The Origin of Species: The Beak of the Finch

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Short Film
Transcript

[NARRATOR:] Our planet has millions of species. Over 300,000 beetles alone. 17,000 butterflies. Thousands of mammals, fish and birds, all astonishingly different. How did so many species come to be? To seek insights into that question, researchers are focusing on places where species recently arose, such as the remote Galápagos Islands.

[CARROLL:] Scientists are making observations and conducting experiments that would have surprised Charles Darwin. And they're discovering new insights into what the great naturalist called the "mystery of mysteries": How new species form.

[NARRATOR:] The Galápagos Islands are one of the most spectacular landscapes in the world, home to a variety of species that live nowhere else. Biologists Peter and Rosemary Grant have been seeking answers to how species arise by focusing on one of the smaller islands, called Daphne Major.

[PETER GRANT:] When we started out, we had no plan for the long term. In fact, we thought it was just going to be just a few years, maybe two years.

[NARRATOR:] Two years have turned into a 40-year odyssey. The Grants have returned every summer since 1973. [ROSEMARY GRANT:] Oh, there's a bird.

[PETER GRANT:] Is that 306?

[ROSEMARY GRANT:] Three oh metal six.

[NARRATOR:] Here, they've made some of the most remarkable observations in the history of field research as they studied the famed Galápagos finches. The finches were first brought to scientists' attention by Charles Darwin, when his voyage around South America brought him to this cluster of islands 600 miles from mainland Ecuador. These volcanic islands are geologically young. They began rising from the ocean floor less than five million years ago. At first devoid of life, they now support a modest number of species. Among them, 13 species of finches found in various combinations on the different islands. The birds live in diverse habitats.

[ROSEMARY GRANT:] The islands are very different from each other. They differ in size. They differ in topography and in height.

[NARRATOR:] Larger trees grow at higher elevations while low islands have mostly cactus, grasses and shrubs. In these diverse habitats, the finches have evolved many ways to survive.

[CARROLL:] So Rosemary, what's the important difference between these birds?

[ROSEMARY GRANT:] This little warbler finch with its very fine needlelike beak is perfect for picking off insects. This one is the woodpecker finch with a rather more robust beak. It concentrates on beetle larvae and termite larvae. Then we have the cactus finch with a much longer sharp pointed beak which probes into cactus flowers. And then these three species are the large, medium and small ground finches. So, Sean, a basic idea is, the beaks are tools and you need the right tool for the right job.

[NARRATOR:] The finches look so different that Darwin first mistook them for entirely unrelated kinds of birds. How did the Galápagos end up with so many species of finches?

[CARROLL:] In terms of the actual history of the finches of the Galápagos, there were many different possibilities. Different kinds of finches could have all come from the mainland separately or the finches could have all evolved out there on the islands. And what do we know about that?

[PETER GRANT:] Well, now we know from DNA evidence that all of the finches are more related to each other than any one is to a species on the mainland. And that tells us only one species arrived on the archipelago, and diversified into the 13 species that we see nowadays in the Galápagos. So they've all come from a single common ancestor.

[NARRATOR:] The question then becomes how did one ancestral population give rise to many different species, each adapted to a different lifestyle. A crucial insight into how adaptation occurs came when the Grants focused on one species on the island of Daphne Major.

[PETER GRANT:] Factor of great convenience for us was the small size of the island. That meant that we could walk all over the place.

[ROSEMARY GRANT:] The idea was that if we worked really hard, we could follow every individual or almost every individual.

[NARRATOR:] They rose at 5:30 each morning to net the island's medium ground finches.

[NARRATOR:] They measured the size and shape of each bird's beak, the bird's weight and they tagged them for identification.

[NARRATOR:] Year after year they returned, at times tracking over 1,000 finches.

[PETER GRANT:] So here's an example of a bird we know intimately over the whole of its lifespan. The number is 5960. We know how many times it bred, which years it bred in, how many mates it had, how many offspring it produced. And then how many of those offspring themselves survived long enough to breed.

[NARRATOR:] Over the first four years, little seemed to change. Then in 1977 a terrible drought began.

[PETER GRANT:] Virtually no rain fell for the next 18 months.

[ROSEMARY GRANT:] The vegetation practically disappeared apart from a few trees without any leaves. And, of course, the cactus bushes were still there.

[NARRATOR:] Now the medium ground finches had to compete for scarce food.

