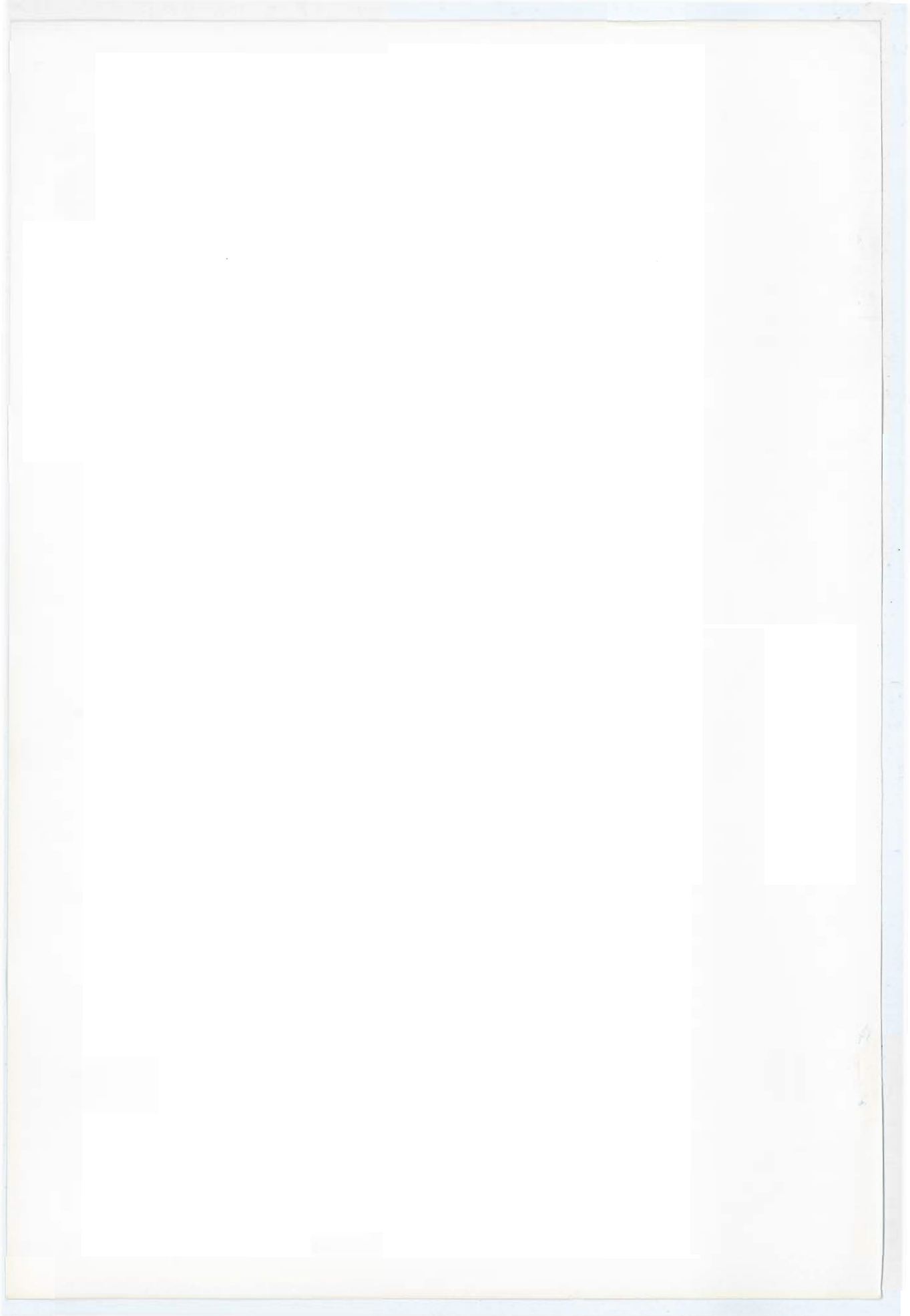


Oceanus[®]

