The Beak of the Finch Study Guide

The Beak of the Finch by Jonathan Weiner

BOOKRAGS

Contents

Plot Summary

The Beak of the Finch is an in-depth look at the research that was begun with Charles Darwin's brief visit to the Galapagos Islands through the late twentieth century with the Grants twenty years of visiting and researching on the islands. The book explains how Darwin's theories began, and how they were proven to be true, false, or just not totally correct. It also gives the reader an understanding of how evolution works over both long and short stretches of time.

The book is separated into three parts. Each part deals with a separate group of issues, but the parts flow together as one large story. There are no gaps or breaks in this chronology of two different time frames, Darwin's time and Grants' time.

Part one gives the reader a basic understanding of how Darwin's finches became famous and introduces the reader to the Grants and their research. It is miraculous that the finches received any attention, since Darwin did not believe they would be as useful as the mockingbirds he found on the islands. However, this turned out not to be the case, and the naturalists at the time honed in on the finches. Darwin, during his visit to the Galapagos, was certain the finches were not important. In fact, even though they made him famous, he did not include them in his book, "The Origin of Species." He did include later research of pigeons, but the finches are mysteriously absent.

Part two brings the Grants' research to the forefront of the book. It explains what they have been doing, what they are looking for, and some of the changes that have taken place over the twenty years of observing the finches. It gives the reader information on natural selection, sexual selection, and environmental changes that contribute to evolution. It also gives brief explanations of other researchers, who are also watching animals in nature and the laboratory and the findings that are very similar to those of the Grants. Just as the Grants, some of these researchers have been watching for twenty or more years. Others have just begun their observations, but were influenced by the Grants, such scientists as Dolph Schluster.

Part three leads the reader to the latter part of the twentieth century. Throughout the book, much of the Grants' time is fairy recent; however, this last section gives an idea of how the information from their research is being used. It includes the use of genetics in the research, and how geneticists are starting to create animals from the very basic ingredient, DNA. Part three leads the reader to have questions about the future of the planet, as well as the future of humanity. The projected future is not dark or warning of devastation, it is just how things the Grants are noticing in the finches gives insight for the future of the human race. This section also includes how the warmer climate of the world is starting to affect the finches. The Grants plan to keep their watch and see what happens.

Part 1, Chapter 1

Part 1, Chapter 1 Summary

Peter and Rosemary Grant travel to the island of Daphne Major, which is located in the Galapagos Islands. They stay for six months out of each year to study the finches indigenous only to this island. They have done this for over twenty years and are the leading experts in the field of evolutionary biology. They take measurements and blood samples from each finch to find proof of evolutionary change in the species. They have watched the population of finches on this island grow to over 1000 and drop to close to 300.

Daphne Major is little more than volcanic rock with no actual shoreline. The Grants and their party have to jump onto a small landing on the side of a cliff to get to the top of the island. They bring six months of supplies, including water, to keep them alive. They also bring tarpaulins, scientific instruments such as measuring devices, paper and pencils. The laboratory equipment would fry on this island, so they write everything down and enter it into the computer when they return to Harvard.

Darwin explained and believed in natural selection without ever truly seeing it in action or studying an isolated population such as the Grants are doing. He used plants, fossils and pigeons to establish his theory. However, not much has changed since Darwin's time. In the 1990s, there was still very little research to substantiate Darwin's Theory. The Grants are one of the few that have taken the first step in the needed research of natural selection.

Part 1, Chapter 1 Analysis

The author uses the Grants and their island laboratory as a starting point to explain evolution and natural selection from the beginning with Darwin through to today's theories. He gives the reader a look at a few of the triumphs and hardships the Grants and the research group endure during one trip to the island to study natural selection with Darwin's finches. The Grants are taking evolutionary biology to the forefront of science.

Part 1, Chapter 2

Part 1, Chapter 2 Summary

There are thirteen Finch species alone on the Galapagos Islands. Each has its own quirks and physical characteristics that differentiates one from another. Darwin first visited the Island of Chatham, followed by four other of the Galapagos Islands. He was initially excited about the number of different plants he found on the islands. The naturalist in him decided to take home animal specimens as well. Several people on the boat took specimens, separating the specimens from each island and marking what was found and where it was found. However, Darwin did not initially separate his specimens by island. He believed that they were just variations, but not separate species. People of the islands told Darwin that each island had different types of the same species; however, Darwin ignored them. For Darwin, botany and naturalism were hobbies. He was educated as a parson and planned on traveling into the countryside and performing his duties. He did believe the crust of the earth changed, but not the species of the earth. To him, that was inconceivable.

Darwin drew this belief from a man named Karl von Linne. Von Linne wrote under the Roman name Carolus Linnaeus and provided naturalists with the connectivity of all creatures on Earth. He broke each group down into several categories such as kingdom, classes, order, genera, and species. Modern naturalists have changed this identification system very little, but have added many new creatures to the list.

Darwin believed the finch would start with a single finch and evolve into the thirteen different finch species. Linnaeus, however, believed that only one creature was created by God, and anything different was variation of the original but not a separate species. In his later years, Linnaeus would ponder these variations, but he did not give up the idea that there was only one original species of each animal and the rest were variations.

However, there were people before Darwin that believed in the evolution of species, that species changed throughout history and would continue to change in the future. The norm for naturalists of Darwin's time was to collect two of each species, one male and one female. They believed they would then have an average set of the species. This is why Darwin did not separate the finches, mockingbirds, and other animals he collected in the Galapagos Islands. He tried to use the collections of his shipmates to help him categorize which islands his specimens had come from, but he was unsuccessful.

When Darwin returned to England, the naturalists of the country were excited by Darwin's finds. They verified that each of his specimens were different species. Two years after his return to England, he married Emma, and worked very hard as a naturalist, instead of a parson. He became very ill with a variety of stomach problems soon after his marriage. They lived in London initially, but they eventually moved to Downe, Kent.

Darwin did not consider his oversight of the finches as a bad thing. He went on to take what he learned and tried to recreate it, to a point. He began to breed pigeons at Down House, some twenty years after he had returned from the Galapagos Islands. He had not been idle all of that time up to then. He had been searching for the proof he needed to explain natural selection. He began by looking at people who were breeders of animals and hybridizers of flowers and plants. He researched all he could about breeding and hybridization and used this information on his pigeons. Within one year of the beginning of his pigeon experiment, he had proof. His "selection" proved natural selection could take place. With this information, and upon the urging of his peers, he wrote the "Origins of Species."

One incredible feature of this book is that it does not mention the finches of his early life. He uses the pigeons and information from animal breeders and horticulturalists as the basis for his hypothesis. He never shows any proof from nature in wild surroundings. Everything is based on domesticated animals and plants and selection techniques used by these people to get the results they desire in their specimen. He believed, and based his book on the fact that, if it can be done in captivity, it must occur naturally in the wild.

Hollywood and textbooks have romanticized Darwin, his finches, and his involvement in evolutionary theory. Although some people have tried to get the true story to the public, they have been unsuccessful. Darwin's finches have been the reason behind many naturalists going to the Galapagos to collect and study these birds. The Grants, however, are the only people that have collected the vital information from the bird and returned the bird to the wild to watch it and its descendents and follow the changes in each species.

Part 1, Chapter 2 Analysis

The reader is given insight into how Darwin collected the specimens and why they were collected in that fashion. It helps us understand that Darwin truly was not interested in the finches and was more interested in the plants and the mockingbirds of the island. He had no idea what an extraordinary discovery he had in the finches. However, he does learn from this mistake and tries to create proof on his own in England with the pigeons. From this experiment and other research, he writes his most famous book, "Origin of Species." Unfortunately, the reason he originally decided to delve in this is not mentioned because he believes that it will discredit him. Therefore, the reader knows that Darwin has learned something from the trip to the Galapagos Islands, but that he still does not understand the importance of the finches and probably never will.

