

Social and Ecological Interactions in the Galapagos Islands

Diego Quiroga
Ana Sevilla
Editors



Darwin, Darwinism and Conservation in the Galapagos Islands

The Legacy of Darwin and its
New Applications

 Springer

Social and Ecological Interactions in the Galapagos Islands

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Diego Quiroga · Ana Sevilla *Editors*

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The Legacy of Darwin and its New Applications

The book explores how Darwin's legendary and mythologized visit to the Galapagos affected the socioecosystems of the Islands, as well as the cultural and intellectual traditions of Ecuador and Latin America. It highlights in what way the connection between Darwin and the Galapagos has had real, enduring and paradoxical effects in the Archipelago. This Twenty Century construct of the Galapagos as the cradle of Darwin's theory and insights triggered not only the definition of the Galapagos as a living natural laboratory but also the production of a series of conservation practices and the reshaping of the Galapagos as a tourism destination with an increasingly important flow of tourists that potentially threaten its fragile ecosystems. The book argues that the idea of a Darwinian living laboratory has been limited by the success of the very same constructs that promote its conservation. It suggests critical interpretations of this paradox by questioning many of the dichotomies that have been created to understand nature and its conservation. We also explore some possible ways in which Darwin's ideas can be used to better understand the social and natural threats facing the Islands and to develop sustainable and successful management practices.

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Chapter 4

Darwinians, Anti-Darwinians, and the Galapagos (1835–1935)

Elisa Sevilla

Introduction: Galapagos as *Classic Ground* for Evolutionary Studies

Explorations of the Galapagos after the *Beagle's* voyage, and especially after the publication of *On the Origin of Species* in 1859, were made by scientists and collectors associated with natural history museums, universities, and private collectors like Baron Walter S. Rothschild. Also, several of the collections and observations were appointed to navy ship officers from Great Britain, Italy, France, Sweden, and the United States (Williams 1911: 291–292; Stewart 1911: 291–292) (see Table 4.1).

Galapagos became a “classic ground” for explorers and scientists interested in “investigating the complicated problems involved in the doctrine of the derivative origin of species” (Salvin 1875: 462). For Theodor Wolf, who visited the Galapagos twice during the 1870s, the Galapagos Islands were a privileged place for science. Mainly, he pointed out to “several circumstances that make them a very exceptional world, especially its isolation, its geological youth, besides the great amount of endemic species of plants and animals, limited to greatly reduced regions”. He concluded that there “is no other place on earth with a similar size, with a creation so particular and isolated, none in which geographical botany and zoology raise the same amount of interesting questions” (Wolf 1895: 248). Even the wife of the skeptic Louis Agassiz thought of the Galapagos as a great place to solve the puzzle of the origin of species: “The archipelago offers at present a fine opportunity for a naturalist, who desires to make a residence here for several years, and thoroughly explore their structure and their productions, to throw a strong light upon the great modern question of the origin of species and the doctrines of evolution” (Agassiz 1871–1872).

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Table 4.1 Chronology of expeditions to the Galapagos

Year of visit	Vessel name	Lead explorer	Institution
1838	La Vénus	Vice Admiral Abel Aubert Du Petit Thouars	French Navy
1852	Eugenie	Kinberg Andersson	Swedish Navy
1868–1869	Mr. Rubira's orchilla fleet	Simeon Habel	Independent
1871	Hassler	Louis Agassiz	Harvard Comparative Zoology Museum, National Survey
1875 and 1878	Local vessels	Theodor Wolf	Independent and as Ecuador's state geologist
1875	Peterel Challenger	Commander Cookson	British Navy
1884		Lieutenants Chierca and Marcacci	Italy
1888	Albatross	Lee Tanner	United States Fish Commission
1891	Albatross	Agassiz, Alexander	United States Fish Commission
1891	Local vessels	George Baur C. F. Adams	Independent
1897	Lila and Mattie	C. M. Harris, Rollo Beck F. P. Drowne G. D. Hull	Walter Rothschild, Frank B. Webster
1898–1899	Julia E. Whalen	Snodgrass, Heller	Hopkins-Stanford Expedition
1905–1906	Academy	Rollo H. Beck, Alban Stewart, W. H. Oschner, E. W. Gifford, J. S. Hunter, J. R. Slevin	California Academy of Science
1906–1907	Local vessels	Nicolás Martínez	Private with support of M. Cobos
1923	Noma	William Beebe W. Morton Williams	New York Zoological Society, Harrison Williams
1924	Monsunen	Wollebæk	Norwegian Zoological Expedition
1924	St. George	J. Hornell	British Navy
1925	Arcturus	W. Beebe	New York Zoological Society
1927	Oaxaca	G. Allan Hancock Joseph Slevin	California Academy of Science
1929	Mary Pinchot	Pilsbry, Fisher, and Wetmore	Gifford Pinchot
1929	Illyria	Schmidt	Chicago Field Museum of Natural History

(continued)

Table 4.1 (continued)

Year of visit	Vessel name	Lead explorer	Institution
1930	Nourmahal	Several scientists	Vincent Astor
1932–1934	Velero III	G. Allan Hancock	San Diego Zoo, California Academy of Sciences Steinhart Aquarium
1932	Zaca	Templeton Crocker, Harry S. Swarth, J. T. Howell	California Academy of Science
1936	Chiva	Ripley	Philadelphia Academy of Natural Sciences— Dennison Crockett
1937	Cressida	Vanderbilt, Gray, Smith	Philadelphia Academy of Natural Sciences—George Vanderbilt
1937	Cotopaxi	Acosta Solís and others from the Universidad Central del Ecuador	Universidad Central del Ecuador, Ecuadorian government

Sources: Oxford and Watkins (2009), Larson (2001), Donohue (2011), Acosta (1937), Martínez (1934)

After the 1932 Templeton Crocker expedition, Howell stated, “It would appear that there are few places in the world where [evolutionary] problems can be studied under such favorable and unusual conditions—a fact which has led me to call the archipelago Evolution’s workshop and showcase” (quoted in Larson 2001: 166). This idea has lingered in the motivations of scientists interested in the Galapagos. The prominent Ecuadorian botanist Misael Acosta Solís argued in the late 1970s that Galapagos is “the most important national park in the World” because of its contribution to the study of the evolution of Earth’s crust and life (Acosta Solís 1979: 51).

Galapagos was central to discussions about the theory of evolution mainly because of two reasons. First, its geology hinted that it was a new world, and thus, there was a question of the origin of its plants and animals. Second, most of these inhabitants were only found in the Galapagos but were similar to the ones in Central and South America. Darwin (1859), Hooker (1851), and Wallace (1892) all agreed that these creatures descended from American ancestors that had been accidentally carried into the archipelago through wind, currents, and birds. The question of how these variants came about was an unresolved topic until David Lack’s work on what he called “Darwin’s finches” (Lack 1947).

