

## CHAPTER 8

# Darwin's Finches

A quarter of a century before Darwin published *The Origin of Species*, he was formulating his ideas about living things as a naturalist aboard the British survey ship *H.M.S. Beagle*. The *Beagle* left England in 1831 on a five-year voyage to chart the waters of South America, and in 1835 it visited the Galapagos Islands in the Pacific, about six hundred miles off the west coast of Ecuador.

While the *Beagle* was in the Galapagos, Darwin collected specimens of the local wildlife, including some finches. Thirteen species of finches are scattered among the two dozen or so volcanic islands. (A fourteenth species lives on Cocos Island, almost four hundred miles northeast of the Galapagos.) The finches differ mainly in the size and shape of their beaks, and it is thought that they descended from birds that arrived from the mainland in the distant past.

In Darwin's theory, a single species diverges into several varieties, then into several different species, through the action of natural selection. Since the beaks of the Galapagos finches are adapted to the different foods they eat, it seems reasonable to suppose that the various species are a result of natural selection. In fact, they seem like such a good example of Darwinian evolution

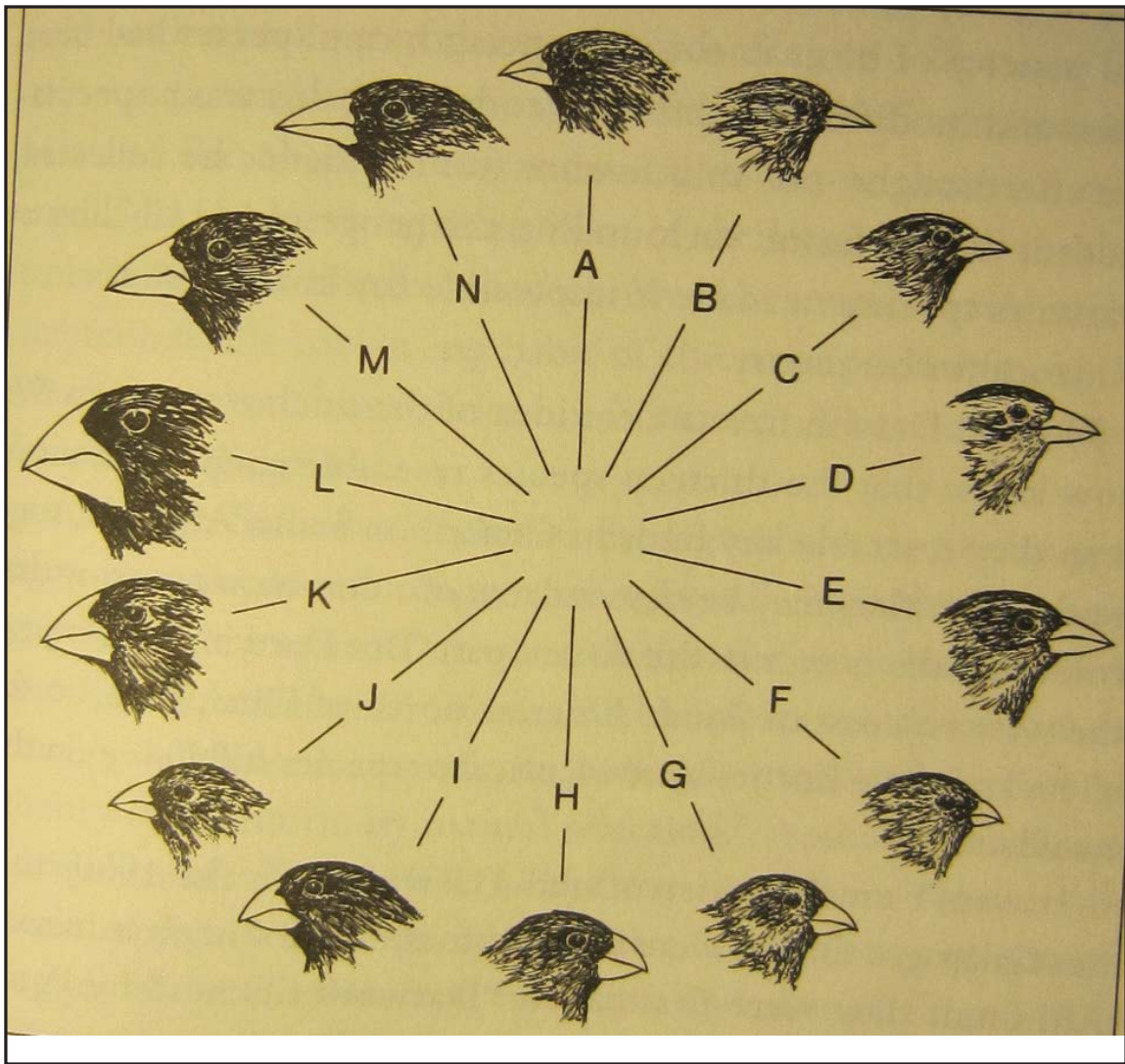
that they are now known as «Darwin's finches.» (Figure 8-1) Many biology textbooks explain that the Galapagos finches were instrumental in helping Darwin to formulate his theory of evolution, and that field observations in the 1970s provided evidence for the theory by showing how natural selection affects the birds' beaks.