The reader is also told that many of the movies and textbook information is not as accurate as one would hope, but that many people, like the Grants are trying to change the inaccuracies and provide accurate information to the world.

Part 1, Chapter 3

Part 1, Chapter 3 Summary

It seems that Peter and Rosemary Grant had more in common with Darwin than finches. They each began their careers in evolutionary biology with a curiosity about the variation of animals and plants.

Darwin studied the variations of barnacles before he ever considered birds on his journey. He spent six years trying to classify each barnacle specimen. Within each barnacle, species there are variations, and Darwin hypothesized these variations eventually led to a change in the species, creating an entirely new species.

In "Origin of Species," Darwin ponders why nature is not in a state of confusion and chaos. His answer is that the cause that creates variations also causes the unneeded and unwanted variations to go away. However, this is only true in part. The finch species are in chaos. There are variations occurring in the present that are causing the lines of distinction between the species to blur. There is a saying at the Darwin Research Center at Santa Cruz, "Only God and Peter Grant can recognize Darwin's finches."

Peter Grant chose Darwin's finches because he needed a new research project and wanted something he could study in the wild. He wanted a population that had been undisturbed by other similar species. He found this population on Daphne Major and Genovesa in the Galapagos. The most interesting aspect of these birds, other than their genetic variations, was their lack of fear of humans.

Within the first year of study, the Grants and their team learned how various and extraordinary the finches truly are. There is variation between the species and within each species. Darwin could never have understood that he was seeing true evolution at work. The Grants have studied live specimens, as well as the specimens found in museums, and their findings are extraordinary.

Part 1, Chapter 3 Analysis

The reader sees more into Darwin's world. He studied plants and barnacles primarily. The mockingbirds were secondary, and the finches were not considered important until after he returned to England.

The reader is also given insight into how and why the Grants chose to study Darwin's finches. They knew they would have interesting results, and after one year, they knew their findings would alter many previous theories.

Part 1, Chapter 4

Part 1, Chapter 4 Summary

Naturalists from around the world studied the beaks of Darwin's finches for more than four decades. Some scientists believed the beaks prove nothing, and the finches were nothing more than hybridized groups. Others set out to prove the beaks were the perfect factor to prove natural selection. With the publishing of the David Lack's essay, the scientific community and the general public finally agreed, or at least understood, natural selection and how the beaks of Darwin's finches proved the theory.

The first year of their research, the Grants focused on measuring every finch they caught, but they also wanted to research the types of food eaten by the different finches. They studied these aspects for the entire wet season. All the birds seemed to dine on similar diets during that first season. However, as they were leaving that first year, Peter Grant was given some advice. He was told that the dry season is very different from the wet season. The wet season has many types of food readily available; the dry season does not. The Grants would learn that in the dry season, the diets of the birds become more specialized. Each species has its own diet because of its type of beak and how the beak was used.

The large and medium ground finches enjoy the seeds of the caltrop; however, this plant has a defense system. Its seeds are inside a spiny shell that the birds must break to retrieve their food. Many of the large ground finches can break the shell with their beaks and get at the seed immediately. The medium ground finches work hard to get only one or two seeds out of each shell and have learned to use rocks to help put pressure on the shells; their beaks cannot extract the seeds without help. They have also learned how to peel, layer by layer, the outer part of the shell to get to the seed. A variation of beak size of only .5mm can be the difference in whether or not the medium ground finch can get to the seeds of the caltrop plant.

The finches are not the only species that has evolved in regards to this plant. The plant itself has evolved as well. In areas where there is a large finch population, the plant has begun producing more spines on the shells and less seeds in each shell. The plants in the areas that have a small finch population have more seeds and fewer spines. These plants are also not indigenous to the Galapagos Islands, but have adapted and evolved to survive in the area.

The Grants have studied the beak variation on two islands, Daphne Major, within the ground finch species, and Genovesa, within the cactus finch species. They have tried to explain how the beaks differ within each species by equating them with tweezers. Each type of tweezers has a specialized job, and using another type tweezers would take a longer time to perform the same task. In the same way, each beak is created for a specialized task to forage for food during the dry season.

Peter Boag decided to use several years of the Grants findings to establish the "heritability" of the finches for his thesis. He also wanted to switch eggs from one nest to another next to see if the hatchling would conform to the adoptive parents or retain the genetics of the true parents. However, he was never able to complete the egg switching, which was fine with the Grants. They believed that if eggs had been switched, Boag would have changed the evolutionary balance of the birds.

Jamie Smith did perform egg switching but within a study population of sparrows. His findings proved that the hatchling retained the traits of the true parents. From these studies, many other studies have been conducted and have proven that almost every detail of a bird species is "heritable" to some extent.

The Grants took home much data about the birds to publish their findings. However, once they had returned home, they knew they would have to go back because they needed more data. The finches seemed to be evolving much faster than other species anywhere on the planet. They realized they might get to see evolution in action. They decide to keep going back and watching to see what would happen.

Part 1, Chapter 4 Analysis

The reader is given the general overview of how the differing sizes of the beaks are important features within each species of finch. No one had truly taken the time to look closely at many aspects of the finches until the Grants began their study, and even they did not realize what they had immediately. However, after starting to sort the information they decided to keep watching and learning about the finches.

Part 1, Chapter 5

Part 1, Chapter 5 Summary

Peter Boag and Laurene Ratcliffe joined the Grants and other scientists in 1977. In previous years, there had been a lot of rainfall on Daphne Major, but this year there was a major drought. Boag and Ratcliffe accompanied the Grants to help them study the fledglings, and if Boag could talk Peter into it, complete an egg switch experiment. However, the study of fledglings and the egg switch ended up being impossible. The ground finches only mate when there is rainfall, and, with no rainfall in 1977, there was no breeding. The cactus finches do not need as much rainfall, so the scientists were able to study some fledglings of that species that year. All of the fledglings died before the age of three months. Many of the adult birds of both groups were dying, too. This episode was very discouraging to everyone, but especially to Boag, who now thought of the trip as a waste of his time.

In actuality, the group was getting to see natural selection in progress. The population of each species of finch dropped dramatically that year, and only the largest and strongest survived. The differences in the survivors and those that died were very small and would seem insignificant to many people. But the .5 mm difference in beak size was enough to decide who would survive the drought.

In 1983, the mathematical equations of partial regression analysis done by the Grants were used to decipher the data from the drought. What came from the analysis was that the females chose the larger males, which is not surprising. The surprise came in the offspring. It seems the females also choose males with the deepest beak within each species. This drought had allowed the Grants and their group to see how evolution was working through natural selection.

Part 1, Chapter 5 Analysis

The year of 1977, had been very depressing. The Grants were losing their research specimens, and graduate students were loosing their thesis research. However, in the long run, they all realized that they were watching natural selection. It was not apparent at the time, but over time, they could see the changes in the offspring that were hatched the following year. The group had experienced the process of natural selection. It was an incredible experience.

Part 1, Chapter 6

Part 1, Chapter 6 Summary

Trevor Price observed the finches the year after the drought. He banded all the hatchlings and knew every bird upon sight. He also made the discovery that the young needed to be big, but the adults needed to be smaller. Big could be a liability if the dry season arrived before the fledgling had fully matured.

Natural selection is one facet of evolution; the other is sexual selection. Price watched the finches for three years and found changes in sexual selection during this time. The years directly after a harsh dry season were different then if the dry season was mild. It proved what Darwin tried to explain in "The Descent of Man." But it also went past his theory to show how sexual selection can change due to natural selection.

