The
Beak of the Finch

A STORY OF EVOLUTION
IN OUR TIME

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Chapter 1

Daphne Major

The Creation is never over. It had a beginning but it has no ending. Creation is always busy making new scenes, new things, and new Worlds.

—Immanuel Kant,
A General Natural History
of the Heavens

Half past seven on Daphne Major. Peter and Rosemary Grant sit themselves down on stones, a few steps from their traps. Peter opens a yellow notebook with waterproof pages. “Okay,” he says. “Today is the twenty-fifth.”

It is the twenty-fifth of January, 1991. There are four hundred finches on the island at this moment, and the Grants know every one of the birds on sight, the way shepherds can tell every sheep in their flocks. In other years there have been more than a thousand finches on Daphne Major, and Peter and Rosemary could still recognize each one. The flock was down to three hundred once. The number is falling toward that now. The birds have gotten less than a fifth of an inch of rain in the last forty-four months: in 1,320 days, 5 millimeters of rain.

The Grants, and the Grants’ young daughters, and a long line of assistants, keep coming back to this desert island like sentries on a watch. They have been observing Daphne Major for almost two decades, or about twenty generations of finches. By now Peter and Rosemary Grant know many of the birds’ family trees by heart—again like shepherds, or like Bible scholars, who know that Abraham begat Isaac, and Isaac begat Jacob; and Abraham also begat Jokshan, who begat Dedan, who begat Asshurim, Letushim, and Leummim.

In each generation there are always a few birds, just one or two in
a hundred, that keep away from the Grants and refuse to be caught. This morning Rosemary, after a week of watching and plotting, has just captured two of the rarest, most difficult finches on the island. She caught them both in the space of a single minute, high on the island’s north rim, next to a fallen cactus pad, in black box traps baited with green bananas. “How about that,” she cried, when the traps’ doors clicked shut. And when Peter strode through the cactus trees and across the lava rubble to join her, Rosemary lifted up her first prize, fluttering in a blue pouch. “I deserve a bottle of wine for this!”

Now the Grants are sitting beside the traps at the edge of a cliff, 100 meters above the Pacific Ocean. Except for the honking and whistling of two masked boobies, courting on a rock nearby, the scene is quiet. The ocean is more than pacific; it is flat as a pond. The morning’s weather is what Charles Darwin described in his diary when he first saw the Galápagos archipelago, “a steady, gentle breeze of wind & gloomy sky.”

From the upper rim of Daphne Major, on clearer mornings than this one, Rosemary and Peter can see the island of Santiago, where Darwin camped for nine days. They can also see the island of Isabela, where Darwin spent one day. They can make out more than a dozen other islands and black lava ruins that Darwin never had a chance to visit, including an islet known officially as Sin Nombre (that is, Nameless) and another black speck called Eden.

“If I have seen further,” Isaac Newton once wrote, with celebrated modesty, “it is by standing upon the shoulders of Giants.” The dark volcanoes of the Galápagos are Darwin’s shoulders. These islands meant more to him than any other stop in his five-year voyage around the world. “Origin of all my views,” he called them once—the origin of the Origin of Species. The Grants are doing what Darwin could not do, going back to the Galápagos year after year; and the Grants are seeing there what Darwin did not imagine could be seen at all.

Rosemary unlatches their tool kit, a tackle box. From it, Peter extracts a pair of jeweler’s spectacles, a plastic mask with bulging lenses, which make him look like Robinson Crusoe from Mars. “Okay, Famous Bird,” Peter says. “Owl! Famous Bird has decided to bite the hand that feeds him.” He grasps the finch with one hand, and its head sticks out observantly from his fist. The bird is about the size of a sparrow, and jet-black, with a black beak and shiny dark eyes.

Rosemary hands Peter a pair of calipers. “Now, here we go,” Peter says. “Wing length, 72 millimeters.”