Yet the Galapagos finches had almost nothing to do with the formulation of Darwin's theory. They are not discussed in his diary of the *Beagle* voyage except for one passing reference, and they are never mentioned in *The Origin of Species*. The natural selection observed in the 1970s reversed direction in the following years, so there was no net evolutionary change. And several finch species may now be merging through hybridization—the opposite of what one would expect from the branching-tree pattern of Darwinian evolution.

### *The legend of Darwin's finches*

While Darwin was in the Galapagos Islands, he collected nine of the thirteen species that now bear his name, but he identified only six of them as finches. Except in two cases, he failed to observe any differences in their diets, and even in those cases he failed to correlate diet with beak shape. In fact, Darwin was so unimpressed by the finches that he made no effort while in the Galapagos to separate them by island. Only after the *Beagle* returned to England did ornithologist John Gould begin to sort out their geographical relationships, and much of the information Darwin provided turned out to be wrong. Eight of the fifteen localities he recorded are in serious doubt, and most had to be reconstructed from the more carefully labeled collections of his shipmates.

Thus, according to historian of science Frank Sulloway, Darwin «possessed only a limited and largely erroneous conception of both the feeding habits and the geographical distribution of these birds.» And as for the claim that the Galapagos finches impressed Darwin as evidence of evolution, Sulloway wrote, «nothing could be further from the truth.»



**FIGURE 8-1 Darwin's finches**

The fourteen species of Darwin's finches. All live on the Galapagos Islands except (B), the Cocos Island finch. The medium ground finch (K) is the species that has been most intensively studied. Note the differences in their beaks.

In fact, Darwin did not become an evolutionist until many months after his return to England. Only years later did he look back at the finches and reinterpret them in the light of his new theory. In 1845 he wrote in the second edition of his *Journal of Researches*: «The most curious fact is the perfect gradation in the size of the beaks of the different species of [finches]. Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends.» But this was a speculative afterthought, not an inference from evidence he collected. Indeed, the confusion surrounding the geographical labeling of Darwin's specimens made it impossible for him to use them as evidence for his theory.

Nor did Darwin have a clear idea of the finches' ancestry. We now know that the thirteen species resemble each other more than they resemble any birds in Central or South America, suggesting that they may be descendants of a common ancestor that colonized the islands in the distant past. But Darwin did not visit the western coast of South America north of Lima, Peru, so for all he knew the finches were identical to species still living on the mainland.

It wasn't until the rise of neo-Darwinism in the 1930s that the Galapagos finches were elevated to their current prominence. Although they were first called «Darwin's finches» by Percy Lowe in 1936, it was ornithologist David Lack who popularized the name a decade later. Lack's 1947 book, *Darwin's Finches* summarized the evidence correlating variations in finch beaks with different food sources, and argued that the beaks were adaptations caused by natural selection. In other words, it was Lack more than Darwin who imputed evolutionary significance

to the Galapagos finches. Ironically, it was also Lack who did more than anyone else to popularize the myth that the finches had been instrumental in shaping Darwin's thinking.