John Endler has been working with guppies in Venezuela and Trinidad almost as long as the Grants have been working with the Galapagos finches. He has conducted two major studies, one in a controlled environment and on in the wild and obtained the same results with each study. Changes in the environment cause natural selection of a species, but it can also change the sexual selection of the species. It was the same finding that the Grants encountered with the finches.

Price had one more year to see if the cycle of larger finches broke. However, the wet season of 1981, produced little if any rain, and when a little rain did finally fall, it was too little and too late for the finches to breed. Price's time was over. The following December, in 1981, Lisle Gibbs took over the watch. He and a field assistant waited for rain. They had a little rain, but again, it was not enough to make a difference. However, by December 1982, the rains finally came. Lisle had decided not wait to go to the island at the usual time, but changed his plans when he received a postcard notifying him of the rain.

Part 1, Chapter 6 Analysis

Price spent three years waiting for rain and watching the cycle change, but he did not get to experience it. The next graduate student waited as well, and was notified the rains had finally arrived in his second year of research. He would get to see the change.

The studies of Endler's guppies give examples of natural selection and sexual selection in a different species, but with comparable results to those of the finches. This leads the reader to gain a broader understanding of evolution and natural selection. The additional study of the guppies gives credibility to the theories based on the finches and allows those theories to be associated with other species.

Part 1, Chapter 7

Part 1, Chapter 7 Summary

It took Lisle only seventy-two hours to arrive at Daphne Major with his field assistant, and they immediately began banding baby finches. The islands of the Galapagos received heavy rains that year. They also received thunderstorms, which are virtually unheard of in the islands. There were flash flood and landslides as well. The new year started with these storms.

El Niso hit the Galapagos that year and caused so much rain that the flora of the islands changed. The cacti died from all the water, and vines took over, making small, soft seeds plentiful. The plants of the Daphne Major dropped seeds at least seven times that year, and the birds took multiple mates, which led to multiple clutches. In fact, some of the birds Lisle and his assistant banded upon their arrival were mating by the end of the wet season. The youngest to mate that year was less than three months old. Normally the birds wait two years.

The other islands were seeing unusual events, too. On Genovesa, the mockingbirds had an epidemic and many of the older birds died, leaving the juvenile birds to fend for themselves.

The islands returned to normal after the rains, with the exception to the changes in flora. The following two years produced very little rain. Lisle discovered natural selection seemed to reverse and was now favoring the smaller birds. It was what Price had wanted to see. He made this discovery in the fall of 1985. The large seeds were harder to find and the large birds were not adept at finding and eating the smaller seeds. Another variation of this time frame was that many of the male birds in all species of finches began to die at a much faster rate than the females. This was the exact opposite reaction as the year of the flood.

Jamie Smith left the Galapagos and went to British Columbia to study sparrows. He took measurements similar to the Grants finches. However, after years of study, as he prepared to publish a paper saying natural selection did not affect the sparrows, Dolph Schluster did not believe it. He reviewed the data and discovered that natural selection did affect the sparrows, but at such an incredible rate that it appeared not to change them, and they seemed stable. By breaking the data down, it was clear that many changes occurred within a single generation.

Darwin believed the evolutionary rate was too slow to watch in nature. In 1949, JBS Haldane agreed with Darwin and created a universal measurement for evolution. He named it a darwin and it represented a 1% change in one million years of time. However, Philip Gingerich proved this theory and measurement not to be completely accurate. He proved that the closer one looks at life, the more evolutionary changes one sees.

The distant past will always show a slower pace. This is because evolution is like a tide. It first goes one way and then the other way, many times in a million years, and will equal out to a point. But if one watches nature closely, one can see evolutionary change within a span of several years.

Because of these findings with the finches and other animals, we now know that the evolutionary process is forever changing everything in the world. It changes the way people view reality, still and stable at a distance, but forever dynamic up close.

Part 1, Chapter 7 Analysis

The author takes the reader to the next point of change: The heavier rains created a wonderland for smaller birds, and the male population began to die off. This is the exact opposite of what happens during a dry season. The difference between the two seasons is demonstrates that evolution was actually occurring during the time the Grants and their team were making their observations, but the scientists were unaware of this fact until years later during analysis of large quantities of data.

This also proves that, to a point, Darwin's theories were correct; his inability to watch evolution in nature was the cause of some of his incorrect assumptions. The fact is that if one blinks, one may miss evolution in action.

Part 2, Chapter 8

Part 2, Chapter 8 Summary

Rosemary and Peter Grant took a year from teaching to clean and run preliminary analyses of the data gathered over the last twenty years. Rosemary sits at a table in her Princeton office sorting data about the finches on her computer. The walls of her office are lined with boxes full of information about the islands and the birds, from seeds and songs to mating and lineage. Their data gathering and analysis are very thorough and extensive.

There has been a strange twist discovered through their data. By all accounts, the hybrid fledglings produced by the mating of two species are usually sterile and do not survive. However, the Grants research has shown on both Daphne Major and Genovesa that the hybrids are not conforming to the norm, but are surviving and reproducing.

Rosemary and Peter are struggling with the numbers, comparing pure-blood mating and hybrid-mating patterns. Before the flood of 1983, the hybrids did not do well, but the pure blood lines did very well. However, after the flood, the pure blood lines began dying out, and the hybrid lines increased in population. The flood of 1983 has changed some factor, and that has changed the birds.

Part 2, Chapter 8 Analysis

The author gives a glance at the findings the Grants analyzed during their sabbatical. It shows, against popular belief, that, at times, hybrids of two separate species are viable and prosper. This is exactly what happened on two of the Galapagos Islands. It is an astounding discovery. Changes on the islands have changed the birds.

Part 2, Chapter 9

Part 2, Chapter 9 Summary

Evolution is always at work. A person cannot see the tiny changes, but the changes are happening. Darwin had evolution in right in front of him but did not see it. He could not believe he would ever observe evolution as it occurred because he believed evolution was a slow process. In 1855, four-fifths of the birds on his property died. If he would have been able to compare the dead birds to those that survived, he may have seen evolution at work. Peter Grant loves talking about variations in relation to evolution and this comes through in his lectures.

Darwin, the Grants, and others in the field of evolutionary science have theorized or demonstrated natural selection within evolution. They all wanted to know what leads to a new species.

Since Darwin, the field of science has debated back and forth as to the validity of Darwin's theory of natural selection. Many have tried to discredit it, while others have fought to preserve it. When the British Museum of Natural History unveiled a display about evolution, the debate heated up again.

The Grants are beginning to see evolution in process with the help of their hybrids. There are many variations of similar plants and animals all over the world; however, there are many places, such as the Galapagos that have plants and animals that cannot be found elsewhere. This uniqueness of the Galapagos has aided the study of evolution.

Darwin believed natural selection was a major factor in evolution, but not the only factor. Darwin's finches are often used to explain evolution and classification of species. The drawing of the thirteen beaks is used in many text books. Many believe the evolutionary process is almost complete, but the Grants know otherwise.

Darwin created many successful experiments to show how seeds could move from one place to another. The experiments also proved a seed could survive a fourteen-hundred-mile journey in the sea and sprout upon reaching land.

The Galapagos are at the beginning of evolution and are still forming new species. To Darwin, the first step to a new species is immigration and colonization. The Grants' belief is that changes in weather, such as that created by the El Niso, can carry seeds from other islands, and birds pick up the seeds and lay them elsewhere. This could explain why some of the Galapagos Islands have certain plants and trees in abundance and other islands have very few, if any, of these plants.

There are vagrant birds arriving at Daphne Major every year, and there are finches that leave. Sometimes this is caused by weather changes, food changes, or restlessness. However, these changes helped create the hybrids the Grants are now watching.