Rosemary jots the number in the yellow notebook. “Tarsus length, 21.5.” (The tarsus is the bird’s leg.)


“Black Five plumage.” The Grants rate the birds’ plumage from zero, which is brown, to five, totally black. Black Five means a mature male.

“Beak black.” Normally these birds’ beaks are pale, the color of horn. A black beak means the bird is ready to mate.

Peter dangles the bird in a little weighing cup. “Weight, 22.2 grams.”

“This bird has lived a long time,” he muses. “Thirteen years.” There are only three others of its generation still alive on the island, and none older. “But I don’t think there’s a single one of his offspring flying around. Not one has made it to the breeding season.” The bird has been a father many times, and never once a grandfather.
Peter puts a gray ring and a brown ring on the bird’s left ankle. He puts a light green ring over a metal one on its right ankle. Bands like these, and an ingenious color code, help the Grant team to keep track of their flocks from dawn to dusk, from the cliffs at the base of the island to this guano-painted rubble at the rim.

Peter holds the bird in his fist one more time and inspects its beak in profile. In rushing up to join Rosemary at the rim, he has forgotten his camera. Otherwise he would photograph the bird just so, from a distance of 27 centimeters. That is the Grants’ standard mug shot for one of Darwin’s finches.

The Origin of Species says very little about the origin of species. Darwin’s full title is On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life. Yet the book does not document the origin of a single species, or a single case of natural selection, or the preservation of one favored race in the struggle for life.

Darwin talks about the breeding of pigeons. He talks about Malthus, fossils, patterns in the geographic distribution of the world's flora and fauna. He marshals an enormous mass of evidence that evolution has happened. Yet Darwin never saw it happen, either in the Galápagos (where he spent only five weeks) or anywhere else.

"It may metaphorically be said," he writes in a famous passage, "that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, whenever and wherever opportunity offers... We see nothing of these slow changes in progress, until the hand of time has marked the lapse of ages, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different from what they formerly were."

That is Darwinism for Darwin. Life changes, down through the generations. The chief mechanism of change is the process that Darwin called natural selection. This process is at work right now around us, "whenever and wherever opportunity offers," as Darwin emphasizes with his italics: not confined to a moment of creation in the dim past. It goes on this year as much as last year, now and forever, here and everywhere, like Newton’s laws of motion. But the action and reaction are too slow to watch.

The invisibility of the process made its demonstration more difficult for Darwin, although the naturalist Thomas Henry Huxley, Darwin’s self-appointed bulldog and griffin ("I am sharpening up my beak and claws in readiness," he wrote, as the Origin went on sale), met critics head on. "It has been urged, for instance, that in his chapters on the struggle for existence and on natural selection, Mr. Darwin does not so much prove that natural selection does occur, as that it must occur," Huxley wrote; "but, in fact, no other sort of demonstration is attainable. A race does not attract our attention in Nature until it has, in all probability, existed for a considerable time, and then it is too late to inquire into the conditions of its origin."

Huxley gave a public lecture with the title "The Demonstrative Evidence of Evolution." His evidence was a series of extinct ancestors of the modern horse, beginning with Eohippus, the "dawn horse," now called Hyracotherium, which lived and died about fifty million years ago. The naturalist Alfred Russel Wallace published "A Demonstration of the Origin of Species by Natural Selection," which consisted of a brief table divided in two columns. The left-hand column listed the keys to the process of natural selection. (Like Newton’s laws of motion, they are so few and so simple that they can be written on the back of an envelope.) The right-hand column listed the logical consequences of these laws, ending with "changes of organic forms," or evolution. Wallace headed the items on the left "Proved Facts" and the items on the right "Necessary Consequences (afterwards taken as Proved Facts)."

Fossils argued that evolution has happened. Logic argued that natural selection can make it happen. But neither bones nor logic could demonstrate the one leading to the other, natural selection causing evolution. In 1893, in an essay entitled "The All-Sufficiency of Natural Selection," the German biologist August Weismann confessed (in italics) "that it is really very difficult to imagine this process of natural selection in its details; and to this day it is impossible to demonstrate it in any one point."