### *Darwin's finches as an icon of evolution*

When Lack elevated the Galapagos finches to iconic status, Darwin's meager contribution to our knowledge of them grew with each re-telling of the story. According to Sulloway, «Darwin was increasingly given credit after 1947 for finches he never saw and for observations and insights about them he never made.» In the most extreme form of the legend, Darwin is said to have «collected species and observed behavioral traits, such as the remarkable tool-using habit of the woodpecker finch, that were not even known in his lifetime.» Thus iconography becomes hagiography.

Although Sulloway exploded the legend almost twenty years ago, many modern biology textbooks still claim that the Galapagos finches inspired Darwin with the idea of evolution. Gould and Keeton's *Biological Science* (1996) informs students that the finches «played a major role in leading Darwin to formulate his theory of evolution by natural selection.» According to Raven and Johnson's *Biology* (1999), «the correspondence between the beaks of the 13 finch species and their food source immediately suggested to Darwin that evolution had shaped them.» And George Johnson's *Biology: Visualizing Life* (1998) maintains that «Darwin attributed the differences in bill size and feeding habits among these finches to evolution that occurred after their ancestor migrated to the Galapagos Islands.» Johnson's textbook even tells students to «imagine themselves in Darwin's place» and «write journal pages that Darwin could have written.»

Yet as far as Charles Darwin's contribution is concerned, the «Darwin» in Darwin's finches is largely mythical. It wasn't until almost a century after Darwin that they assumed their present status as icons of evolution. Of course, if they really were good evidence for Darwin's theory, they might deserve their iconic status anyway.

### *Evidence for evolution?*

If Darwin's theory is correct, then the ancestral finches that colonized the Galapagos in the distant past presumably scattered to the various islands, where they were exposed to different environmental conditions. Birds on different islands probably encountered differences in food supply, leading to natural selection on their eating apparatus—their beaks. Theoretically, this process could have led over time to the beak differences that now characterize thirteen separate species.

This is a plausible scenario, but the evidence that Lack cited for it was indirect. Differences in finch beaks are correlated with different food sources, and the birds are scattered among the various islands (though it is not the case that each island has its own species). The pattern seems to fit Darwin's theory, yet the case would be much stronger if there were some direct evidence for the process.

One sort of direct evidence could be genetic. But apart from knowing that finch beaks are highly heritable—that the beak of finch is very likely to resemble the beaks of its biological parents—we know nothing about the genetics of finch beaks. Chromosome studies show no differences among the Galapagos finches and the DNA studies that have been used to construct molecular phylogenies relied on genes unrelated to beak shape.

Another sort of direct evidence would be observations of natural selection in the wild. This evidence has been supplied by the husband-and-wife team of Peter and Rosemary Grant, who went to the Galapagos in the 1970s to observe evolution in action.