Volume 30, Number 2, Summer 1987

Darwin and the Galápagos: Three Myths

by Frank J. Sulloway



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On 16 September 1835, Charles Darwin landed in the Galápagos Islands and began five weeks of collecting and observing in this famous "laboratory of evolution." While in the Galápagos, the 26-year-old Darwin visited four of the major islands, and, from the *H.M.S. Beagle*, he glimpsed numerous others. Altogether he spent 19 days on land in the Galápagos — five days on Chatham; four on Charles, where he visited the highlands settlement; one day at Tagus Cove on Albemarle Island; and nine days on James, where he collected extensively and spent three days in the highlands (Figure 1).

By current research standards, Darwin's Galápagos visit was remarkably brief. And yet his encounter with these islands was seemingly decisive for his biological thinking. As he wrote in the second edition of his *Journal of Researches*:

The archipelago is a little world within itself, or rather a satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions. Considering the small size of these islands, we feel all the more astonished at the number of their aboriginal beings, and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period geologically recent the unbroken ocean was here spread out. Hence both in space and time, we seem to be brought somewhat near to that great fact — that mystery of mysteries — the first appearance of the new beings on this earth. (1845: 377–78)

When and how Darwin solved this great "mystery of mysteries," and particularly the role his Galápagos visit played in this regard, have become the subject of a considerable legend in the history of science.

According to the legend, Darwin's Galápagos visit first provided him with irrefutable evidence for the mutability of species and converted him, eureka-like, to the theory of evolution. Actually, the impact of the Galápagos was largely retrospective. Darwin was first alerted to the evolutionary significance of the Galápagos species by the vice-governor, Nicholas Lawson, who informed him that he could tell "with certainty" from which island any tortoise had been brought. Darwin was on Charles Island at the time; and according to David Lack, among other commentators, he was sufficiently impressed to begin separating his collections of finches and other species by island, thus securing the necessary biological evidence to back up the vice-governor's extraordinary claim. What Lack and others did not appreciate, however, was that the bulk of the locality information on Darwin's type specimens and in his postvoyage publications was actually derived, after the voyage, from the carefully labelled collections of three other *Beagle* shipmates (all naval personnel). Why Darwin initially failed to heed the vice-governor's remarks about the tortoises must be understood in terms of the intimate relationship between a received theory like creationism, no matter how erroneous, and the gathering and interpretation of scientific evidence.

To begin with, it would never have occurred to a creationist, which Darwin still was in 1835, to label his collections according to island of origin within a small archipelago. As part of a presumed "center of creation," the Galápagos would have been expected to exhibit a uniform flora and fauna by island, making such detailed locality designations superfluous. In this regard, it is noteworthy that those *Beagle* specimens that were carefully labelled by island were collected by the nonscientists on board, who presumably did not realize how unnecessary such information really ought to have been.

We also fail to appreciate how complex and confusing the Galápagos evidence must initially have been, especially to a nonspecialist and

nonsystematist like Darwin. It is not just the theory of evolution that introduces unifying order into many of the enigmas of Galápagos biology; creationism also made a certain reasonable sense out of the facts. From his specimen notebooks and manuscript notes it is clear, for example, that Darwin mistook many species of "Darwin's finches" for the forms that they, through adaptive evolutionary radiation, now appear to mimic. Thus he thought the warbler finch was a "Wren"; and he described the large-beaked ground finch as a "Grosbeak" and the cactus finch as an "Icterus" — the genus to which belong the orioles, blackbirds, and certain other forms possessing a long pointed bill. It is perhaps not surprising then that Darwin, having failed to recognize the closely related nature of the Galápagos finches, also failed to suspect that their island distributions might vary within the archipelago.