Despite this common interest in studying the Galapagos as an “evolutionary workshop” (Howell cited in Larson 2001), these islands were seen, appreciated, and understood in an array of circumstances and under a great deal of theories and paradigms, many times contradicting each other (Larson 2001). This tendency manifests itself greatly between Darwinians and non-Darwinians, both groups using the archipelago as a source of invaluable data to confirm their theories. The case of the debates

between the Swiss naturalist in Harvard, Louis Agassiz, and Charles Darwin is a clear example of this tendency (Lurie 1959, 1960; Winsor 1991; Mayr 1959; Morris 1997).

This leads us to the question raised by Ronald L. Numbers (1998: 27): “what did it mean to be a Darwinist, or, for that matter, an anti-Darwinist? ([...] these are not easy questions to answer, in part because of the complex and changing views of Charles Darwin himself.” The two main goals of Darwin’s theory were to demonstrate transmutation and to explain it mainly through natural selection, even though he pointed out to other mechanisms of change. This is one of the reasons why scientists that adhered to the idea of transmutation of species sometimes called themselves Darwinists even if they did not agree with the concept of natural selection. As Bowler (1988: 6) has pointed out, the term Darwinism has been extensively used as a synonym of evolutionism, producing confusion for those who study the history of these ideas.

Ruiz and Ayala (1999) identified the same problem. They describe the “hard core” of Darwinism to differentiate what should be studied as Darwinism and what should be called something else. Esparza (2014) has recently put forward the concept of “evolutionary thinking” to enclose all variants of theories that try to explain the diversity of life as related to the idea of change. Esparza and Bowler have shown how the variation of interpretations of biological diversity and change cannot be readily dismissed, as Ruiz and Ayala do, because it tells the story about the debates, paradigms, and different positions held by a large segment of the scientific community at the time (Esparza 2014; Bowler 1983, 1988).

At the end of the nineteenth century, there was a vast scientific field of research and theories inspired by non-Darwinian evolution, especially theories marked by the ideal of progress like orthogenesis (progressive evolutionism) or saltationism (Bowler 2005). Bowler’s arguments challenge the view of former historians of Darwinism that saw continuity between Charles Darwin and the Darwinian synthesis. His main argument is that the idea of progress and several theological elements remained in many evolutionary thinkers of the turn of the twentieth century (Bowler 1983, 1988). Bowler proposes several positions among scientists working at the end of the fourteenth century, spanning from biblical theological creationists to true natural selection Darwinians. In the middle, there is an array of positions, like naturalists that agreed with the transmutation of species, but were more Lamarckian in their explanations of change, or those who believed in an inner progressive force of evolution.

In this chapter, we will discuss the arguments of the different scientists that dealt with Galapagos geology and life within the evolutionary framework. What debates motivated the many explorations of the Galapagos archipelago up to 1935, and what arguments flourished from these new visits to the islands? First of all, we will explore the different views regarding the geological origin of the islands. This will lead us to the question of how the Galapagos were perceived as remnants of old lands or as new volcanic islands. Then, we will compare the diversity of explanations of the ways in which evolution took place in the Galapagos. Finally, we will discuss the political motivations regarding the exploration of the Galapagos.

Debates Around the Geological Origin of the Galapagos

The geology and life of the Galapagos struck its visitors as primitive, as remnants of another time. Several scientists and explorers saw the islands as an ancient place frozen in time or as geologically new and thus an example of how a new world developed. Some of these views fueled theories of the geological origin of the islands and related it to its biological colonization.

Most explorers who visited the Galapagos describe them as relatively new volcanic islands (Darwin 1839; Du Petit Thouars 1859; Wolf 1892). Those who supported Darwin's ideas followed this explanation (Wallace 1892). For some scientists that did not see the islands, and to Georges Baur, the only theory that could accommodate such primitive-looking life was a sinking of a continental land, isolating ancient animals and plants. We will first focus on how the islands were described as primitive, and later we will tackle the problem of their geological origin.

Wolf said that the marine iguana was so interesting, because it's "like the last of those gigantic saurians that in our world's primitive times played such an important role" (Wolf 1892: 487). This idea of a new and thus primitive world—in the evolutionary and progress paradigm—is described in Wolf's general description of the islands:

Some places are seeded with the later [secondary craters] like the skin of someone who had smallpox, and give the most singular and grotesque picture that fantasy can imagine: hundreds of cyclopean forges built from enormous pieces of the roughest and blackest lava; between the burnt rocks some corpulent trunk of a cereus or prickly pear cactus; over here a galapago monster, that moves its deformed limbs with an admirable phlegm, over there a group of ugly and strange marine iguanas that are sunbathing. All this nature is extravagant and strange, but the organic and inorganic parts of the picture are in perfect harmony between them, and sometimes remind vividly the antediluvian landscapes that the geologist tend to paint in their fossil descriptions. (Wolf 1892: 472)

Theodor Wolf and Charles Darwin had both an interest in geology and saw the Galapagos archipelago geologically and biologically similar to the times of the dinosaurs. Darwin (1839: 456), when telling about his first encounter with Galapagos tortoises among black lava and large cacti, wrote that they "appeared to my fancy like some antediluvian animals." Later, he stated that the sea iguanas are the only "existing" saurian to be "a maritime animal" and concluded, "If, however, we refer to epochs long past, we shall find such habits common to several gigantic animals of the Saurian race" (Darwin 1839: 472).

Also, Darwin pointed out to the predominance of reptiles and the absence of mammals in the islands, since, like no other place on Earth, "this order replaces the herbivorous mammalia in so extraordinary manner," and the geologist would "probably refer back in his mind to the secondary periods, when the Saurian were developed with dimensions" (Darwin 1839: 473).

When Darwin and Wolf recalled the secondary periods when describing the Galapagos, they both were thinking of the youth of the islands. The French vice admiral Du Petit Thouars (1859: 144) also saw the Galapagos as new volcanic lands and was puzzled by how plants and animals colonized these islands.

However, others saw these prehistoric-looking animals and landscape as remnants of other times. The taxonomist from the British Museum Albert Günther (1875) studied the specimens of giant tortoises brought from the Galapagos to the museum and through comparative anatomy concluded that they were taxonomically closer to extinct species collected in the Mauritius, than to the extant Aldabra tortoise. Even nowadays, it is remarkable to note that, during the Pleistocene, giant tortoises existed in every continent except Australia and Antarctica; however, in modern times, these types of tortoises only exist in oceanic islands in the tropics (Caccone et al. 1999). These facts had led several men of science to the subsidence theory that will be discussed later.

