Unmasking natural selection

40 Years of Evolution: Darwin's finches on Daphne Major Island

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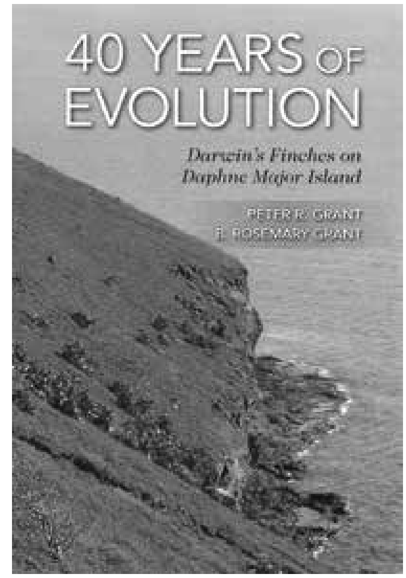
To many people, the word evolution is equated to humans descending from ape-like creatures, or all life originating from simpler life forms. However, if one studies biology, it quickly becomes apparent that the word has a much broader range of meanings. The Grants are evolutionary biologists, and the evolution described in this book refers to the change in heritable characteristics of a population over time. This book presents the results of their 40 years observing patterns of change in several populations of finches on an island in the Galápagos. No, the finches didn't turn into a different kind of bird; instead, the Grants' observations are a gold mine for creationists wishing to understand natural history in a biblical worldview.

The book is very nicely illustrated, containing not only pictures but tables, charts, and boxes with more detailed information concerning what is discussed in the main text. It includes multiple appendices, a list of abbreviations, a glossary, references, and a subject index. Despite their best attempts to make the book as lay-friendly as possible, some of the chapters include rather technical population genetics concepts and discussion of analyses. The summary at the end of each chapter is helpful to gauge if the main concepts of the chapter were grasped. I found myself needing to reread portions of the book.



In fact, this review is being written after the third time I went through the whole book. I think that speaks highly to the value of the book: the basic concepts can be understood by reading the book once, but a deeper understanding is engendered by reading it multiple times a few years apart.

The draw of the finches on Daphne

The preface and early chapters spend a lot of time providing the context for their study, including relevant information about the Galápagos in general, and Daphne Major Island (hereafter, Daphne) in particular. As evolutionary biologists, the Grants are interested in knowing how new species form—a topic of great interest to creationary biologists as well. They discuss reasons for choosing finches on an island (i.e. a small population of easily approachable birds that can be marked for individual identification and tracked through time; figure 1). Their method of tracking finch populations through time is what makes their work so valuable. It steps away from the armchair philosophy and just-so stories that predominate when looking at the current state of a population and attempting to infer how it reached its present condition.

As the bird species and the foods they eat are being presented, the Grants explain what brought them to Daphne in particular. Many islands contain both the medium and small ground finches (*Geospiza fortis* and *G. fuliginosa*, respectively). Daphne only harboured the former granivorous finch, but it was smaller than on other islands in the Galápagos. Thus, on Daphne, the medium ground finch not only occupies the niche it does on other islands, but also that of the small ground finch. The Grants were intrigued, and wanted to know why.

Drawing on previous work, particularly that of David Lack, they describe the concept of *character release*, or expansion into the niche of a missing competitor. They list five assumptions of the character release hypothesis, and spend several chapters discussing how they went about demonstrating the veracity of those assumptions in their study on the Galápagos finches. It is when they list the five assumptions that the proverbial elephant enters the room. The listed assumptions are reasonable enough, but the variability to expand into a new niche has to come from somewhere. This is the primary blind spot of most evolutionary explanations. That is, there is a hidden assumption that appropriate variability is just sort of going to magically be there and natural selection gets the credit for any adaptation. Now, to be fair to the Grants, they do discuss sources of variability in the book (standing variation, interspecific hybridization, and mutation). However, they do not deal in depth with how *appropriate* variation shows up in *appropriate* timeframes, especially as it might relate to mutation.