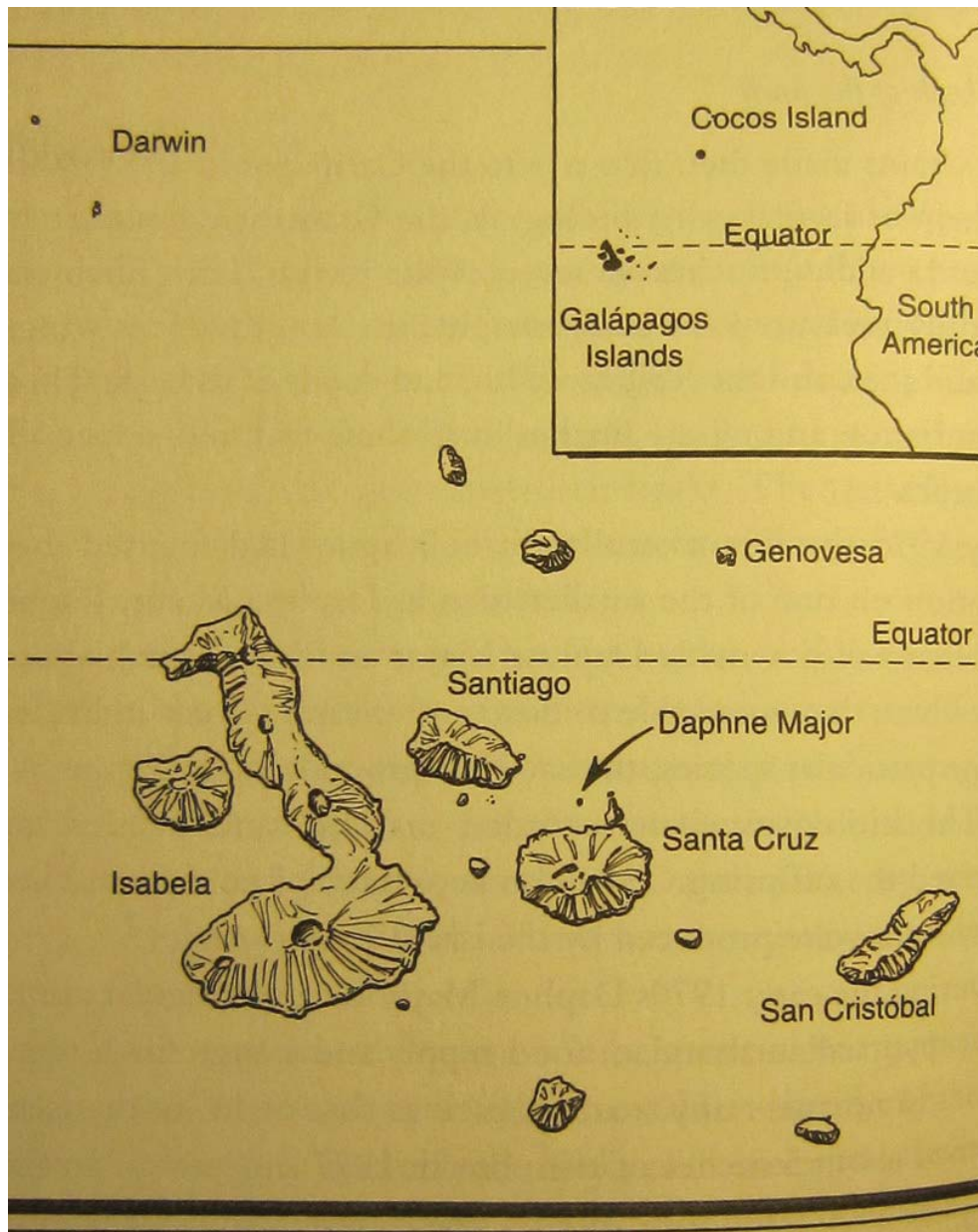
### *The beak of the finch*

The Grants made their first trip to the Galapagos in 1973. With the help of several other biologists, the Grants set about catching and banding finches on seven of the islands. Each finch was carefully measured for body weight, the lengths of its wings, legs and toes, and the length, width, and depth of its beak. There was variation among the finches in all these features—especially the beaks.

By 1975 the Grants and their colleagues had focused their attention on one of the smaller islands, Daphne Major. (Figure 8-2) Its small size made Daphne Major an ideal natural laboratory where they were able to band and measure every individual in one particular species, the medium ground finch. (Figure 8-1, K) The biologists even recorded matings, and banded and observed the offspring. They also kept track of rainfall, and how many seeds were produced by the island's plant species.

During the early 1970s Daphne Major received regular rainfall that supported an abundant food supply and a large finch population. In normal rainy seasons, such as that of 1976, the island received about 5 inches of rain; but in 1977 only about an inch fell. The 1977 drought caused a severe reduction in the availability of seeds, and the island's population of medium ground finches declined to about 15 percent of its former size. The Grants and their colleagues observed that survivors of the

drought tended to have slightly larger bodies and slightly larger beaks. They also noted that the supply of small seeds was drastically reduced that year. They concluded that natural selection had strongly favored those birds capable of cracking the tough, large seeds that remained.



**FIGURE 8-2 The Galapagos Islands.**

The Grants' pioneering work on finch beaks took place mostly on Daphne Major, a tiny island just north of Santa Cruz.