Wallace, who was a promoter of the idea that the Galapagos are new volcanic islands, had a problem with the Galapagos tortoise and had to explain it as a remnant of prehistoric species that once were widespread around the globe:

(...) the antiquity of the genus *Testudo*, which dates back to at least the Eocene formation (in North America) with very little change of form. These sluggish reptiles, so long-lived and so tenacious of life, may have remained unchanged, while every higher animal type around he has become extinct and been replaced by very different forms; as is the case of the living *Emys tectum*,¹ which is the sole survivor of the strange Siwalik fauna of the Miocene epoch. (Wallace 1876: 289)

In his first edition of *Island Life*, Wallace (1880: 268) cited Günther's comparative work of the Mascarene and Galapagos tortoises as an argument of the migration of these reptiles from the American continent (Günther 1877). However, Günther argued that there was no comparative zoology proof of "direct genetic relationship" between continental and island tortoises. Albert Günther did find reasonable a subsidence theory of the Mascarene and Galapagos Islands and of a former land connection between Africa and America. Only the tortoises that were separated from the continents survived the advent of man and carnivorous mammals. Actually, Albert Günther (1895 cited in Baur 1897) later supported the subsidence theory of Baur and agreed that this event occurred in the Miocene period. Larson (2001: 105) argues that this herpetologist was indifferent toward Darwinism, especially to avoid any confrontation with the head of the British Museum, the anti-Darwinian Osborn. However, I have found that he did deal with the question of the origin of species both in his 1871 and 1877 papers. When comparing distant lungfish and tortoises with paleontological related species, he was concerned with forming evolutionary series, even if he was skeptical about a clear line from simple to complex forms (Günther 1871: 560). Especially in his 1877 treaty on giant tortoises, Günther seems to be against Darwinism and more inclined toward an idea of extinction of some species, but not finding evidence for transmutation, that is, species developing from other species.

Those who studied the tortoises usually saw them as remnant of antique species and thus thought of the Galapagos as remnants of old lands. These reptiles were thought to be related to paleontological giant tortoises that were once widespread around the globe² (Baur 1891b; Wallace 1876; Günther 1877 and 1895 cited in Baur 1897).

¹"Indian roofed turtle," today classified as *Pangshura tecta* according to Gray, 1831.

²Recently, it has been shown through genetic analysis that the closest relative to the Galapagos tortoise are the much smaller species of *Geochelone chilensis*, or Chaco tortoise from Paraguay,

Subsidence Versus Volcanic Origin

Georges Baur was one of those naturalists that focused on the Galapagos tortoise to explain the archipelago's particular life-forms. He was interested in explaining the same phenomena observed by Darwin: each island has a slightly different variety or species from the same animals and plants, and the majority of living beings are related to American types. He stated that oceanic islands should have inharmonic flora and fauna, while harmonic³ flora and fauna characterize continental islands.

Baur acknowledged that the vast majority of scientists who studied the Galapagos saw the islands as of new volcanic origin, including Darwin, Hooker, Salvin, Grisebach, Engler, Moritz Wagner, Wallace, and Peschel. The only previous opinion of a continental origin, according to Baur (1891b: 307), came from the French naturalist Henri Milne-Edwards who coedited the second edition of Lamarck's work and who later timidly supported Darwin in the difficult French natural history scientific community (Stebbins 1988: 133–134). In his *Remarques sur la faune des îles Galapagos* (1859), Milne-Edwards commented on the issue raised by the account of the exploration of the islands by the vice admiral Abel Aubert Du Petit Thouars during his voyage around the globe in 1838. The French vice admiral raised the question about the origin of the fauna and flora of the Galapagos and of the coral islands in the Pacific, since he observed almost no similarity between the life-forms found there and those from the coast of South American and other Pacific islands like Hawaii, Marquesas, and Sandwich Islands. Even though Du Petit Thouars (1859: 144) described the volcanic and recent origin of the archipelago, Milne-Edwards had to resort to the subsidence of an ancient continent where vestiges of prehistoric life remained to account for the endemic plants and animals of the Galapagos. He argued that the same geological theory could explain the unique flora and fauna of New Zealand and the eastern islands of Madagascar (Milne-Edwards 1859: 148). The concern of Du Petit Thouars echoed those of other travelers to the islands, if these islands were new volcanic lands, and little by little, water eroded its tops to create lime soil, where did the first seeds come from? He ventured to say that marine birds and winds could carry them from the American continent, since the winds blow westward, but he could not explain the differences from the continental species. Milne-Edwards did not take into consideration this hypothesis from his source.

Bolivia, and Argentina, one of the largest in South America (Caccone et al. 1999, 2002). The hypothesis is that both *Geochelone* species derived from a giant South American ancestor now extinct (Parent et al. 2008).

³What did harmonic mean for Baur? He did not give a definition, but we can interpret that he was talking about the harmony between the animals, the plants, and the natural conditions. For Baur, following Darwin, it takes time for species to accommodate to new natural conditions; this means that the species that came later to the archipelago would still be in a process of "plastic" adaptation. Wolf also mentioned that the "the very scarce and singular vegetation of the islands, with which the no less singular animals are in harmony" (Wolf 1879: 49).

Coming back to Baur's theory, when he examined the common hypothesis that all living organisms came to Galapagos through the currents, he makes the same objection that some transformists made to the idea of successive creations: "To explain this we would have to invoke a thousand accidents" (Baur 1891b: 308). Since this repetition of accidents is improbable, according to Baur, the only explanation for the harmonic life on the Galapagos is that the islands originated from a subsidence of a continent that was attached to the American continent, and then, by isolation, the different species diverged from island to island. Baur used Theodor Wolf's observations to support his theory. He cited Wolf's appreciation that "the flora of the Galapagos at elevations of about 900 ft is typically that of the Andes at an elevation of 9000 ft. How could this alpine flora be explained by the theory of elevation; what is the reason that plants characteristic of an elevation 9000 ft are found at an elevation of 900 ft?" (Baur 1891b: 309). The former Jesuit Theodor Wolf, geologist and geographer, but also interested in Darwinism (Cuvé et al. 2014), lived and explored Ecuadorian highlands and coastal area, first as professor of the state-promoted and Jesuit-run *Escuela Politécnica* and then as state geologist until 1892 when he returned to Germany. When visiting the Galapagos in 1875 and 1878, he commented, "Anyone who is acquainted with the Ecuadorian flora, will notice the analogy that this vegetation presents with the forests in the moors (páramos)" (Wolf 1879: 55).