A few biologists did try to demonstrate it at the turn of the century. A Yankee biologist named Hermon Carey Bumpus thought he saw it at work among a flock of sparrows in Providence, Rhode Island. Other investigators reported natural selection in action among crabs in Plymouth Sound, moths in Yorkshire birch trees, mice in sandhills on an island in Dublin Bay, and chicks in a Long Island poultry yard. But most of these sittings were brief and ambiguous (Bumpus’s data base
was a single snowstorm). The work tended to be neglected by both sides of the debate.

Mountains of books and papers, technical and popular, were published about evolutionary theory. Much of this literature approached the level of abstraction of the medieval scholastics' angels-on-the-head-of-a-pin. Some of the most learned interpretations of Darwinism were more or less unconstrained by reality. In crucial ways, for all the mountainous literature, the theory of evolution by natural selection was still a proof on the back of an envelope, and the origin of species remained what Darwin called, in his journal of the Beagle voyage, "that mystery of mysteries."

"If ever an idea cried and begged" for an experimental research program, a geneticist lamented in 1934, "surely it is this one ... but there have been so very, very few of them." A quarter-century later, in 1960, another geneticist wrote that "the amount of observation or experiment so far carried out upon evolution in wild populations" was still "surprisingly small." He found this impoverished state of affairs disturbing because "evolution is the fundamental problem of biology while observation and experiment are the fundamental tools of science." In 1990, in a one-volume *Encyclopedia of Evolution*, a physical anthropologist wrote that the "complaint of a half-century ago holds good: The number of experimental tests of natural selection is pitiful; the few that have been conducted still do heavy duty as exemplars."

This is also the burden of the Creationists' cry, "Only a theory." According to a little paperback entitled *The Handy-Dandy Evolution Refuter*, whose cover bears the gold seal of the Chapel of the Air, in Wheaton, Illinois, "Neither evolution nor creation can be tested as a scientific theory, so believers in evolution or creation must accept either view by faith." Duane Gish, the most prominent Creationist writer today, declares in his book *Evolution? The Fossils Say No!*, "By creation we mean the bringing into being by a supernatural Creator of the basic kinds of plants and animals by the process of sudden, or fiat, creation. We do not know how the Creator created, what processes He used, for he used processes which are not now operating anywhere in the natural universe." (The italics are his.)

Today more and more evolutionists are doing what Darwin thought impossible. They are studying the evolutionary process not through fossils but directly, in real time, in the wild: evolution in the flesh. "Evolution" comes from the Latin *evolutio*, an unrolling, unfolding, opening. Biologists are observing year by year and sometimes even day by day or hour by hour details of life's unrolling and opening, right now.

So many new studies are coming out that one investigator has published a technical guide for evolution watchers, a detailed and rigorous book entitled *Natural Selection in the Wild*. The centerpiece of the book is a table, "Direct Demonstrations of Natural Selection." This table begins to supply what Darwin, Huxley, Wallace, and Weismann never could. It lists more than 140 instances in which a piece of the Darwinian process has been documented. Some of these case studies, like Bumpus's sparrows, are only flashes in the storm, glimpses of the process that is at work around us, but many of the latest studies, like the Grants', are remarkably, almost panoramically complete.

Taken together, these new studies suggest that Darwin did not know the strength of his own theory. He vastly underestimated the power of natural selection. Its action is neither rare nor slow. It leads to evolution daily and hourly, all around us, and we can watch.