As a result of the drought, the average beak depth of medium ground finches increased about 5 percent. (Beak depth is the distance between the top and bottom of the beak at its base.) This amounted to a difference of about half a millimeter—the thickness of a human thumbnail. This may not seem like much, but for the finches on Daphne Major in 1977 it meant the difference between life and death.

It was also a dramatic example of natural selection in the wild. The story of the Grants' research was recounted in Jonathan Weiner's 1994 book, *The Beak of the Finch*, which called the observed change in beak depth «the best and most detailed demonstration to date of the power of Darwin's process.» Because of this, according to Weiner, the beak of the finch is «an icon of evolution.»

The Grants and their colleagues realized at the time that natural selection might oscillate between dry and wet years, making beaks larger one year and smaller the next. But if beak depth were to continue increasing, then something very interesting might happen. The various species of Darwin's finches are distinguished mainly by differences in their beaks. The Grants reasoned that if natural selection can produce changes in beaks, perhaps it could also explain the origin of species among Darwin's finches.

In *Scientific American* in 1991, Peter Grant explained how this could happen, at least in theory. Calling the increase in beak depth during severe drought a «selection event,» Grant estimated the number of such events required to transform the medium ground finch into another species: «The number is surprisingly small: about 20 selection events would have sufficed. If droughts occur once a decade, on average, repeated directional selection at this rate with no selection in between droughts would transform one species into another within 200

years. Even if the estimate is off by a factor of 10, the 2,000 years required for speciation is still very little time in relation to the hundreds of thousands of years the finches have been in the archipelago.»

Grant's extrapolation depends, of course, on the assumption that increases in beak size are cumulative from one drought to the next. But the Grants and their colleagues knew that this is not the case.

### *When the rains returned*

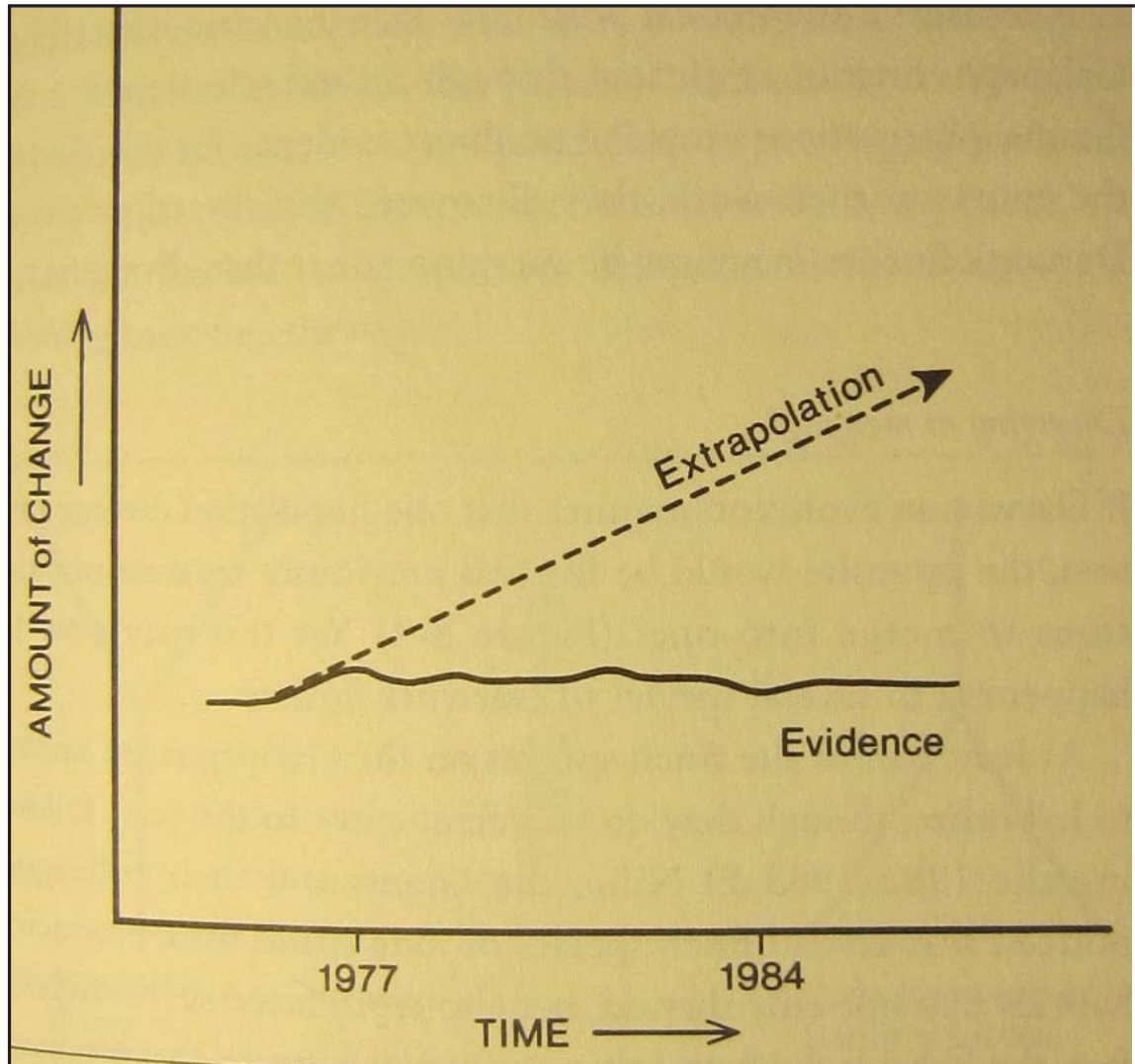
People who live on the west coast of North or South America know that every few years they can expect an El Nino—a disturbance in winter weather patterns caused by unusually warm air over the Pacific Ocean. In the winter of 1982-1983, an El Nino brought heavy rains to the Galapagos Islands—over ten times more than normal, and fifty times more than fell during the drought. Plant life exploded, and so did the finch population.