The evolutionary evidence provided by the famous Galápagos tortoises was also similarly clouded at the time of Darwin's visit. This taxon was then believed by most naturalists to have originated in the islands of the Indian Ocean — hence its erroneous name *Testudo indicus* — and to have been transported to the Galápagos by buccaneers. Thus when Darwin was informed that the tortoises differed by island, he probably initially thought it was a matter of local variations somehow induced by transport to a new and unnatural environment. Moreover, those tortoises actually seen by Darwin, on Chatham and James, were too similar to be distinguished "with certainty"; so the evidence was not as striking, from Darwin's personal observations, as the vice-governor had claimed.

In any event, since tortoises were not supposed to be native to the Galápagos, such differences did not apparently bear directly on the question of what was uniquely "Galápagean," if anything, about the Galápagos. So little value did Darwin place upon the tortoise evidence that he not only failed, at the time of his visit, to collect specimens for scientific purposes, but he apparently joined his *Beagle* shipmates in eating the last of some 30 large tortoises during the cruise to Tahiti. It was only a decade later that Darwin finally encountered Captain David Porter's (1815) description of the dome-shaped and saddleback forms of tortoise and was able to insert this information into the second edition of his *Journal of Researches* (1845: 394).

The *Origin of Species* (1859) was never in any real danger, however, of being sacrificed for a bowl of tortoise soup. Darwin had noticed, while still in the Galápagos, that the mockingbirds differed by island; and he had taken care to separate these specimens from the four islands he had visited. Approximately eight months after leaving the Galápagos he returned to this problem in his "Ornithology" notes. There he compared this anomalous finding to that previously reported to him about the tortoises. Although he was still inclined to suspect that his mockingbirds were "only varieties" rather than true species, he nevertheless speculated that "If there is the

slightest foundation for these remarks the zoology of Archipelagoes — will be well worth examining; for such facts [would inserted] undermine the stability of Species" (1863 [1836]: 262). Darwin thus began, in a tentative but probing manner, the real process of "discovery" about the Galápagos — a process that lay not so much in his observations or collections during his brief visit, but rather in his various reconsiderations of this evidence after his departure.

Following his return to England in the autumn of 1836, Darwin had many opportunities to re-evaluate the Galápagos evidence as expert systematists began to work out his voyage collections and he prepared his *Journal of Researches* for publication. In early March of 1837, he met with the celebrated ornithologist John Gould to discuss the results of Gould's examination of his voyage birds. Gould had immediately appreciated the anomalous but closely related nature of Darwin's Galápagos finches, including the warbler finch, and had named 13 species in three subgenera. In addition, Gould had pronounced as distinct three of the four island forms of Darwin's Galápagos mockingbirds, thus confirming the suspicions Darwin had previously felt might "undermine the stability of Species." Perhaps just as importantly, Gould convinced Darwin of the highly endemic character of the Galápagos ornithology as a whole, something that Darwin, who had not had access to museum collections during the voyage, had not previously realized. These taxonomic opinions, together with a number of others relating to his collections from the South American continent, finally convinced Darwin that species were indeed mutable and sparked his decision to begin collecting facts that might bear on this question. He subsequently commented in this connection: "In July [1837] opened first notebook on 'Transmutation of Species' — Had been greatly struck from about Month of previous March on character of S. American fossils — and species on Galápagos Archipelago. These facts origin (especially latter) of all my views."

In the wake of his conversion to the theory of evolution, Darwin quickly realized his voyage oversight in failing to label his Galápagos specimens by island. He therefore set out to rectify this problem as best he could by asking other *Beagle* shipmates, including Captain Robert FitzRoy, to supply him with the missing evidence. Unfortunately, later curators at the British Museum failed to appreciate that Darwin's published locality designations in the *Zoology of the Voyage of H.M.S. Beagle* (1841) were not derived from his own collections; and where such information was missing from his own type specimens, they added it to some of the labels, creating a number of erroneous localities. Darwin, moreover, compounded the problem by guessing where eight of his own finch specimens had come from; and in several instances he clearly guessed incorrectly. These various confusions over the type specimen localities created a taxonomic nightmare for subsequent ornithologists, who naturally puzzled over the conflicting and aberrant locality