The Grants are leaders of this field, and they are among its ideal representatives. Year after year they go back to the most celebrated place in the study of evolution, the place that helped lead the young Darwin to his theory: the Galápagos, the Enchanted Islands. There they observe Darwin's finches, the birds that Darwin was the first naturalist to collect; the birds whose beaks inspired his first veiled hints about his revolutionary theory; the birds whose portraits in textbooks and encyclopedias have now introduced so many generations to Darwinism that they have become international symbols of the process, totems of evolution, like the overshot brows and cumulous beard of Darwin himself. Now the Grants' work on Darwin's finches is entering the textbooks too. This is one of the most intensive and valuable animal studies ever conducted in the wild; zoologists and evolutionists already regard it as a classic. It is the best and most detailed demonstration to date of the power of Darwin's process.

**TO STUDY THE EVOLUTION** of life through many generations you need: an isolated population, one that is not going to run away, one that cannot easily mix and mate with others and, by mixing, mingle the changes induced in one place with the changes induced in others. If you detect a change in the wingspan of a bird, the teeth of a bear, the fins of a fish, or the mandibles of an ant, you want to be able to explain why the change occurred. You want to know the action to
which the change is a reaction. For this you need something in nature approximating the simplicity and isolation of a laboratory.

Islands are ideal for this purpose, because it is hard for your subjects to leave them, and it is hard for outside influences to invade. Islands are like castles, communities with moats around them. Evolutionists are now watching life evolve on Gotland, in the Baltic Sea; on Mandarte, in the Georgia Strait of British Columbia; on Trinidad, in the West Indies; on the Big Island of Hawaii, in the center of the Pacific. But of all the islands in the world the nearest approach to paradise for evolutionists is still the Galápagos archipelago.

There are about a dozen major and a dozen minor islands in the Galápagos. They are the tips of volcanoes that erupted from the floor of the sea. They broke the surface of the Pacific—within the last five million years or so, which makes them far younger than most of the rock that composes the continents. In fact a few of these islands are still in their birth throes, among the most fiery volcanoes on the planet. Because they are so young, the creation of new forms from old is still in the early stages in the Galápagos: life is evolving as fast and furiously as the volcanoes. And because much of this life is trapped on separate islands—the summit of each volcano is a prison for most of the creatures that live and die there—and because there was never any bridge to the mainland (South America is a thousand kilometers, or six hundred miles, to the east), the life-forms of this archipelago are following strange paths of their own.

Daphne Major, where the Grants have spent most of their time, is small and lonely even by the standards of the Galápagos. There is only one way onto the island. The Grants and their team have to go there at low tide, as early in the morning as they can, while the sea is still relatively calm, and sail around the island’s base to a certain point on the south side. They can’t land a boat, because Daphne Major has no shore, nothing at the waterline all the way around but cliffs two and three stories high. Most of these cliffs are steeper than walls, because the waves have cut them inward, so that the profile of the volcano at the waterline is overshot, like Darwin’s brow. The Grants can’t even anchor, because the waters around the island are absurdly deep, one thousand fathoms of sharks to the bottom of the ocean.

They have to leave their boat’s captain describing figure eights offshore while they search along the south side of the island in a rowboat, which in the Spanish slang of the Galápagos fishermen is called a panga. (The origin of the word is obscure, although a wooden rowboat or dinghy laboring toward black Galápagos cliffs looks frail as a leaf of corn husk, which is also a panga.) They watch for a place where the cliff’s rim stoops toward the water and the angle of the slope becomes slightly more inviting. Just at this spot, there is a wet black ledge near the waterline. An experienced pangero can find it easily. At night this ledge is often haunted by sea lions, octopuses, and night herons, but by day it is guarded only by barnacles.

The first one off the panga has to leap when a swell lifts the boat to the top of this ledge, which has the surface area of a large welcome mat. Often the panga will be flying up above the welcome mat a few meters, then dropping down below the mat a few meters, or more, depending on the mood of the ocean (“miscalled Pacific,” as Darwin notes in his Beagle diary—for it is not always as calm as it is this morning). From the panga the ledge seems to shoot up as high as a ceiling and then plummet as deep as a basement.