After the 1982-1983 El Nino, with food once again plentiful, the average beak size in medium ground finches returned to its previous value. In 1987 Peter Grant and his graduate student, Lisle Gibbs, reported in *Nature* that they had observed «a reversal in the direction of selection» due to the change in climate. «Large adult size is favoured when food is scarce,» they wrote, «because the supply of small and soft seeds is depleted first, and only those birds with large bills can crack open the remaining large and hard seeds. In contrast, small adult size is favoured in years following very wet conditions, possibly because the food supply is dominated by small soft seeds.»

So the evolutionary change that the Grants and their colleagues had observed during the drought of 1977 was reversed by

the heavy rains of 1983. «Selection had flipped,» wrote Weiner. «The birds took a giant step backward, after their giant step forward.» As Peter Grant wrote in 1991, «the population, subjected to natural selection, is oscillating back and forth» with every shift in climate.

By itself, however, oscillating selection cannot produce any net change in Darwin's finches, no matter how long it continues.



**FIGURE 8-3 A comparison of straight-line versus cyclical change.**

The straight line represents the extrapolation that predicts the origin of a new species of finch in two hundred years. The wavy line represents the cyclical changes so far observed.

(Figure 8-3) Some sort of long-term trend would have to be superimposed on the back-and-forth oscillations to produce long-term change, and that is not what the Grants and their colleagues witnessed. Indeed, it would probably take much longer than a decade or two to measure it, even if it were present. Of course, the climate of the Galapagos might change in the future and alter the pattern. But both of these—an unseen trend and future change—are speculations.