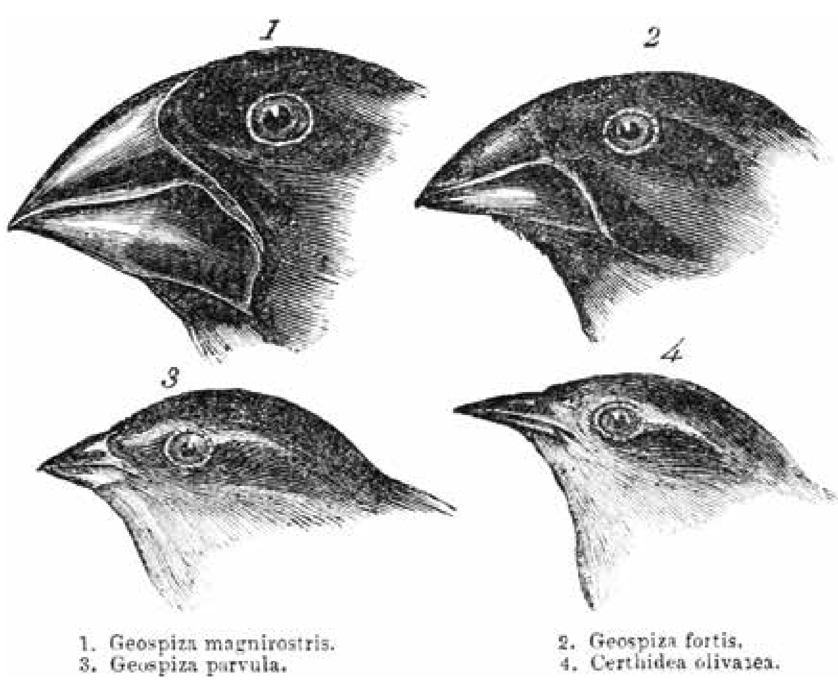


Figure 1. An example of the variation in beak size and shape among finches in the Galápagos. The large ground finch (1) and medium ground finch (2) were observed on the island of Daphne Major. The small tree finch and green warbler-finch (3 and 4, respectively) are found on other islands.

Heritable traits and natural selection

For evolution (in the change over time sense, that no one denies) to occur, heritable variation must exist in the population. The Grants demonstrate that beak length, width, and depth are all highly heritable (and variable) in the medium ground finch (*G. fortis*). They also show that reproductive output varies with the amount of rain and available food, and thus has a heritability close to zero. The primary factor that affected successfully raising offspring that themselves reproduced was related to longevity. And longevity was related to survival during the dry season.

Four years into their study, the Grants observed natural selection in action. There was a drought that resulted in selective mortality. Beak depth was the strongest contributor, as a greater beak depth was necessary to effectively crack and consume the larger seeds that remained available well into the drought. This, and other related observations over the study, make it clear that natural selection does not always act slowly and imperceptibly bringing gradual changes for the good of the organisms involved, as Darwin had argued.[1]

The Grants found that natural selection occurs most strongly when the environment changes. In the Grants' study of the finches, this was during the droughts. Not only did natural selection occur most strongly then, but it was inconsistent in the direction it acted. The first drought they observed resulted in a selective mortality affecting smaller-beaked birds. However, due to exceptionally wet intervening years that resulted in explosive growth of plants bearing smaller seeds, another drought resulted in selective mortality in the larger-beaked birds. This oscillating pattern of natural selection removes useful variation and can potentially put the finch population at risk of being extirpated from the island.

As natural selection acted on the medium ground finches during the droughts, evolution resulted. This simply means that in the next generation there was a shift in the average beak size. However, other aspects of their study made it clear that even in cases where natural selection appears to be acting, evolution does not always result. Instead, the net effect of natural selection is influenced by antagonistic selection, which can occur on the same trait at different times, or on different linked traits at the same time. Thus, it is incorrect to say that natural selection is equivalent to evolution; it is merely one of several possible causes.

Character displacement

During the course of their study, the Grants also observed *character displacement*, the opposite of *character release*. In character displacement, competition between species can result in divergence between the two. The most striking example observed in their study is worth examining in more detail.