However, Wolf explained this fact by the cool climate produced by the effect on these isolated oceanic islands of the cold Antarctic Humboldt Current that sweeps across the Pacific coast of South America, from Chile to Cabo Pasado, near Guayaquil, and then redirects itself to the Galapagos (Wolf 1879: 51). Nonetheless, he left the matter open when he stated, "This particularity (the absence of beautiful 'tropical' flowering species) are not sufficiently explained by the climate alone, especially, if we take into consideration, that the majority of phanerogam plants are endemic." Wolf came to the conclusion that "These are the whims of nature, or, better still, the mysteries of creation!" (Wolf 1879: 56).

To prove the plausibility of his subsidence theory, Baur took into consideration the measurements made by the "Albatross" on his first trip to Galapagos and concluded that "We need only an elevation of about 10,000 ft to connect the Galapagos with America. This would give the highest mountain on the Galapagos an elevation of 14,700 ft. This height is reached by many mountains and very often surpassed" (Baur 1891b: 309).

Another argument for Baur's theory is that the Galapagos tortoise is related to the Miocene fossils. He stated that during the Eocene and even later, the Galapagos archipelago must have been connected to the American continent. He compared languages to species to explain the conservation of antique types by an isolation factor alone: "I believe, therefore, that the peculiar genera we find today on the Galapagos have not originated there, but have been preserved in their old condition" (Baur 1891b: 309).

Theodor Wolf's analysis of the geology of the Galapagos was absolutely contrary to that of Baur, since he concluded, "we face one of the best examples of a [geological] formation exclusively volcanic of the islands by accumulation of eruptive materials."

He pointed out the difference in geological composition of the Galapagos Islands made mainly on basalt rocks versus the Andes composed of andesite and trachyte rocks. To be clear on his position about the subsidence theory, he stated that “These islands haven’t formed from detachment of the South American Continent (like some have dreamt), nor by uplifting of the ocean floor, but simply by successive accumulation of eruptive material, i.e., by volcanic eruptions that at the beginning they took place underwater, and later, over the level of the sea. Nowhere are there any vestiges of uplifted land, nor arguments for subsidence or uprisings” (Wolf 1887: 22).

Elizabeth Agassiz, wife of Louis Agassiz, saw the Galapagos as very new volcanic land. She stated that “Narborough and Albemarle have so fresh a look that you could easily believe that there had been extensive eruptions there within the present century” (Agassiz 1871–1872). Louis Agassiz (1872) stated in a letter to Peirce after his visit to the Galapagos that they are “of MOST RECENT ORIGIN, inhabited by creatures so different from any known in other parts of the world.”

Hartert and Rothschild evaluated Baur’s theory and argued that it has no scientific ground since there is no geological evidence (the geology of the Galapagos differs from that of the American continent) and the soundings made by the Albatross in 1891 showed that the ocean is deeper closer to the American coast. Although they were cautious in their conclusions, in their argumentation they favored Darwin and Wallace’s theory of a recent volcanic origin and colonization of the islands from the American continent (Rothschild and Hartert 1899: 137–140).

Even though many scientists like Theodor Wolf, Alexander Agassiz, Rothschild, and Hartret gave sound geological arguments against Baur’s theory, the debate continued into the twentieth century. Among the scientists of the vast collecting expedition sent in 1905 by the California Academy of Sciences, there were diverse views regarding the origin of the islands and its life. Williams (1911: 290), for example, began his article on butterflies and hawk moths stating that there is an open debate regarding the origin of the Galapagos:

I have considered the Galapagos as oceanic in regards to their natural history; whether they issued in the first place from the bed of the ocean, or whether they were once completely submerged, or all living organisms thereon otherwise totally destroyed simultaneously by volcanic activity, as the flora and fauna would still be oceanic in character, i.e., transported across water to the islands, a condition that the writer believes has happened.

Williams believed that there was good evidence to show that the Galapagos archipelago was once one large island, which, by subsidence, had formed the many smaller islands. This theory, close to Baur’s, helped him explain the existence on all or most of the islands of closely allied species or varieties.

On the other hand, John Van Denburgh (1912a: 331), curator of the department of herpetology, was also ambiguous to the relationship between the snakes and the origin of the archipelago:

(...) the snakes of these localities must have had a common origin. Either the West Indian and Galapagos snakes have been derived from South America, or else all must be descendants of species which, in a former geological period, occupied a great central land-mass which has sunk below the level of the sea, leaving mere remnants in Central America, northern South America, the Antilles, and the Galapagos.

Van Denburgh considered that much could be said in favor of these theories and that the data were not yet at hand for making a decision between them. Nevertheless, either view, according to the herpetologist of the California Academy of Sciences, implied a former land connection and a continental origin of the Galapagos ophiidian fauna. As Baur decades before, Van Denburgh explicitly disagreed with the opinion that the fauna of the Galapagos had reached these islands by the "more or less accidental agency of the winds and ocean currents" (Van Denburgh 1912a: 334). He considered that the various species must have spread slowly over some "continental mass with which the Galapagos were connected or of which they formed a part." Furthermore, Van Denburgh claimed that when the Galapagos finally "became separated from the rest of the world, it is probable that most or all of the present islands remained for a time united" (Van Denburgh 1912a: 334).

Van Denburgh developed his argument even further on another paper addressing the geckos of the Galapagos Islands (Van Denburgh 1912b). As with the snakes, the herpetologist sought to trace the history of these islands from the evidence afforded by a specific group of inhabitants. Van Denburgh's opinion on the origin of the Galapagos Islands discarded two hypotheses. In fact, when he found the same species of geckos (*Phyllodactylus bauri*) inhabiting both Charles and Hood islands, he discarded the possibility of this species having independently evolved in two separate islands. He also abandoned the hypotheses of these inhabitants being carried across the water from one island to the next. This line of argumentation forced him to conclude that Charles and Hood islands were connected "and formed parts of a single large southern island" (Van Denburgh 1912b: 408).

Stewart, the botanist in the expedition, insisted on the improbability of such a connection put forward by Baur in 1891. According to him, the great difference between the floras of Cocos and the Galapagos strongly opposed Baur's view. In fact, Stewart claimed that if there "has ever been a land-mass connecting the Galapagos Islands with the mainland of North America, it must evidently have included Cocos Island region" and this connection between the two groups of islands "should have left a much larger number of species common to the two than is actually found" (Stewart 1912a: 382-383). Stewart finally concluded that the flora of Cocos, like that of the Galapagos Islands, "is distinctly that of an oceanic island." Many facts lent support to this view. Stewart mentioned the relatively large number of ferns, the much smaller number of species in the remaining families, and the total number of species found on the islands.