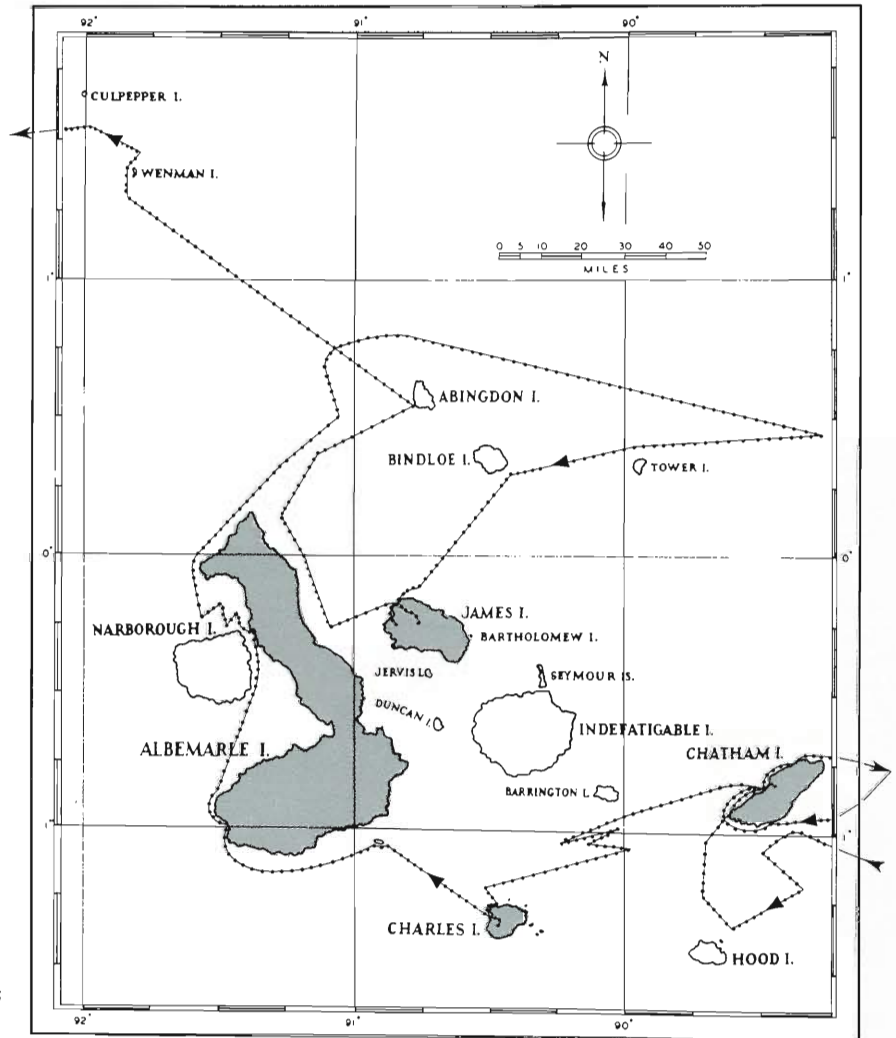


Figure 1: Darwin's route through the Galápagos in H.M.S. Beagle. He visited the four shaded islands and made several inland excursions, also indicated on the map. The occasionally zigzag nature of the Beagle's route reflects the vagaries of winds and currents in the age of sail.

designations on Darwin's specimens and found themselves hard pressed to reconcile this information with present-day distributions of Darwin's finches.

Fortunately, clarification of the retrospective and borrowed nature of the localities on many of Darwin's type specimens has now resolved most of these problems, including the status of several long-debated forms of Darwin's finches. In particular, *Geospiza magnirostris magnirostris*, an extinct form of the large-beaked ground finch, was collected by FitzRoy and others on Chatham and Charles islands, where David Steadman (1981, 1984) has recently found fossil evidence of this subspecies. Similarly, both Darwin and FitzRoy collected specimens of another extinct subspecies on Charles Island — a particularly large-billed form of the sharp-beaked ground finch ("*G. nebulosa*" Gould).