Part 2, Chapter 9 Analysis

One of the biggest debates in evolution is the arguments for and against natural selection. Natural selection has been discredited by many and validated by others. The Grants and others like them, have finally offered hard evidence that natural selection does occur. The finches have shown weather, changes in food, and other changes have mutated them as a species, and they are diverging, although not extremely quickly.

Part 2, Chapter 10

Part 2, Chapter 10 Summary

Darwin wondered if species kept isolated from other like species would change and adapt to new surroundings and create a new species. Darwin realized that competition between species can lead to changes and adaptations within each species to lessen the competition. Natural selection decides which species stay and which species go depending on many underlying factors. But the species that is more adaptable will always win out.

The Grants have watched this phenomenon to an extent with their finches, but since different birds visit the island, the Grants are waiting to see what happens next.

Lack believes competing species adapt to the environment differently, alleviating the competition. Robert Bowman studied the Galapagos, before the Grants, but after Lack. He studied what the birds ate by shooting them and looking at the contests of their stomachs. Each island has different plants, which leads to different adaptations. However, he could find no real competition among the species. Thus began the debate between people believing in the role of competition in natural selection and those who did not.

Peter Grant believes Lack may be right, but, without proof, he is not willing to admit it. However, the specialized eating patterns during the dry season show what Darwin concluded--that isolated species adapt differently and probably by competition. This specialization shows the divergence of each species.

The web of life is not as static as it was previously assumed. The Grants and others that watch life up close observe this web constantly changing. Dolph Schluster did his Ph.D. thesis on the competition between small beaks of other birds and small beaks of the finches of the Galapagos. The first island he visited showed that the territories of each species overlapped, but it was not important because the diets truly differ from one to another. Schluster went to several other islands to conduct the same study. His finding showed what Lack had theorized. The species adapts and changes due to the competition. This creates a divergence and a new species that, in turn, reduces competition.

Dolph saw the evolutionary landscape at work, while studying Darwin's finches. He had seen how the finches have worked their way up the slope to reach the peak. Dolph had created an analysis of the Grants data on beaks and seed as an evolutionary landscape.

In 1979, Dolph decided to try the evolutionary landscape model to prove Darwin's divergence theory. He created a hypothetical island on the computer and entered all the variables, such as types of seeds available, and the range of beak sizes to produce a

hypothetical outcome of the species of finch. His findings showed that three separate species would develop with unfit species lower on the evolutionary landscape. Therefore, a single species placed on this hypothetical island would diverge and change, creating three different species.

Dolph has studied nectar-drinking finches on the Galapagos Islands as well. On the islands that have no bees, nectar comprises twenty percent of the finch's diet. These finches are also smaller then those who do not drink nectar. On the islands with bees, Dolph found there is constant struggle to compete for the nectar, which causes the nectar to fulfill only five percent of the finch's diet. These finches are smaller, too, but they are being forced out of the niche by the bees, which are their only competition for the nectar.

Peter Grant believes divergence between species occurs on separate islands. When these separate species do meet, they are further separated by any competition between them. It is the "struggle for existence."

Part 2, Chapter 10 Analysis

The author gives an explanation of divergence of species. This is another debatable issue that is under constant scrutiny in the field of science. However, the reader knows from Dolph's studies that divergence does occur due to competition. The theory of divergence now has proof, although it is only proof of the divergence of finches.

Part 2, Chapter 11

Part 2, Chapter 11 Summary

Darwin did not believe hybrids created new species. It may have helped the process, but natural selection had already started. Even though he used the knowledge of many breeders for information for "The Origin," he did not think hybridization played a significant role in evolution.

Raymond Pearl, a geneticist from America believed as Darwin; however, after much research and discussion with breeders, Pearl ended up believing that hybridization played a more significant role in evolution than did natural selection.

The Grants have seen from their own research that not only is natural selection and hybridization equally important, but that they work together to cause evolutionary changes in races.

The Grants have seen two types of boundaries that affect Darwin's finches. One is the boundary of the island. The other is the boundary of the species. The species' boundaries are evident during the mating of the finches. Even when there are many species on the island, like tends to stay with like. There are a few hybrids that are doing well, but it is not the norm. By staying within their own species, they are giving the offspring a better chance of survival. Their offspring will have refined evolutionary characteristics that will help them survive.

The Grants have also discovered that each species of finch has its own mating song. The male finch will sing one of his species' songs, which he usually learns from his father. This attracts the female of the species and courtship begins. However, sometimes when the finch is small, he learns the wrong song. This means he calls to the female finches of another species. When this happens the male usually does not mate, but it is also the way hybridization occurs. Other strange things can happen as well. One example is when two female finches of separate species lay their eggs in the same nest. They eventually fight over all the eggs until one of the female's wins. Another example is of a male finch that had two nests at the same time, one with his mate of the same species and one with his mate of a separate species. It is not common, but it does happen.

Through experiments, the scientists found other interesting factors about how the species tells itself apart. One is the song, but only the males sing. The second is the males' visual inspection of the females' head, mainly the beak.

Darwin had briefly discussed sexual selection, but did not feel that it was as important as natural selection. However, studies of the finches in the Galapagos and the Hawaiian Drosophila, as well as several other studies, are proving that sexual selection is just as important in evolution as natural selection. It had been assumed that sexual selection

was a permanent force; however, it has become increasingly obvious that this force is as adaptable and changeable as each species itself.

When the Grants started watching the cactus finches of Genovesa, they saw long beaks and short beaks. This was the year after the drought of 1978. They thought they saw a space being created between these birds. However, over the years, these finches have drifted back and forth, splitting and merging. They are surrounded by other species of finches, and therefore, evolution, natural selection, and sexual selection keep them in check. Should one of the other species of finch not be on the island with them, the cactus finches may separate, but it is unknown for certain if that would happen.

Part 2, Chapter 11 Analysis

The author introduces the reader to the discovery of sexual selection. Like natural selection, sexual selection helps evolution change species and is very important. Through many studies, the Grants have seen what the ground finches and the cactus finches look for in a mate and how they call the mates to them. Each species is specialized, and any mutations are usually rejected. The reader now has a basic understanding of how sexual selection and natural selection work together within each species and the species' evolution.

Part 2, Chapter 12

Part 2, Chapter 12 Summary

Darwin could not conceptualize divergence happening quickly. He was certain it took thousands of generations to become noticeable. However, this has been proven false. As early as 1963, a study of South American fruit flies showed a change to a new species in only five years. Because these flies were not watched very carefully, the researchers do not know when the change occurred, or how long the change took to complete within that five years. Many hypothesize that the original species of flies became infected with a bacteria, which caused them to change, but it also suggests that this type of infection could affect any species currently alive in a similar way.

Adaptations are usually small variations in a species that create a new way of life and become more relevant the more the change occurs during the future generations. A study of crossbill finches proved this point. Even when the beak was cut and barely crossed, the birds could get to their specialized food sources. The more the beaks re-grew and crossed the easier the food was obtained, thus proving that adaptation usually occurs gradually. Maybe not over thousands of generations as Darwin thought, but it still took a little time.

Dolph Schluster decided to watch divergence at work, too. He found lakes in British Columbia that have two separate species of stickleback fish. He created several manmade ponds and stocked each. One lake had one of the species, while the other lake had the second species. He wanted to watch and see if they ended up evolving in similar ways. He also interbred the species to watch evolution. He figured it would take about ten years before he had enough data to get the information he was looking for in the study.