In 1937, Misael Acosta Solís visited the archipelago with the Ecuadorian National Scientific Commission to celebrate Darwin's centenary in the Galapagos. He published a study of the islands centered in its vegetation and economical importance (Acosta Solís 1937). When describing the theory of subsidence put forward by Baur, he recognized that "this hypothesis has had many followers (...), the author was also an adept before knowing the Archipelago; but since then I know and have studied better, more carefully, I cannot be with (the position) of G. Baur, and in this matter I am now with Wolf" (Acosta Solís 1937: 437). On the other hand, another visitor to the Galapagos to celebrate the 100 years of Darwin's landing in the archipelago, Victor Von Hagen, wrote that Baur's land bridge theory was attractive, but

that the geological and oceanographic evidence of Darwin, Wolf, and Agassiz pointed out to a recent volcanic origin (Von Hagen 1936: 589).

Although all geological descriptions and studies of the Galapagos concluded that they emerged from underwater volcanoes and that they were new land masses, some skeptics of accidental migrations avoided all the evidence of this new volcanic origin and had to resort to a theory of a continental connection and submergence of a bigger land mass, leaving the mountaintops as islands. Darwinism was difficult to grasp, especially the idea of accidental migrations and random variation.

Biodistribution, “Harmony,” and Evolution

Between the publication of the *Journal*’s first edition in 1839 and its second edition in 1845, Darwin pressed for results from the analysis of his botanical collections. Unlike the birds he collected, he had labeled his plants according to their respective islands, and he wanted to know about the patterns of distribution of these specimens and whether or not they reflected similarity to American plants. In his field book, he recorded: “I certainly recognize S America in Ornithology, would a botanist?” (Darwin 1835: 30). Of the plant specimens collected during the *Beagle* voyage, 211 stem from the Galapagos Islands (Porter 1980). Darwin’s collection covered about 24% of the flora of the archipelago known today, and it became the basis for the later description of the vegetation of the Galapagos (Stöcklin 2009). On his return to England, Darwin gave the collection to John Henslow (1796–1861), hoping that he would examine them, but he did not fulfill the task. Darwin transferred the specimens to the more approachable Joseph Hooker in 1843.

Darwin’s letter of reaction to Hooker’s results written in 1845 is a wonderful gateway both to Darwin’s intellectual and emotional moments: a baby is born; “may he turn out a naturalist.” Instead of blessing the baby, his father’s wish is that he may turn out a naturalist (Darwin 1845).

Wallace’s synthesis on the relationship between biogeography and evolution appeared in his *Geographical Distribution of Animals* (1876) and more specifically concerning the Galapagos, in his *Island Life* (1892). In his second edition, Wallace concluded that

all these phenomena are strictly consistent with the theory of the peopling of the islands by accidental migrations, if we only allow them to have existed for a sufficiently long period; and the fact that volcanic action has ceased on many of the islands, as well as their great extent, would certainly indicate a considerable antiquity. (Wallace 1892: 283–284)

As well as Darwin, Wolf observed island-specific speciation but continued to be ambivalent about its origin when regarding plants but less so when talking about the land birds:

The non-endemic plants have evidently immigrated from the continent, since they can also be found in the coasts of Colombia and Ecuador, from Panama to Guayaquil. The endemic plants have their origin in the islands themselves, be it that they were especially created for

them, be it that they were born from a slow and successive transformation from species and genera immigrated in time immemorial from the continent. (Wolf 1887: 14)

They [the land birds] cannot hide their analogy with those from the coasts of the continent, from which they probably derive through a successive transformation and accommodation. (Wolf 1887: 17 and Wolf 1892: 484–485)

Baur tackled the question on the origin of the different variations in the organic forms on the different islands. As well as for Wolf, the characters of the fauna and flora of the Galapagos were due to the differences in physical conditions of the islands. Variation aroused due to the pressure made by these changing conditions. Baur's hypothesis was that the archipelago was once a big island that subsided and was divided into different islands. He imagined a moist island, with a single species of each genus. Then, gradually the species found themselves in drier country, which "affected the flora and fauna; and the flora again the fauna" (Baur 1891b: 312). When trying to understand what Baur meant by harmony and disharmony, it seems that he saw evolution as a processes that was not continuous but instead there were periods when animals and plants were imperfectly adapted to their environment and that is when Baur would see disharmony. After adaptation took place, the species would become harmonious. In Baur's arguments, you cannot find a single example of a true oceanic island with inharmonious life. Instead, many oceanic islands, like Revillagigedos and even Sandwich, seem to be wrongly categorized by Wallace, according to Baur (1891b: 310).

The Galapagos finches were one of the puzzles that attracted much attention from scientists and explorers. The collections made by Habel in 1868 were studied by Salvin and Slater and compared with the specimens from Darwin's collection. In 1863, Salvin wanted to travel to Galapagos with encouragement from Joseph Dalton Hooker and Charles Darwin; however, he never got there (Grant and Estes 2009: 241–242). His work *On the Avifauna of the Galapagos Archipelago* was published in 1875 and endorsed the Darwinian transmutation theory, even though, as Larson (2001) points out, he could not explain how the Galapagos birds were modified from the continental immigrant ancestors "by different circumstances with which they became surrounded" (Salvin 1875: 509). He did, however, point to several interesting issues: first, the species of land birds were not island specific, but several species could coexist in the same island, although it seemed to him from Dr. Habel's collection that some species prevail in every island. Second, he tried to resolve the problem that certain species were difficult to separate. He said that the beak size seemed to be the only aspect that was less gradual, compared to coloring, general size, and locality. He mentioned, in particular, the relationship between the black plumage of male *Geospiza* and sexual selection. Salvin noted that, to establish clearer species boundaries, it would be very helpful to study the birds' behavior in field observations to see if there is sexual selection regarding the black plumage of the cock birds. Salvin thought that the plumage had no important role in selection because only a few individuals showed this color, since it takes 3 years to develop. Although Dr. Habel described the food inside each specimen, Salvin did not take this data into consideration. His conclusion was that "the members of this genus present a field where natural selection has acted with far less rigidity than is usually observable" (Salvin 1875: 470).

Darwin read Salvin's work and was surprised and interested in the fact that "the birds from the different islands prove so similar." He insisted that the study and comparison of the habits, nests, and eggs of the commonest species of each island would throw a "flood of light" on variation (Darwin 1875 published in Donahue 2011: 55).