Although Darwin (1845: 395) later suggested, based on the joint *Beagle* collections, that the Galápagos finches might have different geographic

distributions, he was also aware that the case was a complex one and that his own data on the subject were meagre and probably suspect. Partly for this reason he did not mention his celebrated Galápagos finches in the *Origin of Species* (1859). It is only in this century, after the splendid ornithological studies of Harry Swarth (1931), David Lack (1945, 1947), and many other researchers, that these finches have become such a convincing paradigm of evolution in action. In keeping with the Darwin-Galápagos legend, however, much of this modern evidence is often erroneously attributed to Darwin. For example, he never saw all 13 species of Galápagos finches (Gould's 13 "species" encompassed only nine of the presently recognized forms), and he was also unaware that differences in the beaks were correlated with differences in diets.

Even after he had finally become an evolutionist in 1837, Darwin's understanding of the Galápagos Islands continued to undergo a slow evolution of its own. The mockingbirds and

tortoises had convinced him of the importance of geographic isolation in the evolution of new species; and in 1838, after reading Malthus's *Essay on the Principle of Population* (1798), he hit on the theory of natural selection. (Even this important insight, however, was not as sudden as Darwin later recalled.) For approximately a decade more he nevertheless failed to understand why evolution should promote widely divergent species on islands, like the Galápagos, that are seemingly identical in climate and general geographic character.

Darwin solved this vexing problem only in the mid-1840s after reading Joseph Hooker's reports on the flora of the Galápagos. Hooker had found that numerous representative species were indeed present on the separate islands, as Darwin had always suspected but had never been able to prove conclusively. In July of 1845, Darwin wrote to his friend: "I cannot tell you how delighted and astonished I am at the results of your examination; how wonderfully they support my assertion on the differences in the animals of the different islands, about which I have always been fearful."

Darwin was equally impressed with Hooker's (1847) discovery that the different islands possessed plants that were apparently random colonists, present only on one island. In the margin of his copy of Hooker's paper Darwin wrote: "so the flora of different isld[s] must be very different independently of representation." Darwin now began to appreciate that although the various

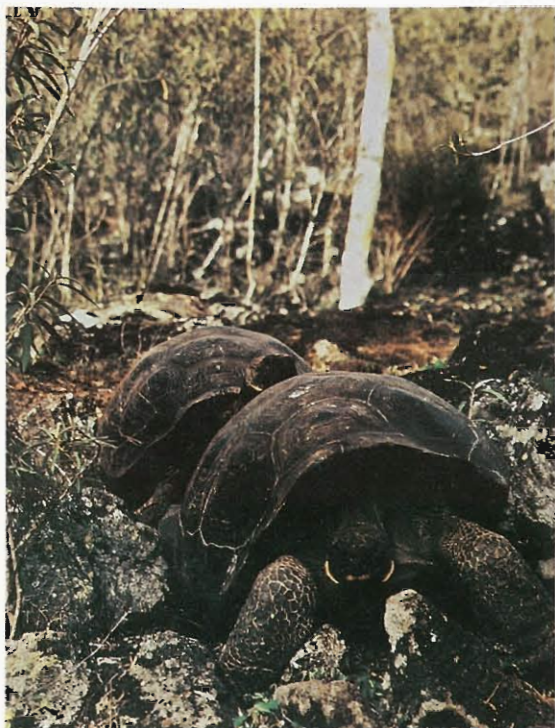
islands in the Galápagos might look superficially similar, they were biotically quite distinct. These biotic differences, moreover, must provide natural selection with a wide scope for expression, thus explaining how representative species had evolved so easily on each island. This basic idea, which Darwin developed in the 1850s into his principle of divergence, altered much of his general thinking about evolution and was given a prominent place in the *Origin of Species* (1859). Thus Darwin required almost two full decades to understand the biological significance of his Galápagos findings and to integrate them into his theory of evolution by natural selection.