When their study began there were no large ground finches (*G. magnirostris*) that bred on Daphne. Occasional migrants would visit, but until a very favourable El Niño year (1982) none stayed to breed. One important observation made by the Grants is that of the migrants who visited, those that stayed to breed were not a random sample of the total visitors. They differed genetically (more heterozygous) and phenotypically (larger beaks) from those that left. This is significant because evolutionists commonly assume that colonization is random for their models of gene flow and statistical tests designed to detect natural selection.

The number of large ground finches increased slowly over the next decade, and then suddenly increased more dramatically. For many years there wasn't much competition between them and the larger-beaked medium ground finches (*G. fortis*). That changed near the end of a two-year drought (2003–2005) when the large seeds they both consumed were depleted. The death toll was heavy for both species. In the medium ground finch (*G. fortis*), there was a size biased mortality (the larger-beaked birds were more severely affected), but in the large ground finch (*G. magnirostris*) mortality was not size biased.

The size biased mortality was an example of natural selection in action, and evolution resulted. There was a dramatic drop in the average beak size for the medium ground finch population in the next generation. The Grants point out that this example of character displacement was not from constant, ongoing competition. Special conditions were required for it to occur. The reduction in average beak size of the medium ground finch was dramatic, and this measurement remained smaller throughout the rest of the study.

Hybridization and genetic correlation

It wasn't just natural selection that caused changes in traits, such as average beak size. Hybridization between the medium ground finch (*G. fortis*) and two other species (*G. fuliginosa* and *G. scandens*) was important as well. The difference was that hybridization was more persistent, occurring at low levels throughout the study. This is in contrast to the dramatic impact of natural selection operating during a drought.

There was no breeding population of small ground finches (*G. fuliginosa*) on the island, but sometimes migrants from this species would stay and breed with the medium ground finch (*G. fortis*). Hybrid offspring which survived to reproduce would breed with a medium ground finch, which brought variation into the population. This was tremendously valuable, particularly after a drought which had selectively removed birds with smaller beaks. Birds with smaller beaks are much more efficient at consuming the smaller seeds, and this hybridization allowed the resident medium ground finch population to effectively exploit that resource again.

Hybridization between these two granivorous finches also explains the puzzle that brought the Grants to the island initially. The medium ground finch was relatively small on Daphne because it received genetic material from the small ground finches who occasionally stayed to breed. Rather than establish a population, which could have eventually led to competition between the two species, the small ground finch brought in useful variation. Since the medium ground finch on Daphne never hybridized with the large ground finch (*G. magnirostris*), it had no way to regain the lost variation in the larger size range after the drought depleted it in 2005.

A second factor that affects how a trait can change is how they are correlated. Beaks can vary in three dimensions: length, width, and depth. Often, two of the dimensions are correlated, and this has to do with the underlying gene expression differences that control beak size and shape.[2] While natural selection can easily shift the beak size up or down, changes in beak shape are more complex.

In addition to granivorous finches, Daphne is home to the cactus finch (*G. scandens*). In the granivorous finches, beak length and depth increase similarly with increases in size. In the cactus finch, beak length increases considerably faster than beak depth as size increases. The longer beak facilitates feeding on the cactus plant (*Opuntia echios*; figure 2). While natural selection is less effective in transforming beak shape, hybridization between the two species broke down the correlation.

Coalescence or speciation

In the first few years of the study, there was a dramatic difference in beak shape between the medium ground finch (*G. fortis*) and the cactus finch (*G. scandens*). Then hybridization was observed between the two species. It was never pervasive, as only a few individuals were involved in any particular breeding season. However, it became persistent, happening in most years. The hybrids would breed back to one of the parental species, bringing in new variation. As they did so, a dramatic shift in beak shape occurred. This was most noticeable in the cactus finch population, as it was smaller. Despite the adaptive advantage of having a long beak to feed on cactus, the cactus finch beak became blunter from the incoming ground finch genes.

Figure 2. The Galápagos prickly-pear cactus (*Opuntia echios*) found on Daphne. Due to the greater length in their beaks, cactus finches are skilled at biting open the fruits and buds on this plant, as well as probing the flowers for nectar.