On the other hand, Salvin and Darwin were both interested on how species migrated to oceanic islands. On 1868, Salvin communicated to Darwin that he saw a bivalve freshwater shell clasped into the foot of a sandpiper that he collected in Norway (Salvin 1868).

Different Proposed Mechanisms of Evolution

Louis Agassiz (1807–1873) belonged to the generation of naturalists who followed the steps of Cuvier. Following French empiricists, he was weary of both speculative philosophy (including *Naturphilosophie*) and religious dogma (Winsor 1979; Numbers 1998).

For Agassiz, real science was based on the accumulation of facts. This is mainly the reason why the Swiss naturalist dismissed Darwinism as "an ingenious but fanciful theory" (Agassiz in Numbers 1998: 31). Agassiz' (1857) own theory was elaborated and published in 1857. He saw in nature a correspondence between living beings and environment as harmonious and as evidence of a Creator who planned nature. He also argued that there was no evidence in contemporary nature or in the paleontological record of gradual change. His main arguments used the example of some advanced animals, like the shark, that had remained unchanged through very long periods of time (Numbers 1998).

In 1871, Louis Agassiz sailed on the vessel of the US Coast Survey fleet, *Hassler*; its itinerary included a visit to the Galapagos. Agassiz did not sail to the Pacific just to test evolution in abstract terms; his initial plan was to do deep-sea dredging of the ocean floor in search for fossils that will confirm his creationist assumptions. He, in fact, chose a specific route that would challenge Darwin in a direct way. However, as Gould (1983) has shown, Louis Agassiz didn't write anything to contribute to his debate against Darwinism. His wife's account of one of his lectures on the trip between Galapagos and Panama shows that what worried Agassiz the most is "[Darwin's] present influence on science very pernicious as favoring the habit of 'filling up the wide gaps of knowledge by inaccurate and superficial hypotheses'" (Agassiz 1871–1872). The conclusion made by his wife Elizabeth C. Agassiz (1871–1872) shows that they are skeptic of evolution although they share the same facts as Darwin, that is, that "the Galapagos have a fauna and a flora decidedly of an American type, yet decidedly peculiar to themselves," and that "the islands are to my eye much more recent in their formation than Juan Fernandez." She thought that the Galapagos was the perfect place for recovering data to solve the origin's question since she saw them as puzzles themselves: "younger than Juan Fernandez, purely volcanic, bringing no seeds from the bottom of the sea, not having had time to alter and amend species introduced from the mainland." His husband was more closed to the transformation hypothesis since in his letter to Peirce, the extreme

youth of the islands didn't give enough time for a transformation from continental species into the endemic Galapagos ones (Agassiz 1872). With the particular case of the Galapagos, according to the Agassiz, "the mystery of change (...) is only increased, and brought to a level with that of creation" (Agassiz 1872). For Louis Agassiz, science needed more facts, more knowledge for a "fair discussion of the origin of organized beings" (Agassiz 1872).

Another interesting case is that of the former Jesuit naturalist Theodor Wolf, who came to Ecuador as a university professor and later became state geologist. In Theodor Wolf's works, there is ambivalence in his opinion about the origin and evolution of the Galapagos life. At the same time that he employed the term "creation" to refer to living organisms, he stated that introduced species are "perfectly adapted" or that the small vegetative organs in the plants are explained by its "provident accommodation to arid climate" (Wolf 1892: 487, 388 and 480). Does he adhere to the idea of several creations or to the transmutation of species? Another observation about adaptation made by Theodor Wolf regarded the tameness of the land animals in contrast to the sea animals, especially birds. He said that in the islands more visited by man, Floreana and Chatham (San Cristóbal), birds were surlier than those from the least visited, like Albemarle (Isabela). He concluded that "it seems that birds get used with difficulty and very slowly to fear and flee man by instinct; but once this instinct is acquired, it stays hereditary and they keep it for many generations" (Wolf 1892: 485). The other way round, he observed that the aquatic birds, which to him emigrated from the continent many generations ago, are still cautious toward man. Does this mean that Wolf saw land animals as originated in the islands and aquatic animals as immigrants from the continent?

Baur not only theorized about the geological origin of the Galapagos but also ventured in a theory of variation. His view is fundamentally neo-Lamarckian. He started by stressing that the environment can modify biological organisms. Actually, he closed the first part of the article on the subject of the origin of the Galapagos with a quote from Darwin in a letter to Wagner⁴: "In my opinion, the greatest error which I have committed has been not allowing sufficient weight to the direct action of the environment, i.e., food, climate, etc., independently of natural selection" (Baur 1891a: 319).

Baur had a clear neo-Lamarckian explanation of variation, stating that different environmental conditions produced changes in the most "plastic" younger individuals of the population. Gradually, the older nonplastic individuals died, and the transformed ones took over. His concern with harmony appeared again in this explanation of transmutation since he considered this process to occur until "harmony is reached

⁴This letter is not yet identified in the Darwin Correspondence Project. Moritz Wagner (1813–1887) was a German explorer and naturalist, professor at Munich University, who developed the migration theory of fauna and flora in 1868 with great weight given to geographical isolation in speciation. Darwin corresponded with Wagner and in the 5th edition of the *Origin*, he cited Wagner's article stressing that although geographical isolation was important for preventing crosses between new varieties, it was not necessary for the formation of new species (Darwin Correspondence Project, Baur cited Wagner, Moritz. *Die Entstehung der Artendurch Frdumliche Son-derung*. Basel, 1889).

again between the individuals and the conditions” (Baur 1891b: 313). This process was exacerbated by the effect of isolation, concluded Baur, taking into consideration the work of Vladimir Schmankewitsch on *Artemia salina* and *A. A. mnuhza-uisenii*. This neo-Lamarckian mechanism is divided into two processes, first “a new species on the same spot through the change of conditions; in the second a portion of the individuals becoming isolated from the original stock develop into a new form” (Baur 1891b: 314). Baur (1891b: 315) baptized his theory “the process of harmonic growth, founded on the plasticity of the younger individuals.”

Darwin and Galapagos: Beyond Scientific Debates

In this section, we will discuss how the image of Darwin and Galapagos science were used in Ecuadorian politics and policy at the end of the nineteenth century and around the centennial of Darwin’s voyage.

Ecuador took possession of the Galapagos two years before Darwin’s visit through the efforts of Villamil. During the nineteenth century, there were poor attempts of colonization from Ecuador and rumors of selling or alienation of the archipelago from countries like Peru, France, and the United States. This was due to the belief that there was guano in the islands at first and then as a strategic and coal deposit in the Pacific, especially in anticipation to the opening of the Panama Canal (Larrea 1960; Latorre 1999; Luna Tobar 1997).

