it possible, there would be little to write about the first beyond what has already been included in a chapter on Galápagos in a book about Darwin, or a chapter on Darwin in a book about Galápagos. We have used our unique and intimate knowledge of all the islands in Galápagos to interlace a scenic backdrop to blend with the natural history facts Darwin recorded. We have also applied the findings of modern scientists and our own insights accumulated from over 50 combined years of ecological research on various land birds, sea birds, reptiles, mammals, invertebrates, and plants in Galápagos to give a modern perspective to Darwin's observations.

The story of Darwin in Galápagos would have little meaning without some understanding of Darwin, the man. The maxim, "we are the sum of all the moments of our lives,"⁷² cliché though it sounds, is key to understanding Darwin's visit to Galápagos. Everything Darwin did, observed, collected, and thought in Galápagos was directed by what he already knew, what he was in the process of discovering, and what he yearned to understand better. A look at Darwin's life before Galápagos, and especially at his education both before and during the voyage, is therefore needed to make sense of his Galápagos visit. It is important to know that Darwin attended two of the most respected universities in Great Britain, and was one of the most highly trained men of his age.⁷³ Before arriving in Galápagos he had been introduced to a wide range of scientific ideas and was aware that the scientific community, although heavily predisposed toward creationism, was also debating the concept of transmutation. Indeed, it can be said that many of the ideas Darwin developed were "lying fallow" in some form or another in England before he sailed on the voyage of the *Beagle*. It was the combination of Darwin's university training, his experiences during the voyage, and the "literary counsel" he received along the way that enabled him to pull it all together.⁷⁴

This book does not pretend to be a biography; it purposefully emphasizes one stage in his life. But in order to put Darwin's Galápagos

experience in perspective with the rest of his life and the development of his scientific thinking, we take a chronological pathway. Drawing principally from Darwin's autobiography, the Darwin biographies of Janet Browne and Adrian Desmond and James Moore, and the critical analyses of James Secord, Peter Bowler, and other historians of science, we provide glimpses of the experiences and ideas that helped shape Darwin and prepare him for Galápagos. We start with Darwin growing up as a child naturalist in England during the Industrial Revolution. We progress through his years at university, where he learned the scientific theories of the day. We then examine how Darwin matured on the voyage of the *Beagle*, and how his experiences in South America prepared him for what he would observe in Galápagos. We next take a step-by-step exploration of Darwin's journey through Galápagos and beyond, and demonstrate how the islands gradually changed his way of thinking. Finally, we look at Darwin after the voyage of the *Beagle* and show how Galápagos affected his life, and work, back home. The greatest portion naturally takes place in Galápagos for it is our principal aim to take the readers to the islands and have them put on Darwin's proverbial hiking boots and discover Galápagos as he did . . . as we did.

To make Darwin's visit to Galápagos a story rather than a fact sheet we have used some poetic license. It is impossible to determine what Darwin thought or how he felt at all times. He was a prolific writer⁷⁵ but a factual one; his personal journal, at least in the second half of the voyage, was often short on emotion, opinion, and the daily insignificances that one might expect to find in a diary. We have gleaned what we can of his psychological state from his letters home, though they were few and far between during the months surrounding his visit to Galápagos. Having said this, the book is nonfiction, and wherever we veer strongly away from known fact, we make clear our digression and our reasoning for it.

In the book we refer to both Darwin's diary and his journal. An explanatory note is in order to distinguish between the two, because Darwin confusingly used the word "journal" for both manuscripts. Darwin's diary is the "journal" of his activities and observations while

on the voyage of the *Beagle*. This *Beagle* diary is one of the most illuminating volumes about the voyage. Darwin's granddaughter Nora Barlow published the first edited version in 1933 and Darwin's great-grandson Richard Keynes published a second version in 1988. Even though Darwin never published his diary himself, he used it and the letters he had written during the voyage to compose a more polished account of the *Beagle* voyage—his published *Journal*. This tome, originally entitled *Journal and Remarks*, was first published in 1839 as the third and last volume of Captain FitzRoy's *Narrative of the Beagle*. Later that same year Darwin's contribution was republished as a separate book under a new title: *Journal of Researches into the Geology and Natural History of the countries visited during the voyage of HMS Beagle round the world*. In 1845, after most of the *Beagle* specimens had been examined and described by taxonomists, Darwin rewrote his *Journal* to include what he had learned from them. The title remained the same, except the order of the words *Geology* and *Natural History* was switched to reflect a change in emphasis. Later editions of the same book were called *The Voyage of the Beagle*.⁷⁶ To avoid confusion, and for consistency's sake, whenever we quote from Darwin's *Journal* we revert by default to the 1839 edition, unless the material occurs only in later editions.

Except here in the Introduction we have chosen to use the original English names of the Galápagos Islands, because they were the ones used in Darwin's day. We identify the modern Spanish name of each island in the corresponding chapter headings, and in a table in appendix 1. Site names are also listed in this table. Species are identified by their modern nomenclature (common name and scientific name), unless otherwise stated.

For simplicity, throughout the book we use the terms "evolution" and "transmutation" synonymously, defined as the process by which populations of organisms change from one form into another.⁷⁷ Darwin first used "transmutation" and then "descent with modification" to express his developing ideas on biological change. While he used the word "evolve" once at the end of the first edition of *The Origin of Species* published in 1859, he did not adopt the term "evolution" until the 1870s.⁷⁸

Many people were instrumental in producing this book and we have endeavored to give them full credit in a section devoted to their acknowledgment. Here, however, we wish to make it clear that there were really three authors to this book, just as there were three principal leaders on our 1996 expedition. Darwin “wrote” much of this book, and many of the quotations are his.