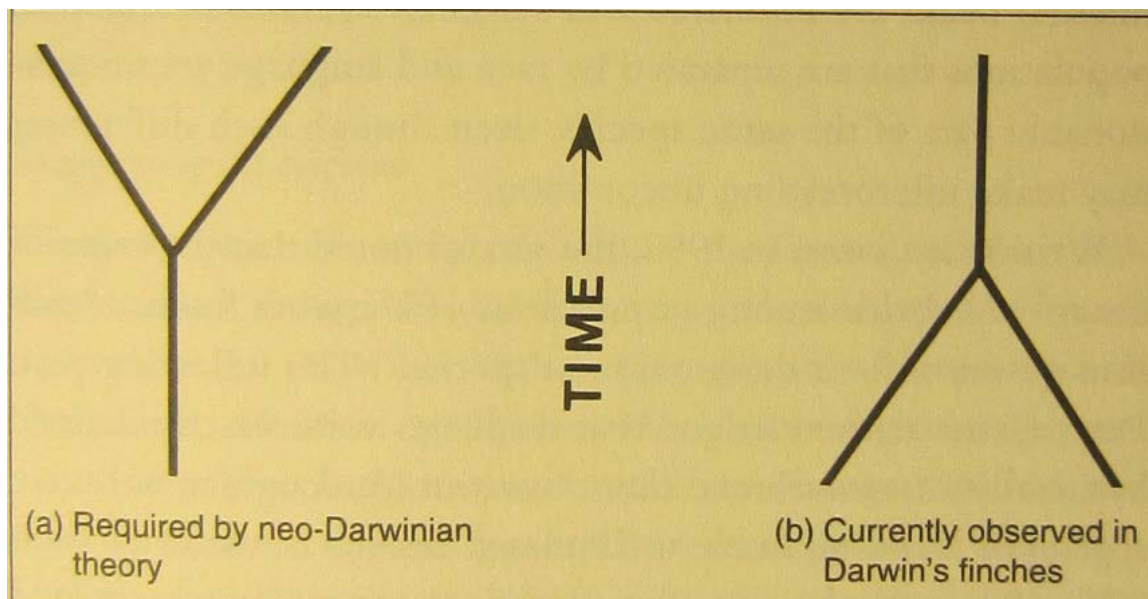
It remains a theoretical possibility that the various species of Galapagos finches originated through natural selection. But the Grants' observations provided no direct evidence for this. And in the course of their work, they discovered that several species of Darwin's finches may now be merging rather than diverging.

### *Diverging or merging?*

If Darwinian evolution requires that one population diverge into two, the opposite would be for two previously separate populations to merge into one. (Figure 8-4) Yet this may now be happening to several species of Darwin's finches.

At least half of the finch species on the Galapagos are known to hybridize, though they do so infrequently. In the years following the 1982-1983 El Niño, the Grants and their colleagues noticed that several finch species on one island were producing hybrids that not only thrived, but also reproduced successfully. In fact, the hybrids did better than the parental species that produced them. The Grants noted that this process, if unchecked, «should lead to fusion of the species into one population.» This would not happen overnight: Extrapolating from the observed frequency of hybridization, the Grants estimated that it would take one hundred to two hundred years for these species to merge completely.

So if we extrapolate from processes observed in the present, we obtain two contradictory predictions: unchecked selection for larger beaks could produce speciation in two hundred to two thousand years, while unchecked hybridization could produce the opposite of speciation in one hundred to two hundred years. Clearly, the tendency to diverge is more than offset by the tendency to merge. Of course, the fluctuating climate of the Galapagos means that neither process is likely to continue indefinitely, and the Grants concluded that «over the long term there should be a selection-hybridization balance.» According to Weiner it seems that a «vast, invisible pendulum [is] swinging back and forth in Darwin's islands, an oscillation with two phases,» in which the finches «are perpetually being forced slightly apart and drifting back together again.»



**FIGURE 8-4 Diverging vs. merging.**

(a) The splitting of one species into two, as required for Darwinian evolution, (b) The merging of two species together due to hybridization, currently being observed in several species of Darwin's finches.

So Darwin's finches may not be merging or diverging, but oscillating back and forth. Their success at hybridizing, however, raises a question about whether they are separate species at all.

*Fourteen species, or six?*

It turns out that most of the fourteen species of Darwin's finches—or at least most of the thirteen living on the Galapagos Islands—remain distinct primarily because of mating behavior. Evidence suggests that the birds choose their mates on the basis of beak morphology and song pattern. The former is inherited, while the latter is learned by young birds from their parents.

But one might expect that true species would be separated by more than beak morphology and song pattern. In human populations, race is inherited and language is learned—just as, in finches, beaks are inherited and songs are learned. Yet human populations that are separated by race and language are unquestionably part of the same species, even though such differences may make interbreeding uncommon.