The Darwin-Galápagos Legend

The publication of the *Origin of Species* not only revolutionized the biological sciences, but it also made Darwin into a celebrated intellectual hero—a man thoroughly worthy of scientific deification and hence destined to become the subject of legend. And because myths and legends, above all else, gravitate toward the problem of origins, Darwin's discoveries increasingly became enshrouded by the typical misconceptions of reconstructed "heroic" history. Accordingly, the true story of Darwin's conversion to the theory of evolution is a far cry from the Darwin-Galápagos legend that has arisen in the wake of Darwin's scientific triumph, and that adorns so many of the biology textbooks today. In fact, the legend, which is composed of three major component myths, tends to obscure precisely what



Darwin's Galápagos mockingbird specimens (British Museum of Natural History, Tring). From top to bottom (in the order that Darwin collected them): the Chatham Island mockingbird (*Nesomimus melanotis*), the Charles Island mockingbird (*N. trifasciatus*), and the Galápagos mockingbird (*N. parvulus*). Darwin collected two specimens of the latter, one on Albermarle and the other on James islands. The fact that Darwin procured only four specimens during his Galápagos visit—one from each island—shows that he was collecting within a creationist perspective. To an evolutionist there can be no single "type" specimen, since the variation within the species is an important part of its genetic nature and not simply a "deviation from the type." (All photographs are by the author)



Three subspecies of Galápagos tortoise. Left: a pair of Chatham Island tortoises (*Geochelone elephantopus chathamensis*), displaying relatively dome-shaped carapaces. Right: the Hood Island tortoise (*G. e. hoodensis*), an extreme saddleback form similar to the now-extinct Charles Island race (*G. e. galapagoensis*). Below: the James Island tortoise (*G. e. darwini*), a dome-shaped form. Darwin unfortunately saw only the two similar dome-shaped forms.



it pretends to explain, namely, the nature of scientific insight.

The first of these component myths is that of Darwin's "eureka-like" conversion during his brief visit to the Galápagos Islands. It may appeal to our romantic conception of scientific discovery to imagine the lone voyager suddenly throwing off the shackles of creationist thinking when finally confronted, in the Galápagos, with a microcosmic paradigm of evolution in action. But this myth, for all of its inherent allure, is both wrong and misleading. What this myth especially tends to obscure is the fascinating question 'Why Darwin?' That is to say, why was it that Darwin, and no one else, was converted by evidence that was widely known to many other contemporary naturalists—naturalists who, like Richard Owen and John Gould, were often far superior to Darwin in their experience and abilities as systematists? The answer to this question is closely associated with the real nature of Darwin's genius as a scientist. As the far-seeing amateur among specialists, Darwin exhibited his unique intellectual caliber in the pattern of

"gifted individualism" that manifested itself in the process of his conversion. While other naturalists stood by and calmly rationalized the Galápagos evidence in creationist terms, Darwin—virtually



The remarkable diversity in the forms of the Galápagos finches is shown here by three species that initially misled Darwin into thinking they were members of separate families or subfamilies: the large-beaked ground finch (*Geospiza magnirostris*), using its powerful jaws to crush a large seed; the cactus finch (*G. scandens*), feeding on the flowers of *Opuntia*; and the diminutive warbler finch (*Certhidea olivacea*) looking for insects in the highland *Scalesia* forests.

alone—took up the heterodox challenge offered by that evidence. Expressed another way, the Galápagos did not make Darwin; if anything, Darwin, through his superior abilities as a thinker and a theoretician, made the Galápagos; and, in doing so, he elevated these islands to the legendary status they have today.

The second of the three component myths associated with Darwin and the Galápagos is the myth that these islands provided him, at an early stage, with a basic paradigm for his theory of evolution by geographic isolation and natural selection. As I have shown in the case of Darwin's finches, nothing could be further from the truth; and the same conclusion applies to Darwin's Galápagos observations as a whole, which were only slowly incorporated into his final theory. Thus the *Origin of Species* was ultimately the product of 24 years of thinking and further research (1835–59), not the five weeks that Darwin spent in the Galápagos Islands or even the five years that he spent accompanying *H.M.S. Beagle* around the world. True, the Galápagos certainly provided Darwin with some crucial hints; but Darwin's full understanding of both evolution and the Galápagos

case required almost as long as it took him to publish the *Origin of Species*.