They leap onto the welcome mat and climb the little cliff, hand
over hand, on rock that is dark, wet, and many-formed, much abused by the waves, until they come to an upper ledge they call the Landing. Then they form a human chain and pass up tent canvases, bamboo poles, clothes, crates of tinned soups, all of their food for the next six months, including hefty water barrels called chimbuzaos. They cannot land without all these provisions because there is no food or water on Daphne Major. On many days the little island feels like the solar face of Mercury. The black lava gets hot enough to fry an egg (not the proverbial egg, a real one). A jerrycan of water left out in the sun at noon can come so near a boil that it is too hot to sip. Every drop they drink they have to carry up the cliff on their backs in the chimbuzaos, and each chimbuzao weighs fifty kilos, or about a hundred pounds.

Everyone in the Grants' group detests landing day. "Nobody's talking science," Rosemary says.

"Or talking," says Peter.

"It is possible to see some slightly frayed tempers," says Rosemary, mildly.

Of course, the Grants chose the island partly for its inconveniences. The whole of the archipelago was discovered by human beings rather late in the heyday of global exploration. The first historical account of them dates from the sixteenth century, when the third bishop of Panama was swept off course on a mission to Peru and almost died there. (The bishop wrote not only the first but the best one-line description of the islands: "It looked as though God had caused it to rain stones.") In the next century the place became a retreat for buccaneers. By the time of Darwin's visit there were a few settlers who led "a sort of Robinson Crusoe life" in the islands, hunting the descendants of the wild pigs and goats that the buccaneers had brought there. There was even a penal colony on the island of Floreana.

But even then, not many soldiers, sailors, jailors, pirates, or whalers would have taken the trouble to climb onto this steep little rock of an island. Those who did would have needed only an hour to walk around the island's base, and twenty minutes to walk around the rim. It is unlikely that before the arrival of the Grants and their team a single human being ever actually tried to live there, and even though the island is located in the very center of the archipelago it was not even included in some of the earliest maps. (It may be a nameless speck on the chart made by Ambrose Cowley, the buccaneer, in 1684, but it is not on the chart made by Alonzo de Torrés, a captain in the Royal Spanish Armada, more than a century later.) Nor did Darwin himself see Daphne Major. The Beagle missed it by dozens of kilometers. The island may have been briefly visible during the voyage of HMS Beagle as a homely blip on the horizon. Even today, in spite of its central location, Daphne is a rare and restricted stop for the tourist cruises that now crisscross the Galápagos. The average tourist would probably fall right off the island.

On landing day, the Grants and their assistants store some of their supplies in caves above the welcome mat. But they have to lug most of their gear almost to the rim of the volcano. This is the only spot on the island where it is flat enough to pitch a tent, aside from the crater floor, which is forbidden ground because it is the nesting place of blue-footed boobies. The trail that slants up from the Landing to the camp is not very steep, but even with the sky cloudy and a wind blowing it is still hot, muggy, and full of glare. Much of the rock, solid or loose (and almost all of it is loose and broken up to some extent), is white or near white, from many long-worn coats of guano. The whitest birds on earth, masked boobies, scream and whistle and honk from their nests along the edges of the trail, or in the middle of the trail, but do not budge. Sometimes it is hard to step around the boobies without falling off the island, for the trail is narrow, the rock is loose, and the boobies are vociferous—long darting necks, long sharp beaks, and angry honks and whistles. (The Beagle's captain, Robert FitzRoy, when he landed on his first Galápagos island, called it "a shore fit for Pandemonium.")

At their campsite, the Grants lash tarpaulins to bamboo poles and prop up the poles with strings tied to piles of stones. These days they use materials that can survive the vertical sun at the equator. In earlier expeditions they used ordinary tarps. The sun and the wind beat down until, according to Trevor Price, a veteran of the finch watch, the tarp was "reduced to a symbolic flag flying from half a bamboo pole. When 'whites' arrived in camp," Price remembers wickedly, "they got into all sorts of contortions trying to stay in its shade and prevent pinkness."