Part 2, Chapter 12 Analysis

The author is giving the reader more insight into adaptations among species and how these adaptations work toward evolution. The use of specialized species is making this type of study easier to undertake and watch. It has led to many surprising discoveries; more are probably coming in the future as more of these types of studies are being undertaken by evolutionary biologists.

Part 2, Chapter 13

Part 2, Chapter 13 Summary

Rosemary and Peter are cleaning up the data they have collected over the past twenty years to ensure it has all been entered correctly. They are feeling as if they are above the island watching the evolution of the finches come to life.

The Grants have discovered through their research that the plants on Daphne Major have changed drastically, which in turn is changing the finches. With the gradual disappearance of the cacti, the number of cactus finches is dropping very quickly. But since the super El Niso, the hybrids are flourishing, along with the medium ground finches. This shows that while the cactus finches are not adapting to the changes very well, the medium ground finches are adapting quite nicely. Of course, maybe the cactus finches are adapting, too, through interbreeding with the medium ground finches.

Another study with fruit flies shows that after only one generation, hybridization can create the needed characteristics for survival of both species. Even though the hybridization seems to be advantageous now, the Grants suspect it will not last much longer. They watched the disadvantaged hybrids for the first ten years and now they have watched the advantageous hybrids for the last ten years.

Peter Grant believes hybridization is like a pendulum, sometimes good and sometimes bad. However, there is never enough swing in either direction to keep the changes from happening or to create a new species. Hybridization mingles the genes of the species and can produce rapid evolutionary changes in both species. Hybridization among plants is a desired product. The Grants seem to think that the hybridizations of the finches may be necessary to keep the different species alive. It keeps the selected genes needed for the survival of each species and causes diversity.

Part 2, Chapter 13 Analysis

Hybridization is discussed in this chapter. The chapter gives more of an explanation about why it is so remarkable that the hybrid finches are actually surviving. The reader is told that the hybridization may be a necessity as a means for survival. However, the hybrids' future is unclear even to the Grants. While it is desired in plants, hybridization is not always advantageous among animals.

Part 2, Chapter 14

Part 2, Chapter 14 Summary

In Darwin's time and up until the Grants research, evolution was not truly considered a science because it had no means to prove any of its theories. The Grants project has helped to change that. Through twenty years of research, they have watched evolution swing back and forth. Even though hybridization affects so many species, evolution keeps the species separate. It seems that hybridization is just a mingling of the genes needed for survival.

There are many species that have adapted themselves to their environment, and many of these come from the same ancestors. This is living evolution.

The Grants are focusing on the possibility of their hybrids actually becoming a new lineage. They know the chances are slim, but they will need to keep watch, read, and measure more before they will have conclusive data.

Part 2, Chapter 14 Analysis

The reader knows that the Grants have helped to establish evolution as a true science because of the work they have done with the finches of the Galapagos Islands. It is also apparent that the Grants are hoping their hybrids will create a new species, so that they can see how the origin of a species starts. It is what they have wanted to know from the beginning.

Part 3, Chapter 15

Part 3, Chapter 15 Summary

Darwin had many questions but no answers. He knew blood was the key to explain variations. He also knew variations were the origin of evolution. He just had no way of getting the proof during his life time.

Peter Boag still works with the Grants and the finches, but he now does it from a laboratory. He takes blood samples from the finches and extracts the DNA, then gives the DNA to the Grants for their research. The DNA between ground finches and tree finches are different, but the DNA is forever changing. Boag and his post-graduate helper, Hans Gelter, have been working with the Grants' finch blood for years and hope to one day figure out which finch started the different species on the Galapagos.

DNA has an SOS response in times of stress to reevaluate and change itself to adapt to its new situation. This allows the species to adapt as well. The Grants believe something similar to this is happening on Daphne Major. The birds are creating new variations in their species by the interbreeding and the mingling of the genes. The Grants think it must be similar to the time when the birds first immigrated to the island millions of years ago.

Part 3, Chapter 15 Analysis

The author gives a quick lesson on DNA from the research Peter Boag has conducted on the blood of the finches. It becomes apparent that the species are not as separate as expected, but they are separate. The DNA of each type of finch, however, is ever changing and will continue changing and having more variations with the increased interbreeding since the flood of 1982.

Part 3, Chapter 16

Part 3, Chapter 16 Summary

Darwin took the innocence of the birds and animals of the Galapagos as proof that Lyell's second volume of "Principles of Geology" theories were true. Although the entire book was an argument against evolution, one theory in the book was that by introducing a new player to an area, everything would change. The example in the Lyell's book was the introduction of polar bears into Iceland. Darwin used his own example in his book, "The Origin" using cats introduced to a village. Each example lays out the possible outcomes of the introduction of a new species to each of the situations. For Darwin it was proof of the competition between species.

Hermon Carey Bumpus was teaching biology at Brown University in 1898, when he noticed this evolutionary invasion. English Sparrows had been introduced to the United States in 1851, and though a winter storm killed many of the sparrows around Brown University, Bumpus collected as many as he could. Most were still alive, but some did die. Bumpus made many measurements and came to believe that the dead sparrows were the group that had diverged too much from the original species in what is called "stabilizing selection." Peter Grant was so interested and excited by this report when he read it, he decided to reevaluate Bumpus' data. Peter Grant discovered two types of natural selection at work. This inspired him to take his first trip to the Galapagos.

The chain of events is available to watch in almost every sector of the planet because, due to travel by boats and planes, new animal and plant species are being accidentally introduced to new areas all the time. The University of Utah evolutionist Scott Carroll is helping to prove that the integration of new food sources is changing the soapberry bug across the south-central United States, from Arizona to Florida.

Darwin saw insects and plants changing all around him, especially when a new species of plant or animal was introduced to an area. His prime example was the insects that originally fed on the weeds and hedges on a farm. Some of these insects eventually changed to start feeding on the farmers' crops as well. He referred to this variation in "The Origin."

Benjamin Walsh was a graduate of Cambridge the same year as Darwin. He, too, discovered he preferred insects to the ministry and bought a farm in the United States. After many careers with some failures and successes, he returned to the study of the insects, mainly the haw fly. He predicted this insect would eventually infest the entire New World with the introduction of apple trees. He had seen some of these flies changing from living on hawthorns to living in apple trees with the apple flies. Walsh died shortly after he published his paper on the haw flies, but his prediction of the infestation was correct.

Speciation was originally thought to occur only in species that are completely isolated, but many evolutionists are now wondering if this is true. This is another area of contention in the field of evolution.

Jeffrey Feder is looking at the differences between haw flies and apple flies on a molecular level. The differences of these species are extremely small and have to do with the number of enzymes at work, rather then the types of enzymes. He believes he is seeing one of the very first stages of the divergence of two species. When Feder introduced apple flies to the similar blueberry flies in a laboratory setting, the two species mated and produced viable offspring. However, when he looked at them on the molecular level, the genes of each were distinct and separate. This meant they would almost never interbreed in the wild, no matter how close in proximity to one another. This is happening all over the world within many species at this moment.

Part 3, Chapter 16 Analysis

The reader is now introduced to another factor in evolution, the invasion of another animal or plant species into an already ecologically sound area. This integration would cause the fluctuation of the entire system and a stabilizing shift to occur. It is shown in this chapter through the use of current studies of insects that are changing to coincide with new plants. It is also suggested in the animal world through the use of the cat and polar bear experiments. The reader can now assume that with the amount of travel done each day, new species are being accidentally sent all over the world at an incredible rate, changing the ecological systems where ever these new species land.

Part 3, Chapter 17

Part 3, Chapter 17 Summary

Several of the islands of the Galapagos have been inhabited by people. They have cleared pastures for their animals and planted gardens and orchards. It has had an interesting effect on the finches. The finches have quickly adapted to the changes and have learned to live with the people of these islands.