Writing in *Science* in 1992, the Grants noted that the superior fitness of hybrids among populations of Darwin's finches «call into question their designation as species.» The following year Peter Grant acknowledged that if species were strictly defined by inability to interbreed then «we would recognize only two species of Darwin's finch on Daphne,» instead of the usual four. «The three populations of ground finches on Genovesa would similarly be reduced to one species,» Grant continued. «At the extreme, six species would be recognized in place of the current 14, and additional study might necessitate yet further reduction.»

In other words, Darwin's finches may not be fourteen separate species. Perhaps they are in the process of becoming species.

But then we would expect their tendency to diverge through natural selection to be greater than their tendency to merge through hybridization, and this is not what the evidence shows. Perhaps the Galapagos finches used to be separate species and are now in the process of becoming fewer. But then they demonstrate the opposite of Darwinian evolution, which occurs when one species divides into separate species.

The increase in average beak size in several species of Galapagos finches after a severe drought—and its return to normal after the drought ended—is direct evidence for natural selection in the wild. In this limited sense, the finches provide evidence for Darwin's theory. As examples of the origin of species by natural selection, however, Darwin's finches leave a lot to be desired—though this hasn't stopped some people from using them as examples anyway. But the only way they can do this is by exaggerating the evidence.

### *Exaggerating the evidence*

Thanks to years of careful research by the Grants and their colleagues, we know quite a lot about natural selection and breeding patterns in Darwin's finches. And the available evidence is clear. First, selection oscillates with climatic fluctuations, and does not exhibit long-term evolutionary change. Second, the superior fitness of hybrids means that several species of Galapagos finches might be in the process of merging rather than diverging.

The Grants' excellent field work provided us with a good demonstration of natural selection in the wild—far better than Kettlewell's peppered moths. If the Grants had stopped there, their work might stand as an example of science at its best. Yet they have tried to make more of their work than the evidence

warrants. In articles published in 1996 and 1998, the Grants declared that the Darwinian theory of the origin of species «fits the facts of Darwin's Finch evolution on the Galapagos Islands,» and that «the driving force» is natural selection.

This claim was echoed by Mark Ridley in his 1996 college textbook, *Evolution*. Like the Grants, Ridley extrapolated the increase in beak size after the 1977 drought to estimate the time it would take to produce a new species. This «illustrates how we can extrapolate from natural selection operating within a species to explain the diversification of the finches from a single common ancestor.» Ridley concluded: «Arguments of this kind are common in the theory of evolution.»

Indeed. But arguments of this kind exaggerate the truth. And this exaggeration seems to characterize many claims for Darwin's theory. Evidence for change in peppered moths is claimed as evidence for natural selection even though the selective agent has not been demonstrated. And evidence for oscillating natural selection in finch beaks is claimed as evidence for the origin of finches in the first place. Apparently, some Darwinists are prone to make inflated claims for rather meager evidence.

Does the National Academy of Sciences endorse «arguments of this kind» that exaggerate the evidence? A 1999 booklet published by the National Academy describes Darwin's finches as «a particularly compelling example» of the origin of species, booklet goes on to explain how the Grants and their colleagues showed «that a single year of drought on the islands can drive evolutionary changes in the finches,» and that «if droughts occur about once every 10 years on the islands, a new species or a finch might arise in only about 200 years.»

That's it. Rather than confuse the reader by mentioning that selection was reversed after the drought, producing no long-

term evolutionary change, the booklet simply omits this awkward fact. Like a stock promoter who claims a stock might double in value in twenty years because it increased 5 percent in 1998, but doesn't mention that it decreased 5 percent in 1999, the booklet misleads the public by concealing a crucial part of the evidence.

This is not truth-seeking. It makes one wonder how much evidence there really is for Darwin's theory. As Berkeley law professor and Darwin critic Phillip E. Johnson wrote in *The Wall Street Journal* in 1999: «When our leading scientists have to resort to the sort of distortion that would land a stock promoter in jail, you know they are in trouble.»