Once they have pitched camp, however, the world of the Galápagos settles around them. They can sit on the cliff edge at sunset and watch the nearer islands turn golden. They can watch Galápagos sharks patrol the Landing, and great manta rays leaping from the water,
schools of dolphins, and sometimes breaching whales. Lava lizards skitter across the rocks. Owls emerge from crooks in the rocks, and so do scorpions. Some of the finch watchers hang their boots from bamboo poles to keep scorpions from crawling into the toes.

After dark, they can sit on thrones made of relics of several shipwrecks apiece and lashed together with bits of string, and read the Origin by candlelight. And a single black male finch sits at the top of a cactus tree giving out long, repeated whistles, very lonely and melancholy. Before going to bed they sometimes look up and see great frigatebirds like black angels silhouetted against the moon.

The limits of the island make it almost like the frame of a work of tragic art in which someone has tried to put everything of life and death in a single place, in a single piece, in a single play. The place speaks of bare necessities, these white rocks and pale rocks and streaked lava rocks all in a pile beneath a dark gray sky and climbing out from the dark blue sea, with the long scar of the trail to the crater rim. It is an island's island, with just one half-safe place to land, one dented place to camp.

The Grants and their team live and work there like those cartoon castaways who squat on a single lump not much larger than a Galápagos tortoise, with one palm tree growing from the center. Only here, there is not even a palm tree, and the castaways are all business and vigor and eagerness, with not much time to talk.

The whole island is a diagram of limits. If a castle describes the impossibility of assault, an Alcatraz or Devil's Island the impossibility of escape, then Daphne Major suggests the near impossibility of life, and the near impossibility of its study by human beings. Yet both have triumphed. The bizarre flora and fauna hang on here drought after drought, deluge after deluge. And these biologists, all of them, team after team, year after year after year, are coming away with gold, so that the prison has become a treasure-house.

"LET'S GET ON with the measuring, darling, because this bird is a breeder too," says Peter Grant.

The beak of the bird in the second trap is as black as the first, but slightly larger. It is 15.8 millimeters long, 9.7 millimeters deep, and 9 millimeters wide. This finch is also heavier than the first, by 2.2 grams. "Probably had lots of banana," Rosemary jokes.

She and Peter band the bird's left leg with orange over black ("It's a Princeton bird, isn't it?" Rosemary says), and they band his right leg with white over metal.

The last four years on the island have been the kind that highlight Darwin's "struggle for existence." With virtually no rain, there has been virtually no breeding—so there are virtually no na"ive birds to catch. Despite the Grants' nets and traps, their young assistants, and their almost unlimited interest, they have never been able to catch these two birds. Rosemary succeeded this morning only after a large investment of time. She has been coming to this spot all week. On Monday she did nothing here but watch her quarry. On Tuesday she brought up two traps and baited them, but left the doors open. On Wednesday and Thursday she kept the doors wide open, changing the bananas each morning. Now it is Friday, and she has them.

Her shorts and her pink shirt are torn, and speckled by the brown sap of the Crotol trees, which have decorated the clothes of virtually every scientist in the Galápagos since Darwin. Her hair is so light that it would be hard to say if it is blond or gray, and her cheeks, despite years beneath the equatorial sun, have the kind of rosiness that is prized on islands halfway across the planet, the British Isles, where she was born and raised.

Peter's shirt too is splotched by the sap of the Crotol trees. He is tall, fit, wiry, with a memorable beard. In his mid-fifties, he has just started wearing glasses. He grew up on the southern edge of London, one hour's drive from Darwin's old homestead, and as the tip of his beard turns white his resemblance to Darwin is growing almost uncanny. Of course, Darwin by this age was an invalid. (His health may have been destroyed by a tropical disease, or by his own theory, which he worked on more or less in secret for twenty years after the voyage of the Beagle, the daily anxiety almost killing him.) Peter strides up the volcano at a pace that would be brisk on a level in England, or New England. His bare brown legs are as well toned as the legs of an athlete of twenty. He wears a set of small black binoculars around his neck with which he can identify a bird—read its I.D.—from a dozen steps away, and he whips them up often as he walks.