In both these strategies, scientists played an important role. I will focus on how the Ecuadorian state used science to take and show possession of the islands.

As Ana Sevilla has described in Chapter 3 of this volume, Theodor Wolf made two trips to the Galapagos from Guayaquil, the latter commanded by the government of Ecuador as state geologist. Wolf worked the geology and climate of the islands and also the economic possibilities of colonization and its natural resources. He was personally inspired by Darwin’s work and had planned to explore the Galapagos years before, while being a professor for the Jesuit-run, state-owned polytechnic school. He finally made the trip on his own for the first time in 1875 and then was sponsored by the government’s interest in surveying natural resources and making a map and geological description of the Republic, including the Galapagos. This work aimed at the final product, the *Geography and Geology of Ecuador* and its accompanying map, both published in 1892. These different interests, both scientific and practical, can be seen in the articles published by Wolf in Ecuador concerning the Galapagos. The same can be said of Misael Acosta Solís, who visited the islands with a National Scientific Commission sponsored by the Ecuadorian government and university in 1937. In his article, Acosta Solís (1937) also mixed scientific observation with practical recommendations regarding tourism, fishing resources, and agricultural potential of the islands.

In 1936, the Ecuadorian government declared the Galapagos a natural reserve. Before this, in 1934, a decree was issued protecting the fauna of the islands. Acosta Solís (1979: 52) argued that this regulation came from “hints from a group of professors of the Universidad Central del Ecuador, Nature lovers, especially Professor

Jonás Guerrero, my Sciences teacher.” However, Barrow (2009) and Hennessy (2015) argue that the draft came from the American naturalists Moore and Coolidge who collaborated with V. M. Egas, former Ecuadorian consul in Los Angeles, to propose a draft of legislation to protect the fauna of the Galapagos; Acosta Solís said that the decree project was written by Professor Guerrero and that it was type-written by himself (1979: 29). Acosta Solís might be confusing the 1934 decree with the one of 1936, since he recalls giving the decree proposal to President Federico Páez, who was in office from the September 26, 1935, to October 22, 1937 (Acosta Solís 1979: 52).

Misael Acosta Solís recalled that ever since getting to know the “magnificent explanation of the origin of the species and its adaptations to the local environment, from the great naturalist Charles Darwin” in 1933, he was interested in protecting the Galapagos (1979: 59). In 1936, he prepared a paper on Darwinism that was published in the *Anales de la Universidad Central* (Acosta Solís 1936). In 1937, he was part of a National Scientific Commission for Galapagos prepared by the university and supported by the Ecuadorian government. The Commission visited the islands during 18 days only and came back and prepared an exposition and a report for the government urging for the conservation and scientific exploration of the islands. Acosta Solís published in the local press and in an academic article that appeared in the *Anales*, where he insisted on the necessity of protecting the islands and creating a scientific research station (Acosta Solís 1937). In the 100-year celebration of the visit of Darwin to the Galapagos, there were three parties involved: (1) Von Hagen and the Darwin celebration expedition that promoted local support through meetings with influential people, the promotion of a “Corporación Científica Nacional para el Estudio y Protección de las Riquezas Naturales del Archipiélago de Colón” (Scientific Corporation for the Study and Protection of the Natural Riches of the Colon Archipelago), with academic members from Quito and Guayaquil universities (among them Dr. Teodoro Maldonado Carbo, eminent surgeon and Dean of the Universidad de Guayaquil) (Von Hagen 1935 and Baquerizo Maldonado 2011), (2) Misael Acosta Solís and other professors from the Universidad Central del Ecuador from the Corporación Científica Nacional, and (3) Ecuadorian consul Egas together with the American scientists Moore and Coolidge (Corley Smith 1990: 6).

Von Hagen sought local support by giving medals with the portrait of Darwin to government dignitaries and two busts of the British naturalist to the universities in Quito and Guayaquil to be unveiled on September 17, 1935, besides the one erected in San Cristóbal (Chatham) on the place where Darwin first set foot on the archipelago (Von Hagen 1935, 1940, 1978) (see Fig. 4.1). These busts were cast in Quito by the sculptor and Director of the Escuela de Bellas Artes, Luis Mideros, from a plaster cast made from a Darwin sculpture at the American Museum of Natural History. The inscription on the monument was written by Major Leonard Darwin, the last surviving son of the great naturalist (Von Hagen 1940). Today, the bust of the Universidad Central del Ecuador in Quito is displayed in the Historical Area of the new Library (see Fig. 4.2), and in the Universidad de Guayaquil, it stands next to the Casona Universitaria; it had been “restored” by Alfredo Palacio (Guerrero 2013). The text of the accompanying plate is in English in Guayaquil and in San

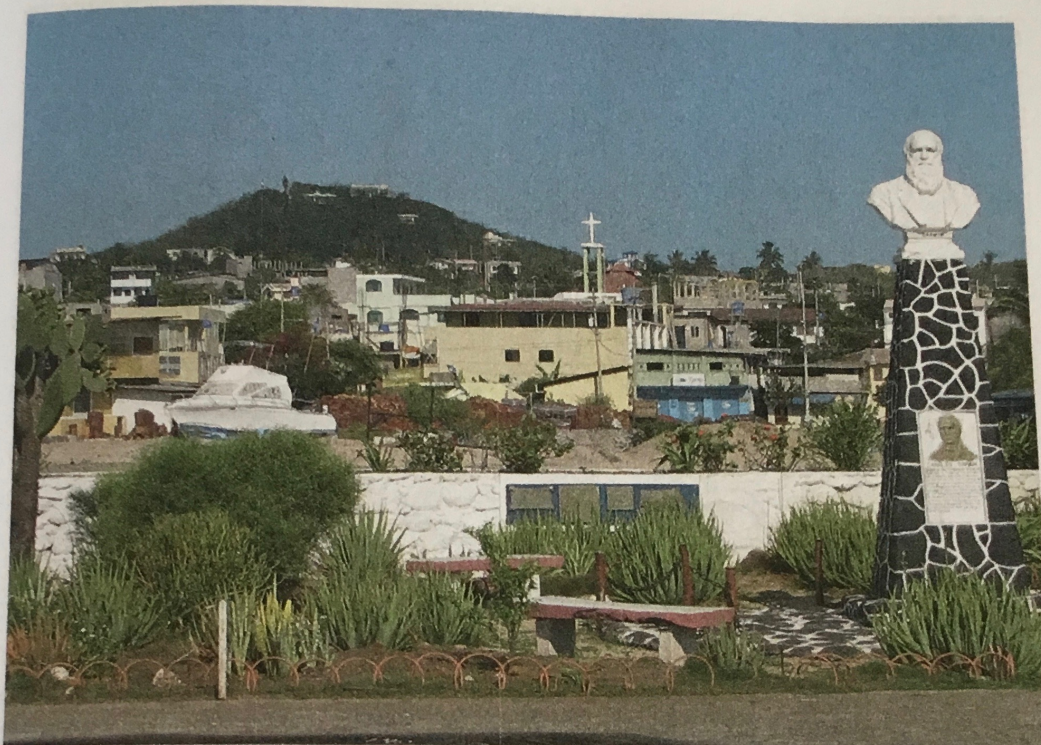


Fig. 4.1 Bust of Charles Darwin erected by Von Hagen in San Cristóbal (Chatham). The monument has been moved to the Naval Station. Source: (Guerrero 2013)