One librarian of the Charles Darwin Research Station admits to feeding the birds rice at work and home. Some have even flown into her home for food and medical attention. Another inhabitant living away from the station may not be abiding by the laws protecting the finches. The finches eat crops and destroy gardens. One person admitted to killing the finches that were in her garden and making finch soup. No one is truly sure what is happening away from the station, but this woman's actions are probably the norm.

The influx of humans, their plants and animals have not been researched by the Grants, but they have seen strange changes to the finches living in proximity to human inhabitants. The Grants believe that close proximity to humans have begun to merge the different species, mainly because there is not real need to specialize with the abundance of food and water now available with the influx of people to these islands.

A botanist by the name of Edgar Anderson "coined the term introgressive hybridization." This was what he called the regressing of hybrids with the one or both of the parent species lineages. He believed that humans are helping to increase the number of hybrids in all facets of plants and animals. He explains that the changes may not be noticeable in the first generation of the hybrids, but in following generations, the gap will become bigger, and the differences more noticeable. These hybrids will also need a new habitat, which is usually the reason for the hybridization. He believes this chaos has happened many times before with the emergence of animals into the realm of plants, with the herbivores, with large land mammals, and with human. However, humans may be making evolution work more rapidly than any other group because of the speed at which humans travel and change their home surrounding with plants and animals they have gathered on their travels.

On the island of Floreana in the Galapagos, Darwin saw huge finches, larger than any other finch at the time. However, in three short years the giant finches were gone. The only change was the creation of a prison colony on the island. It had been established before Darwin reached the island. When he arrived, there were over two hundred prisoners, who had cleared land, and hunted wild game, including finches. The prisoner also brought animals that were not indigenous to the island. These new animals hunted the large finches as well. Another factor is that the probable main food supply, a large cactus, went extinct, which lead to a possible food shortage for the large finches. When the prisoners were taken off the island, they left their animals. These wild animals killed

the last of the cacti. With the cacti gone, the large finches had little food, and the mockingbirds of the islands had no where to next. Both species are now extinct.

Today, the Charles Darwin Research Station is trying hard to keep the species of the island from going extinct. Peter and Rosemary Grant are doing the same on the islands where they go to study. They wash and clean everything before stepping foot on the island to ensure that nothing has tagged along for a ride. They want to keep the islands as they are and do not want to be blamed for a destructive force they might have brought by accident. That is why they are very careful and have even brought along bug spray in case anything gets by their cleaning.

Many of the natural animals and birds of the Hawaiian Islands are now extinct due to the influx of people and animals. In fact, the United States tried to save a bird on an island not far from the Hawaiian island. They reintroduced the birds to two small island reefs in Hawaii to save it. What has happened in the twenty years the birds have been there has been studied by Sheila Conant. The birds's beak size has changed to accommodate to the new environment, in which they were place. This happens all the time as wild-life conservationists try to help endangered species by moving them. The species change to adapt to the new environment and are not longer truly the same species as the originals animals.

Part 3, Chapter 17 Analysis

The author is showing the reader how humans have changed the natural course of evolution all over the world. Even conservationists, who try to help endangered animals, change the species by moving them from their natural habitat. The reader understands that the Grants and others like them work hard to keep their study area clean of new animals and plants. The introduction of new life forms would disrupt their studies and the natural evolution of the animals and plants on the islands. Any disruption that is not natural would skew or destroy their study and its validity.

Part 3, Chapter 18

Part 3, Chapter 18 Summary

A post-doctorate student, Martin Taylor is working with gray moths to find out how they continually change to become resistant to pesticides. The pesticide industry has produced hundred of chemicals to kill insects since the 1950s, and continually has to reevaluate because the insects build a resistant in only a few generations. Martin thinks the pesticide companies need to look at evolution when they are preparing their insecticides, but in the bible belt of the United States which is anti-evolution, this is not an option. However, evolution is what is happening and should be looked into, which is exactly what Martin is doing for the pesticide companies.

Physicians and medical researchers are having the same type of problems with antibiotics. Each disease is resisting the new antibiotics as fast as the antibiotics are being created. Many studies of E.coli have shown that even if the majority of the bacteria are destroyed, one or two cells that are left can re-infect a person very quickly and will not respond to antibiotics. AIDS is also being studied, but it is not only resistant to antibiotics, it changes without any stimulus. "The weapon of the virus is variation itself."

Influenza evolves rapidly as well, and strains from animals can mix with strains from humans. Researchers are watching carefully because if Darwin's theory holds true, then there is no reason why the influenza virus and the AIDS virus cannot hybridize and create a new plague for the planet that is virtually incurable.

When humans and predators aim at a species, the species retaliates, whether it is bacteria, elephants, guppies, or any other animal. These unnatural selections cause the species to change their evolutionary progress to coincide with the requirements of their environment. Examples are the effects of poachers on elephants in Africa. The heavily poached areas are seeing more and more elephants without tusks. The fishing industry is seeing more and more small fish. These are just two examples of how human intervention can change a species.

The moths are changing faster than Martin can keep up with them, and the yield in crops is still similar to medieval Europe, with farmers loosing around 7% of their crops. However, these pests are not likely to give in and will overtake the crops if not kept in check. New pesticides that are not researched correctly will be of little use. Just as doctors are prescribing antibiotics less and less often to their patients because of the resistance to the medicine, the overuse of these chemicals needs changed because they are the cause for the increase in pests and diseases.

Part 3, Chapter 18 Analysis

The reader is given the factor of resistance in this chapter. Resistance as an evolutionary factor is not considered by many people who have to deal with the effects of resistance on a daily basis. They do not tend to look at it as evolution, but that is exactly what it is, and it works just like the evolutionary adaptations of the finches of Daphne Major. The bacteria and animals change in response to man-made changes in their environment and will continue to change, until someone focuses on the evolution of these species rather than just the resistance.

Part 3, Chapter 19

Part 3, Chapter 19 Summary

Global changes are likely to change the finches of the Galapagos, global warming being the main culprit. However, all the toxins that are being, and have been, released into the atmosphere have also rapidly increased the evolutionary path of the world and its species.

During the industrial age, with smoke stacks filling the areas around them with black soot, animals in the vicinity changed, too. With the advent of environmental laws, the evolution reversed itself. It is seen all over the world.

In the Galapagos, where El Niso is effected by global warming, the finches could fuse together into a single species. Unless the reversal changes are dramatic, they may fuse beyond the chance for rapid reversal, and their divergence could take thousands of years. The Grants had never thought about the changes in the climate affecting their finches, but in the last two years, they have watched it in action. With new information about global warming, they have to include this factor into their research.

Others are working with the genes of plants and animals to help evolution along in the growing changes of the world. These researchers may eventually be able to change humans if they are allowed. They have already manufactured two new genes and a mouse in a laboratory setting. Their research is interesting, but it is also changing the natural evolution of the world.

Every facet of life for every species is being changed because of the technology of the human race. There have only been a few times in history that chaos overtook the planet on a similar scale as the chaos the human race is causing. The world is changing, and evolutionists are watching and hoping the past will give them insight into the future of the planet.

Part 3, Chapter 19 Analysis

The author pulls all the information together regarding evolution. He pulls all the factors together and shows that it has been human intervention in just about every area of the world that has caused much of the evolution that has taken place in the last hundred or so years. It is also the humans that will be the cause of the next major upheaval of the planet and evolutionary change. This chapter puts many issues into perspective and shows why the study of evolution is important for the survival of our species and all the species of the world.

Part 3, Chapter 20

Part 3, Chapter 20 Summary

Humans are different from every other species because of our consciousness. However, many evolutionists assume that humans are not the only species with self-awareness. The difference is the degree of self-awareness that humans have at their disposal.