Rosemary swabs the finch's wing tip with an alcohol pad to clean the skin beneath its feathers. While she swabs, she chats, rather as a doctor might while preparing a patient for an injection. Just a quick prick—the bird doesn't even seem to notice. She blasts the drop of blood with the same filter paper that nurses use in hospitals with newborn babies, and presses the alcohol pad to the feathers for a moment.
When the Grants leave the island, this drop of blood and the morning's numbers will travel back to them to their other lives in Princeton, New Jersey, for analysis. There too, Rosemary and Peter work side by side. They have adjoinging offices at Princeton University. Rosemary is a lecturer in the Department of Ecology and Evolution; Peter is, this year, the chairman of the department.

Their tools on Daphne are low-tech; tools have to be simple to work reliably, month after month, on a desert island that Robinson Crusoe would have laughed at. But the instruments that are trained on their results in Princeton and elsewhere are among the most sophisticated in the armamentarium of science: computers, of course, to store and analyze the decades of marching numbers; and equally powerful but more exotic machines to read the coded messages that are inscribed, as if on myriad twisted and spiraling scrolls, in every drop of bird blood. Between the numbers in the notebooks, and the sentences in the blood, the Grants and others are now reading the story of life from the outside in and from the inside out. They are watching evolution in the flesh, and evolution in the blood.

"In the distant future I see open fields for far more important researches," Darwin writes in the last pages of the Origin. "... Light will be thrown on the origin of man and his history." The study of evolution in action throws light on our origin and our history, on the silent bones of Olduvai Gorge and Koobi Fora. It also casts a new light on our tumultuous present and our destiny: for the processes that are illuminated by these studies, the processes that got us here, are in turmoil. With the conditions of life on this planet changing everywhere faster and faster, the pressures of natural selection are everywhere increasing in intensity, daily and hourly, even on islands as remote as the Galápagos. Whether or not we choose to watch, evolution is shaping us all.

This is the view of life that is opening now, for those who stand on Darwin's shoulders. They can see farther than Darwin ever dreamed, and much lies in the offing, or beyond the offing.

Chapter 2

What Darwin Saw

Steeped in fable, steeped in fate . . .

—HERMAN MELVILLE,
"The Coming Storm"

There are thirteen species of finches in the Galápagos. Some of them look so much alike that during the mating season they find it hard to tell themselves apart. Yet they are also spectacularly and peculiarly diverse.

The black cocks that Rosemary trapped this morning are cactus finches. Cactus finches do more with cactus than Plains Indians did with buffalo. They nest in cactus; they sleep in cactus; they often copulate in cactus; they drink cactus nectar; they eat cactus flowers, cactus pollen, and cactus seeds. In return they pollinate the cactus, like bees.

Two other species of Darwin's finches use tools. They pick up a twig, a cactus spine, or a leafstalk, and they trim it into shape with their beaks. Then they poke it into the bark of dead branches and pry out grubs.

One finch eats green leaves, which birds are not supposed to do. Another, the vampire finch, found chiefly on the rough, remote, cliff-walled islands of Wolf and Darwin, perches on the backs of boobies, pecks at their wings and tails, draws their blood, and drinks it. Vampires also smash boobies' eggs against rocks and drink the yolk. They even drink the blood of their own dead.

There is a vegetarian species—know how to strip the bark off twigs into long curling ribbons like Geppetto's shavings, to get at the cambium and phloem. There are also species that perch on the backs of iguanas and rid them of ticks. The iguana invites a finch to perch by assuming a posture that makes it look like a cat that wants to be petted.