Charles Darwin
http://www.amnh.org/exhibitions/darwin/evolution/

Birds' eggs and sea shells, beetles and coins, moths and minerals—as a child, Charles Darwin collected all of these and more. Born in 1809 to a wealthy family in rural England, he spent hours watching birds and lying under the dining-room table, reading. He was **an indifferent student,** though, and school bored him. He despaired of learning Latin and memorizing verse, "for every verse was forgotten in 48 hours." But he **never tired of studying the details of the natural world.**

As a teenager, Darwin was thrilled by chemistry, biology, botany and geology. Yet all the while he dutifully pursued the careers his father had selected for him: doctor and then clergyman. As he studied at the University of Cambridge, though, **Darwin was singled out by an elite circle of academics** who recognized his potential. Finally, his true talent for natural history blossomed..

By this time, geologists had shown that **Earth was not static or fixed—clearly it had undergone sweeping changes over time** and was, in fact, still changing. This idea had a huge influence on Darwin's thought. Pondering the long, slow changes in Earth's history would later help shape Darwin's ideas about how plant and animal species, too, had changed over millions of years.

In 1831, Charles Darwin received an astounding invitation: to join the HMS *Beagle* as ship's naturalist for a trip around the world. For most of the next five years, the *Beagle* surveyed the coast of South America, leaving Darwin free to explore the continent and islands, including the Galápagos. He filled dozens of notebooks with **careful observations on animals, plants and geology,** and collected thousands of specimens, which he crated and sent home for further study.

In addition to the ships official purpose of mapping the foreign cost lines, it was understood that Darwin was to make scientific observations. So while the ship systematically measured ocean depths, Darwin went ashore to explore and collect specimens. In fact, two-thirds of Darwin's time was spent on dry land, largely in the South American wilderness of Brazil, Argentina, Chile and remote areas such as the Galápagos Islands. By any measure, Darwin's labors were hugely successful. He brought back specimens of more than 1,500 different species, hundreds of which had never before been seen in Europe.

Some of the most extraordinary animals Darwin encountered were those living on isolated islands like the Galápagos. Having lived for generations in a land free from hunters, many had no fear of humans.Many Galápagos animals were as strange as their surroundings, and they tended to blend with the lava around them. A few, though, such as the blue-footed booby and Sally lightfoot crab, had bright coloring; these were typically migrants from the mainland.

Darwin noticed that many species seemed a perfect match for their environment, even down to their coloring. Describing "most disgusting clumsy Lizards" that were "as black as the porous lava rocks over which they crawl," Darwin mused, "They assuredly well become the land they inhabit."

While exploring the Falkland Islands, Darwin was interested to observe the behavior of the upland goose. Like birds on the Galápagos Islands, this goose had no instinctive fear of humans, and a hunter could kill "more of the upland geese in one day than he can carry home." On the mainland, however, where it had been hunted for generations, Darwin noted that the same species was wary of hunters and avoided people. Clearly, a species could change over time in response to its environment, at least in its instinctive behavior.

Fossils raised many questions about the origin of species-and not just for Darwin. Discoveries in geology had already challenged the idea that the world and all its species had been created at the same time a few thousand years ago. Fossils clearly showed that in past ages, the world had been inhabited by different species from those existing today. Old species had died out, and new species had appeared at many different times in Earth's history.

Fossils also revealed another intriguing pattern: new species tended to appear where similar species had previously lived. Why would one species replace a similar one in the same location? Or perhaps, Darwin would eventually wonder, had the older species somehow given rise to the new ones? Back in London, the relationship between old and new species, as shown in fossils, would become one of the main lines of evidence leading to Darwin's theory of evolution.

Why, Darwin wondered, had so many species gone extinct, only to be replaced by similar ones? And not just once, but again and again? Perhaps the newer species were better suited to the changing environment, he reasoned. All around him, he was seeing evidence of slow, gradual, geological changes. But if Earth's changes were slow and gradual, what did that mean for the changes in species? Back in England, Darwin would ask himself: Over long periods of time, could older species have evolved into new ones?

The puzzling distribution of plants and animals in South America and the Galápagos would later make Darwin question how species originated. If each plant and animal was created to match its habitat, why didn't the same species appear in similar environments? Why create the ostrich in Africa and a different running bird, the rhea, in America?

And why, within each continent, were there so many variations? One rhea might have been sufficient in South America—yet there were two distinct species, living in adjacent regions. The strange plants and animals of the Galápagos Islands puzzled Darwin. Many lived only on the Galápagos—and sometimes only on one specific island. How had these species gotten there? And why weren't they the same as those on similar islands around the world?