Moreover, much of Darwin's evolutionary argument, as finally presented in the *Origin*, had to be constructed from alternative sources, owing to Darwin's failure to appreciate, and to collect, the necessary Galápagos evidence in 1835. Other scientists have been collecting that "necessary" Galápagos evidence ever since, which leads me to the third of the three component myths encompassing the Darwin-Galápagos legend.

This third and last myth involves the notion that Darwin singlehandedly discovered almost everything there is to know about evolution in the Galápagos—or at least everything of *basic* importance—and hence that subsequent research in these islands has merely been a sort of mopping-up operation characteristic of "normal," postrevolutionary science. This myth, promulgated in the biology textbooks and especially in the popular literature about Darwin and the Galápagos, is largely a natural extension of the first two Darwin-Galápagos myths.

As a typical manifestation of this third myth, Darwin is frequently credited with insights about his famous Galápagos finches that were actually the product of extensive post-Darwinian ornithological research. For example, in spite of Darwin's own famous *Journal* (1845: 380) remark about one species of finch appearing to have been "modified for different ends," Darwin was by no means personally convinced that all 13 species of Galápagos finches (especially the warbler finch) were indeed derived from a single ancestor (see also Darwin, 1841: 105). Darwin's lingering doubts

about the finches' possible common ancestry apparently contributed to his decision, when writing the *Origin of Species*, to omit any specific reference to this now famous biological paradigm of "evolution in action." During the remainder of the 19th century, ornithologists generally believed Darwin's finches were descended from two or three different ancestors—a warbler, a ground finch, and a separate form that gave rise to the six species of *Camarhynchus*. This issue of ancestry was not resolved for more than half a century after the *Origin of Species* was published.

David Lack's classic book *Darwin's Finches* (1947) did much to perpetuate this third aspect of the legend, even though Lack himself personally knew better. Indeed, Lack, in reversing his original position on the possible adaptive significance of the beaks among the different species of Darwin's finches (1945, 1947), went through much the same experience of *ex post facto* 'discovery' that Darwin himself did. For it was only after leaving the Galápagos Islands that Lack reached his new theoretical position and then realized the need for the kind of follow-up studies of the finches' feeding behavior that various other ornithologists have subsequently carried out.

Similar "delayed discoveries" have undoubtedly characterized the work of numerous other Galápagos researchers. Unlike Darwin, however, they have often had the opportunity to return to the Galápagos Islands in order to collect crucial data, and to make observations, that previously seemed unimportant. Thus the history of research in the Galápagos Islands has been anything but the history of "mopping up" the scientific tidbits that Darwin left behind. Rather, it is only after repeated expeditions by six generations of post-Darwinian scientists that the Galápagos archipelago has yielded—with a seeming air of reluctance—many of its richest biological treasures to the world of science. And even today, after so much scientific progress, almost as many questions remain about evolution in the Galápagos as there are answers to the mysteries that Darwin and others have successfully resolved.

Of all the scientists who have made important discoveries in the Galápagos, only to realize later that they have merely scratched the scientific surface and thereby created the need for



Darwin in 1840, at age 31, five years after the Beagle voyage. (By George Richmond, courtesy of Downe House, Downe, England)

further research, Charles Darwin perhaps expressed it best. In 1846, shortly after Joseph Hooker had so delighted him with the results of his analysis of Darwin's Galápagos plants, Darwin declared to his friend: "The Galápagos seems a perennial source of new things." The Darwin-Galápagos legend notwithstanding, these famous islands will doubtless remain "a perennial source of new things" in science; and no one would be more disappointed than Darwin if this were not the case.

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