While hybridization can cause two different species to coalesce, as was beginning to happen in the above example, it can also have a different outcome. The Grants document this by tracing the offspring of a large juvenile that arrived on Daphne in 1981 and stayed to breed with the medium ground finches. In the book it was suggested to be a cactus finch/medium ground finch hybrid, perhaps backcrossed to a medium ground finch (based on microsatellite comparisons). Subsequent genome sequencing indicates it was actually an Española cactus finch (*G. conirostris*), originating from over 100 km away.[3]

Despite being 70% larger and singing a different song, this large male immigrant bred with the medium ground finch. Some of his smaller offspring continued to do so, and became absorbed into the *G. fortis* population. However, part of his lineage quickly (within three generations) began interbreeding only among themselves, forming a distinct population. Initially the Grants had no idea what the outcome would be, so they called this population the Big Bird lineage and continued to track it. For over 30 years, the Big Bird lineage has remained separate, thus qualifying it as a separate species under standard rules of taxonomy. Its beak size is between that of the medium and large ground finch populations. In addition to consuming seeds in the expected size range, this new species can effectively exploit cactus as a food source.

Singing and hybridization

In several different chapters, the Grants discuss the importance of song and morphology (i.e. size and shape) in choosing a mate. Young birds normally learn the song of their fathers, and the males sing it as an adult. Females recognize the song, and tend to mate with a male like their fathers. There are a few circumstances that can cause a breakdown in this pattern, including the death of the father during the formative years of the young. Occasionally, a young bird might learn the song of a neighbour, which might not be of the same species.

In cases of hybridization between the medium ground finch and the cactus finch, the offspring would breed back to the paternal species. Song and morphology appear to be the reason why. In the case of the Big Bird lineage, these appear to be the factors that prevent them from hybridizing with other finches on the island. Thus, the main reason the species remain separate is behavioural, rather than the inability to produce viable, fit offspring.

Extrapolation

In the last few chapters, the Grants summarize their major findings, including the long-term effects they observed from both natural selection and hybridization. They point out that there is an ebb and flow of various morphological traits over time, and that species can be ephemeral. They use what they have learned to make inferences about the past (through a molecules-to-man evolutionary lens) and the future. Except for the timeframe and the assumption of universal common ancestry, they make a number of points that are quite reasonable in a creationary worldview as well. What is missing from the discussion is a sense of awe for the Creator who provides for these birds even in a changing, sometimes hostile, environment in our fallen world (Matthew 6:26; Luke 12:6–8).

What does this mean for creationists?

One of the more obvious implications of the Grants' work is that natural selection does not operate as many evolutionists have traditionally claimed. The Grants' observational data helps expose some of the poorer arguments that have been used to support natural selection as the dominant explanation for the variety of species we see today. Consider the following quote from the *Understanding Evolution* website (a collaborative project of the University of California Museum of Paleontology and the National Center for Science Education):

> "An adaptation is a feature that is common in a population because it provides some improved function. Adaptations are well fitted to their function and are produced by natural selection."[4]

This is utter nonsense; no trait can be *produced* by natural selection! The trait must already exist in the population (standing variation), or be brought in by some means (migration, hybridization, or mutation) within a timeframe where it can be helpful. Once the trait is in the population, natural selection is one of several possible mechanisms by which the trait can increase in frequency, and thus become common. Other mechanisms that can alter the frequency of a trait include migration (in or out, based on suitability of traits for that environment), hybridization, and meiotic drive (a well-known type of non-Mendelian inheritance that needs to be considered in future studies).

It is realistic to view natural selection as a shaping force. It can result in divergence by eliminating overlapping phenotypes between two species. It may, at times, explain why certain variations are uncommon or absent. It is also one factor that may contribute to the formation of a new species, especially through allopatric speciation. While the latter wasn't directly observed in the Grants' study, they do provide examples of divergence between the same species on different islands associated with different environmental conditions. If this continues long enough, it could result in speciation.

However, in contrast to claims of 'armchair' evolutionists, natural selection is not an explanation for any adaptation because it does not explain the origin of any trait. It was observed to be intermittent and oscillating, in contrast to Darwin's belief that it was continuous and always worked for the benefit of the organisms involved. Natural selection is not the major factor involved in the diversification of the kinds God created at the beginning, but hybridization between species can now be seen as another important component of God's providential care for his creatures.[2]

References

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