Cristóbal, but it was translated into Spanish in the one displayed in Quito. We do not know who was in charge of the translation, which includes a change of meaning because, in the original plates from Guayaquil and San Cristóbal, it says:

Charles Darwin landed on the Galapagos Islands in 1835 and his studies of the distribution of animals and plants thereon led him for the first time to consider the problem of organic evolution. Thus was started the revolution in thought on this subject which has since taken place.

And in the Quito Spanish version, the idea of “studies of the distribution of animals and plants” is replaced by “his studies on the classification of animals and plants.”

It is important to note that this bust with its inscription, both in English and in Spanish, sets Darwin’s landing in the Galapagos as the first step toward the “Darwinian revolution,” collaborating in the construction of the Darwin-Galapagos legend studied by Sulloway (1984).

Another difference is that the ones in Guayaquil and San Cristóbal are mounted outside, on top of a stone pyramidal base, and the inscription is accompanied by a high relief sculpture of young Darwin’s bust, also by Luis Mideros, while the bust in Quito is set inside the university’s library, on a wooden base, and the inscription does not have the sculpture of young Darwin (see Fig. 4.1 and Fig. 4.2).



Fig. 4.2 Bust of Charles Darwin donated by Von Hagen to the Universidad Central del Ecuador, Quito. Source: Elisa Sevilla

The celebrations in the Universidad Central del Ecuador included a conference by Dr. Jorge Andrade Marín (1936) where he described evolution and concluded that it should be taught in schools and universities to transit into the “why” questions of biology instead of staying in the “what” questions of descriptive and classificatory biology. The Ministry of Education published the chapter of the *Journal of Researches* concerning the visit to the Galapagos in commemoration of Darwin’s exploration of the islands 100 years before. However, the document doesn’t go into Darwin’s theory of transmutation by natural selection (Torres 1935).

The celebrations were also present in Guayaquil. The Colegio Nacional Rocafuerte of Guayaquil donated a plate commemorating the centennial of Darwin’s visit to the Galapagos that today is displayed in the naval base at Chatham next to Von Hagen’s Darwin bust (Guerrero 2013) (see Fig. 4.1).

Nicolás Cuví (2005) rescues the figure of Acosta Solís as an active and early promoter of the protection of the archipelago from a conservation and scientific point of view. He was the only Ecuadorian scientist in the Charles Darwin Research Station inaugural cruise and symposium held in the *Golden Bear* vessel. He promoted the cause inside and outside Ecuador. In those early years of his career, he promoted nature conservation with the goal of economic and rational use of the resources (Cuví 2005).



Fig. 4.3 Ecuadorian stamps in commemoration of the visit to the Galapagos by Charles Darwin. Source: http://www.paleophilatelie.eu/images/sets/ecuador_1936_darwin.jpg

It is interesting to note that conservation efforts go hand in hand with an interest in commemorating Darwin. In 1936, a set of stamps were issued from the Ecuadorian government to commemorate the centennial of Darwin in Galapagos. These stamps represented Columbus (after whom the archipelago was renamed in 1892), a map of the islands with its Ecuadorian names remembering Columbus' "discovery" of America, a landscape with palm trees that do not correspond to the typical image of the Galapagos reminding us of the introduction of species to the islands, the characteristic reptiles (land iguana and Galapagos tortoise), and the picture of old Darwin and the *Beagle*. These stamps were meant to finance the Galapagos Research Station in the scheme conceived by Von Hagen. However, as he recalled in a letter to G. T. Corley Smith in 1978, this plan did not turn out because the Ecuadorian "President was deposed" (Von Hagen 1978). President Velasco Ibarra was turned over by a military coup on the August 21, 1935. The stamps were finally printed the next year, in 1936 (see Fig. 4.3).

Hennessy (2014) argues that Von Hagen did not succeed in his commemoration plan because he was not recognized as a member of the scientific community; instead, he was seen as a promoter. It is interesting to note that Acosta Solís (1979) does not mention Von Hagen's efforts to promote the conservation and establishment of a research station in the Galapagos. It seems that the Ecuadorian conservationist did not approve of his personality or methods either.

The results around the centennial of Darwin's visit summed up to the Executive Decree 607 issued in 1934 for protecting key species, regulating scientific

collections, and controlling visiting yachts and the Supreme Decree 31 of 1936, declaring the Galapagos Islands as a national reserve and establishing a National Scientific Commission to propose strategies for the conservation of the archipelago (Oxford and Watkins 2009).

Conclusions: Galapagos, a Place of Dispute

In this chapter, we have seen how the Galapagos peculiar geology and life have been explained by a diversity of theories. To some like Darwin and Wolf, the primitive volcanic appearance of the islands pointed out to a new world where species of animals and plants had to be recent and derived from ancestors from the American continent. To others, this seemed like science fiction, too many accidents, and thus, many saw the prehistoric landscape and inhabitants of the Galapagos to be remnants of life from another era that survived without the depredation of carnivorous animals, especially man. These theories usually came from those scientists studying reptiles, in particular, giant tortoises. Those who focused on birds were less inclined to resort to the subsidence theory. Another conclusion is that there is a very tight relationship between geological explanations and the theories about biodistribution concerning the Galapagos.

The proposed mechanisms of transmutation were also varied. Some followed Darwin and Wallace's idea of natural selection, while others talked more of plasticity of the young; somewhat like Lamarck. And there were those to whom the Galapagos prehistoric-looking saurians were proof that species didn't vary over time.

Finally, Darwin was not only an inspiration for further scientific explorations of the Galapagos. Some international scientists and the Ecuadorian government and universities were also involved in exploring the islands in commemoration of the centennial of Darwin's visit to the Galapagos.

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