[PETER GRANT:] They started off with a big food supply of small seeds, medium seeds, large seeds. As these small seeds became very scarce, they had to turn increasingly to the large and hard seeds. Well, only birds with large beaks can crack open these woody, spiny fruits.
[NARRATOR:] The birds with the smallest beaks had the most trouble.

[ROSEMARY GRANT:] They were scraping about amongst the rocks, and their plumage got so worn that they could barely fly.

[NARRATOR:] That year, over 80 percent of the medium ground finches died.

[PETER GRANT:] We would go around looking for birds that had died. And it's very sad to pick up a bird and say, "3972. "Oh no, not that bird. "Oh."

[NARRATOR:] When they inventoried the surviving medium ground finches, they discovered that one trait had made the greatest difference between life and death.

[PETER GRANT:] What I'm showing here, a distribution of beak depths of the population in 1976. The survivors of this group are shown in black.

[CARROLL:] Oh. So the larger the beak, the better your chances?

[PETER GRANT:] The larger the beak, the higher the likelihood of surviving through the drought of 1977.

[PETER GRANT:] 18.6 grams.

[NARRATOR:] When they looked at the offspring, they found an even greater surprise. The average beak depth was more than four percent larger than the previous generation. Natural selection had changed the average beak size.

[CARROLL:] Could you have ever imagined measuring and observing something like this on such a short time scale until you actually did it?

[PETER GRANT:] When we started, the answer is no. We could not imagine we would be able to do it.

[NARRATOR:] But was this a fluke? Or are changes like this happening all the time? Five years later in 1983, an unusually strong El Nino brought ten times more rain than normal. And the island was overrun by vines that covered even the cactus. The rains changed the vegetation on the island, such that two years later, when drought struck, larger seeds became scarce. The birds with larger beaks now had difficulty picking up the more abundant food: the small seeds produced by the vines. That year many more finches with small beaks survived, and their offspring inherited smaller beaks.

[PETER GRANT:] So the selection had swung in the opposite direction, and evolution had occurred as a result.

[CARROLL:] In an amazingly short period of time, the Grants had measured evolution of beak size, not once, but twice, demonstrating that when birds encounter different environments they will change over a very short amount of time.

[NARRATOR:] Over millions of years, changes like these occurring throughout the Galápagos generated all sorts of beak sizes and shapes. But that's only part of the story. How did finches with different beaks become distinct species? Species are defined as populations whose members don't interbreed.

[CARROLL:] So how does one species split into two? A typical scenario is that two populations become separated geographically, and undergo enough change in their respective habitats, that if or when they come into contact again, they do not mate.

[NARRATOR:] So in the Galápagos, the Grants asked what keeps different species of finches from mating?

[ROSEMARY GRANT:] We were very conscious that on any given island, the different species sing very different

songs. This is what a cactus finch sounds like. [chirping] Whereas the medium ground finch sounds very much like this. [chirping]

[NARRATOR:] So to see if songs keep the species apart, the Grants, and their student Laurene Ratcliffe, played each species' songs through a loudspeaker.

[ROSEMARY GRANT:] When we played back the cactus finch song, cactus finch came to the loudspeaker and the medium ground finch completely ignored it.

[NARRATOR:] The males only responded to songs of their own species. The Grants looked at whether finches might also choose mates based on appearance. So they put out stuffed female specimens to see if males would respond.

[ROSEMARY GRANT:] Clearly they could discriminate. The male vigorously courted a female of his own species; completely ignored the other one.

[NARRATOR:] The males only courted females that had a similar size and similar beak. Song and appearance both play a role in keeping different species from mating. So when populations of the same species are separated, changes in these traits set the stage for the formation of new species. The Grants have shown that both geography and ecology are keys to the evolution of the Galápagos finches. The most likely scenario is that, two million years ago, a single finch population arrived from the mainland. When their descendants reached another island, they faced new conditions. As those isolated populations adapted to their surroundings, their traits changed. If the changes included traits involved in mating, and the populations came into contact again, they no longer mated. They had become distinct species. While unique to these remote islands, the history of the Galápagos finches offers a general insight into why the world is populated with so many species.

[PETER GRANT:] The more diverse the environment, the more opportunities for evolutionary change to produce those new species.

[NARRATOR:] Over 150 years after Darwin first recognized their significance, these unassuming birds still illuminate how the great diversity of life arose and continues to evolve.