Before the *Beagle* reached home, Darwin began to wonder if species from the mainland had reached the Galápagos, and then changed—as they adapted to this new environment. Was it possible? Over time, could species change?On the Galápagos, Darwin found plants that were related to daisies and sunflowers—but grew to the size of trees. Like the marine iguanas, these island residents seemed to have adapted to their environment: with plenty of sun and little competition, daisies and cactuses could grow to the size of trees.

Darwin noticed another "truly wonderful fact" about these giant daisy relatives. He had found six species, now classified in the genus *Scalesia*, and remarkably, "not one of these six species grows on any two islands." It was not enough that they were found only on the Galápagos—each species was found on only one island. The same was true of dozens of other plants. What could account for this diversity?

Near the end of his voyage, Darwin pored over his notes and began to compile them. In a set of notes on birds, written while still on the *Beagle*, Darwin first began speculating about evolution in writing. Darwin wondered: Were the different mockingbirds he had seen in the Galápagos just varieties of one species, or were they distinct species? Or might they even be varieties on the way to becoming different species? It would take years of thinking about the idea of evolution, and a great deal more evidence, for Darwin to convince himself his suspicions were correct. But once raised, the question would not go away. Could species evolve?

At the beginning of his voyage, Darwin saw animals like this green iguana as unique marvels. But by the end, he was looking at species in a different way: He was becoming interested in how species might be related to one another.

Within months of stepping off the deck of the *Beagle*, Darwin settled in London, the nerve center of Britain. Now on fire with the ambition to join the "real naturalists," Darwin plunged into the work of writing up his *Beagle* research. Meanwhile, **a huge idea was taking shape** in his mind. Had those first shipboard insights been right? Could new species arise from old? If they could, how did it happen?

Darwin's Galápagos birds told an amazing story—but it was one Darwin fully understood only when he heard it from the experts. For instance, Darwin was stunned to learn, back in London, that a group of Galápagos specimens he had thought included many different birds were actually all finches. They were just finches that looked remarkably different from one another—almost as if, he would later write, "one species had been taken and modified for different ends." And there was more news. Ornithologist James Gould told Darwin that he had brought home three entirely new species of mockingbird, two of the three confined to different islands. Darwin quickly saw what this meant for evolution. Did islands—and isolation—somehow give rise to new species? Had all these diverse-looking finches, and these species of mockingbirds, diversified from South American ancestors?

Once Darwin started thinking seriously about evolution, he grasped its essentials with astonishing speed. Only a month or so elapsed between the time he opened the first full

transmutation notebook, in about July 1837, and the time he drew a crude—but unmistakable—**evolutionary tree**. This drawing, with the most ancient forms at the bottom and their descendants branching off irregularly along the trunk, reveals that Darwin understood all plants and animals are related. Above his tree Darwin wrote firmly, "I think."

Limbs that look very different and serve different functions-"the hand to clasp, the bat's wing to fly . . . the porpoise to swim" -are often much alike in skeletal design. For Darwin, this resemblance was further evidence that large classes of organisms, such as mammals, shared a common ancestry. Here, each of the bones in this bat wing has a counterpart in the bones of a human hand.

Darwin always read widely, on the lookout for new ideas. In late September 1838 he found himself reading—"for amusement," he later recalled—the "Essay on Population" by political economist Reverend Thomas Malthus. In this essay, Malthus argued that human population could quickly outstrip the food supply: competition for food or space was a constant force keeping population in check.

Darwin immediately saw how the idea could be applied to the natural world. **More animals were born than could survive.** They constantly struggled against one another for food or room to grow, he thought. That meant any plant or animal with a competitive edge—drought tolerance, a thicker-than-average coat—could live longer and leave more offspring than its fellows. The presence of such adaptations controlled, in effect, which individuals would represent the species in the next generation.

Now Darwin could see how variation could make a difference: **individuals with useful traits would, on average, survive to reproduce and pass along those traits**. "It is a contest, " he wrote, and "a grain of sand turns the balance."

By the late summer of 1842 Darwin felt ready to commit an outline of his theory to paper. The main points were clear: plants and animals with useful—and heritable—variations were likely to live longer. That meant they could leave more offspring, some of which would carry the new trait. Over time, **species could change through this process of "natural selection,"** a term Darwin first uses here.

In 1842 Charles Darwin and his family fled London **in search of peace and quiet**. They found it in a tiny village 16 miles outside the city, and for the next 40 years their home—called Down House—was Darwin's **retreat, research station** and the **hub of his vast scientific network**. Working in his study, greenhouse and garden, corresponding with scientists around the world, Darwin patiently completed the puzzle of evolution by natural selection.