Many other species learn from their elders, who learned from their elders, and so on. They make tools and have their own speech. Humans do the same. Humans have written history from which to learn, as well as teachers, professors, parents, family, friends, and society from which they learn. Humans make tools and have speech. The degree of self-awareness seems to be the major factor that has allowed the human race to take over the world. The fact that humans have all these advantages allows them to adapt at a faster rate by learning from history more than any other species in the world.

Darwin wrote to a botanist friend that the variations of species only vary by degree, and not by other factors. The botanists wrote back that it was not as easily measured in plants. Darwin agreed from his own research that he was unable to show the various degrees in plants. However, in animals this is not a problem.

Within society, the human species specializes from the earliest of times. Each person learned a skill or trade and then collectively worked together. Humans seek the tasks for which they feel are the best fit for them. Without these urges, everyone would possibly be doing the same thing, and there would be no diversity within the human race, and extinction would follow. This led to the divergence of skills and the ability of the human race to survive.

The cactus finches of Daphne Major and Genovesa have shown that sometimes individual birds will act defiantly at risk to the entire species. However, these deviants are not punished in any way and have just as much chance of survival as the rest. Humans can act this way too. Sometimes an individual or community will act in such a way as to harm others in the species, putting the human species at risk, but humans, so far, have always found a way to survive. Humans still ask the same questions of hundreds of years ago, but use technology to answer those questions on a higher level than before; this may ensure the survival of the human species.

Part 3, Chapter 20 Analysis

The author gives humanity hope in the form of the evolutionists and other researchers. These people ask the questions that are needed to continue the survival of the human species even when some of the species does not act in its own best interest. It is through the adaptations brought about by molecular, biological, medical, and evolutional research that humanity will continue to prosper.

Epilogue

Epilogue Summary

As of 1993, the Grants had been watching the finches for twenty-one years and had three years of El Niso on the island, whether the meteorologists thought of them as such or not. The island of Daphne Major had more flora on it than ever before, and finches that were ten to fifteen years old were still breeding.

Darwin's finches were among the first species to land on the Galapagos Islands, which is one reason so many different species of the finch can be found. Those who have had invasions of competing species have changed and re-specialized to continue to survive or have become extinct.

Even islands that had once been above the water are now found around and between the Galapagos, and the mainland puts new light on how the finches may have traveled to the islands. It is a new factor in what may have helped the finches to evolve into the forms that are found on each island.

All the studies that are being conducted are showing evolution at work through natural selection, sexual selection, climate, human interventions, and many other factors. The only thing that is constant in evolution is that evolution will continue to occur.

Epilogue Analysis

Even with all the studies, no one knows the outcome of evolution, and probably never will in the current age of technology. The author tells the reader that it takes years to get any worthwhile data before predictions can be made. However, these predictions can be changed if even one of the factors changes even slightly. The reader now understands that evolution is always changing the species and the world itself. Nothing is static, except the theory that everything changes to try to survive.

Characters

Peter Grant

Rosemary Grant

Charles Darwin

Karl von Linne

Carolus Linnaeus

Peter Boag

Laurene Ratcliffe

Trevor Price

John Endler

Lisle Gibbs

Jamie Smith

Dolph Schluster

Philip Gingerich

J.B.S. Haldane

Hermon Carey Bumpus

Edgar Anderson

Objects/Places

Princeton

This is a university in New Jersey, where the Grants work when they are not on their islands in the Galapagos.

Galapagos Islands

This is a group of islands on the eastern side of central and northern South America. These are the islands where Charles Darwin found the finches and began his career in evolution.

Daphne Major

Daphne Major is an island in the Galapagos where the Grants watch ground finches and cactus finches.

Genovesa

Genovesa is an island in the Galapagos where Rosemary Grant watches cactus finches

Pinta

Pinta is an island in the Galapagos where Dolph Schluster studied competition in feeding patterns of finches.

Los Hermanos

Los Hermanos is an island in the Galapagos where Dolph Schluster studied competition in feeding patterns of finches.

Santa Cruz

Santa Cruz is the island of the Galapagos that is home to the Charles Darwin Research Center. It is also one of the islands where Dolph Schluster studied competition in feeding patterns of finches.

Espanola

Espanola is an island in the Galapagos where Dolph Schluster studied competition in feeding patterns of finches.

Down House

Charles Darwin's home in Kent, England is the Down House. This is the farm where the majority of his experiments and research took place and led to his writing the "Origin of Species" and "Descent of Man."

S. S. Beagle

The ship Charles Darwin used to travel for five years around South America was the *SS Beagle*. This ship took him to the Galapagos Islands and the finches.

Charles Darwin Research Center

It is located on Santa Cruz. Its main function is the research and preservation of the species of animals only found in the Galapagos.

Themes

Creation versus Evolution

This argument has been around since the beginning of the thoughts of man being created by another method other than God. Christianity has spent hundreds of years trying to convince people to believe in the creation story through doctrine and sometimes by force. This argument was present in the ideas of many learned persons when the theories associated with Lack and Darwin started to be given to the public.

The church had spent years trying to quiet this new belief in the creation of man. The Church did not want the public to be given the information because they feared it would change people's beliefs and pull them away from the Church.

However, during this time, many learned people were pulling away from the church without knowing about or believing in evolution. They based their changed beliefs on philosophy. When evolution began to gain popular ground, this gave them more ideas and beliefs in which to philosophize. In many ways, evolution did not discredit God--it showed how God made plants and animals that adapted to their new environments. This is how Charles Darwin viewed the theory.

Darwin was a Christian man and had studied to be a minister, however, his interest in naturalism overcame his call to the ministry, and he followed the career of a naturalist. Darwin did not see evolution as refuting God. He believed God gave the species of the earth the ability to vary from the original, but he did not believe they were separate species. They were all still the same species, with variations.

Evolution had a hard time proving itself as a true field of science for many years. There were many theories and ideas, but no proof to validate these theories and ideas. Scientists in other fields wanted the proof, but evolution was not about proof, until the Grants came along. They have proven evolution with numbers and have gained legitimacy for their field of science. In fact, there are geneticists and evolutionary biologists trying to understand how the species change to better understand the world at large. They do not discredit God or discuss God at all. They just feel that people have to be aware that species change, sometimes for better and sometime for worse.

History versus Present

Looking at history, evolution is seen to take hundreds of thousands of years and sometimes even millions of years. During Darwin's time, and until fairly recently, this was the prevalent belief. When scientists of hundred years ago said evolution happened faster than Darwin and his peers believed, they were not taken seriously. Everyone was sure you could not watch evolution in action. It was just not possible. Darwin even thought about invisible factors in the body that would explain the variations. But that, too, was impossible to prove in his time.

However, people like Peter and Rosemary Grant, Dolph Schluster, Peter Boag, and many others are doing what many thought was impossible. They are watching evolution. They have gained an understanding of natural selection, sexual selection, environmental changes, and even the songs, and the DNA of each species. They are learning how these factors help to change the species. This process has taken twenty years. The researchers will tell you that although changes do not take hundreds of thousands of years, it still takes fifteen to twenty years to get data that is accurate and that offers actual proof that natural selection is happening, and, therefore, evolution is happening. It is these changes that when combined in a species creates a new species through evolution.

Natural v. Laboratory Environment

With any field of science, it is best to find the proof in nature rather than in a laboratory, but many people did not believe they could watch evolution any where but a laboratory with human intervention causing the changes. The thought was that humans could bring about changes in the laboratory that would be accelerated from those conditions in the wild. Although this does work, it does not prove anything would happen in the natural setting without the intervention of humans.

Peter and Rosemary Grant are helping to change this. They take special precautions during their trips to ensure they do not bring along non-native species to the islands where their research takes place. They wash everything to keep off the insects, spiders, and seeds. They want to watch the finches in their natural setting with absolutely bare minimal human involvement. The only time they touch birds are to band them and take measurements. Even during droughts, they do not feed the birds. They have spent twenty years watching the birds flourish during good times and die during bad. But the information they are obtaining will be proof that natural selection does take place in the wild, just as it does in laboratories.

Others are creating man-made environments that are equivalent to the natural environment of the species. Here they can conduct experiments in a laboratory setting, but also have a control setting that simulates the natural setting. They are learning to create nature and study it within limitations. Of course, some of their experiments include human interventions, but there are always some settings where they just watch and learn without much interaction.

Style

Point of View

There are actually two points of view in this comparative narrative. It is a narrative in that it tells the readers facts about the subject. How it differs is that it is partly historical and partly interviews.

The first point of view is historical and focuses on the actions, beliefs, and experiments of Darwin and his contemporaries in the field of evolution. It explains how he started research on natural selection with the ending of a five-year journey along the coast of South America. It gives the reader insight into how Darwin reached his conclusions that ended up in his books, "Origin of Species" and "Descent of Man."

The other point of view is the interviews and explanations of data that Peter and Rosemary Grant gathered during their twenty-year vigil watching the finches of Galapagos Islands. The Grants talk to the author about how they got started on what is their life's work. The author also talks to those people who have been associated with the team in different capacities, the majority of them starting as graduate students who spent a few seasons on the islands with the Grants.

By using the mixture of history and present-day information, the author has closed the gap between the two. He has explained how the theories started and how they are being proven in the modern world.

Setting

The setting is the present day, with flashbacks to the past. The story of the Grants' twenty years of research is at the heart of this tale. It is through their research that the author can bring the theories and experiments of Charles Darwin to the surface. The Grants watch the finches of the Galapagos Islands looking for proof of evolution through natural selection, sexual selection and environmental changes. They use information from Darwin's time through the present to gain insight and information for their research. Although the setting is in the latter part of the twentieth century at Princeton University, it is also set on the Galapagos Islands of Daphne Major, and Genovesa, and at Down House, in Kent England. All three places are important to this story and to the theories of evolution.

Language and Meaning

Jonathan Weiner uses language that is powerful and full of facts, but is easy enough for a lay person with no scientific background to read and understand. He explains why certain measurements and procedures are done and how they are done, if it is something the normal person outside the field of science would not necessarily

understand. He goes to great length to ensure the information is communicated in plain English but is also correct in its general and scientific meaning. He pulls both sectors together in this book to create an enjoyable tale with information that will have the reader thinking over even after they have finished reading the book. It answers many questions, but even the Grants do not know what will happen in the future of the finches. The author expands this to a point and allows the reader's mind to make assumptions, ask more questions and search for more answers.

Structure

The Beak of the Finch is divided into three parts and an epilogue. They all fit together smoothly and the readers would be lost if they skip even one chapter. The chapters flow together building on the information that had been given in previous chapters to help the reader understand the findings and the predictions of the future that are presented at the end of the book.

Part one starts with the Grants, but only uses them to understand how Darwin became known as an evolutionist. It gives Darwin's background, his interests and how he discovered the finches of the Galapagos Islands, but thought they were insignificant and never used the findings for anything other than personal observation.

Part two focuses on how the theories of Darwin are being proven and seen in the research of the Grants. They are watching finches on two of the Galapagos Islands and have seen natural selection at work on both. It has been a wonderful and incredible discovery.

Part Three and the Epilogue focus on current discoveries and the future of the finches, showing the changes in science that can accelerate or change evolution. The findings have shown natural selection to act as a pendulum until changes are made either for good, or until they start moving back toward the original side. The future of the finches is up in the air. The changes in the environment of the world, such as global warming, could change or cause the extinction of the species of finches. This has been seen to have already started in areas of the Galapagos that are inhabited by humans, but other factors are now showing up and are likely to take these birds in a new direction.

Quotes

"These islands meant more to him than any other stop in his five-year voyage around the world." Part 1, Chapter 1, page 4

"The 'Origin of Species' says very little about the origin of species." Part 1, Chapter 1, page 6

"With the conditions of life on this planet changing everywhere faster and faster, the pressures of natural selection are everywhere increasing in intensity, daily and hourly, even on islands as remote as the Galapagos." Part 1, Chapter 1, page 16

"This was the verdict that Darwin had conjectured 'would undermine the stability of Species.'" Part 1, Chapter 2, page 28

"The great power of this principle of selection is not hypothetical." Part 1, Chapter 2, page 30

"Stated briefly, the argument is as follows: selection has plainly worked in domesticated races, analogous results and appropriate processes and conditions are found in nature, therefore we may assume that selection works in nature." Part 1, Chapter 2, page 35

"Variations are the cornerstone of natural selection, the beginning of the beginning of evolution." Part 1, Chapter 3, page 37

"'Thus,' Darwin says in the *Origin* 'extinction and natural selection go hand in hand.'" Part 1, Chapter 3, page 40

"'The smallest grain in the balance' can decide who shall live and who shall die." Part 1, Chapter 4, page 64

"And what made the difference between life and death was often 'the slightest variation,' an imperceptible difference in the size of the beak, just as Darwin's theory predicts." Part 1, Chapter 5, Page 78

"The closer you look, the more turbulent and dangerous the action; the farther your removed, the more the living world seems fixed and stable, hardly moving at all." Part 1, Chapter 7, page 111

"Watching natural selection in action is one way to get beyond the debates and abstractions that have wrapped this subject in a century and a half of philosophical fog." Part 2, Chapter 9, page 131

"Natural selection organizes life." Part 2, Chapter 10, page 143

"Behavior is the product of forces, contending forces that are still contending today, struggling within each generation." Part 2, Chapter 11, page 170

"In other words, the origin of a species can live in the kinds of small, subjective decisions and revisions that in our species come under the heading of romance." Part 2, Chapter 11, page 171

"Like Belshazzar, king of Babylon, who saw the writing on the wall, Darwin knew the characters in the blood would turn out to be of the utmost significance. But Darwin could not see the writing himself, and he had no Daniel to read it for him." Part 3, Chapter 15, page 214

"A 'web of complex relations' binds all of the living things in any region, Darwin writes. Adding or subtracting even a single species causes waves of change that race through the web, 'onwards in ever-increasing circles of complexity.'" Part 3, Chapter 16, page 225

"The second generation will be made up of individuals each of which will require its own peculiar habitat for optimum development." Part 3, Chapter 17, page 241

"You don't find situations that chaotic under natural condition, but you do find them in the havoc that human beings bring in their train." Part 3, Chapter 17, page 242

Topics for Discussion

Explain how Darwin viewed the finches of the Galapagos when he first found them? Why did he feel this way?

Explain why Darwin preferred to use the experiments with the pigeons of Down House instead of the Galapagos Finches in his book "Origins of the Species?"

On what premise did Peter Boag base his desire to conduct an egg switch experiment on Daphne Major? What did he hope to prove?

What happened on Daphne Major after the drought of 1977? How was natural selection being put to use?

Explain the experiment of Dolph Schluster and the stickleback fish? What is he trying to prove or disprove?

How are the songs of the finches different and how does this affect their lives?

Explained what happened on Daphne Major after the flood of 1983, and how natural selection was at work.

The Grants have discovered that hybrids are thriving on Daphne Major, explain why.

The Grants have many concerns for their finches, but the El Niso is one of the issues at the top of the list. Why?

Explain Generation of Diversity and what the researchers are trying to do.