THE BEAK OF THE FINCH

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In January 1991 Peter and Rosemary Grant were sitting on stones, a few steps from their finch traps on the uninhabited island, Daphne Major in the Galapagos archipelago. The Grants and a long line of assistants had kept coming back over twenty years, representing about twenty generations of finches. Each finch that they captured in their traps had detailed measurements and was banded. It was Darwin's finches whose beaks inspired his first veiled hints about his revolutionary theory. The work of the Grants is the best demonstration to date of the power of Darwin's process.

The island, Daphne Major, is described as feeling like the solar face of Mercury. The black lava gets hot enough to fry an egg and a jerry-can of water left out in the sun at noon would come near to a boil. When they returned to Princeton, sophisticated instruments analyzed the data that they had collected, proving evidence for evolution.

There are thirteen species of finches in the Galapagos and each species has a beak to go with it. In 1935 an ornithologist by the name of Peter Lowe had declared his belief that the birds were not a separate species but what he called "hybrid swarms", and that their beaks offered no scope for observing Natural Selection. That became, for Peter Grant, a wonderful way of stimulating people to go out and disprove him.

Their first trip to the Galapagos was in 1973. The birds turned out to be easy to catch and iheir beak measurements were meticulous using a specially made caliper.

During their first field season also they staked out eight sites of twenty three thousand square meters using red flags tied to trees. Each morning they surveyed the sites with binoculars to record what the finches ate. They found that they concentrated on about two dozen kinds of seeds and they then measured the seeds as carefully as they measured beaks. Using a special nutcracker with an attached scale they used a measuring unit known as a Newton. A grass seed needed less than ten Newtons to crack it. A big cactus seed the size of a peppercorn took 50 Newtons. Cracking the toughest seeds required 250 Newtons, a force that would be capable of lifting more than a thousand finches into the air.

The Grant team had visited the island in the wet season and they thought that the dry season would be the time to watch life squeeze Darwin's finches. So they returned a few months later and recaptured many of the birds they had caught previously. The volume of finch food was down by 84 percent and the birds had become specialists, set by the shape of the beak. Finches were locked in the most deadly competition, depending on their ability to crack seeds. Between a beak big enough to crack the seed called *caltrop* and a beak that could not, the difference in size was only half a millimeter. Darwin had written "what a trifling difference must determine which shall survive and which perish." After a good part of a lifetime on Daphne Major, the Grants found it obvious.

Darwin argued that favorable variation would be more likely to be passed down. Boag, a member of the team, found that the beak of the finch is passed down faithfully from one generation to another. In the fifth year of the study there was a severe drought. Afterwards they found fewer than 200 finches alive on the island. They measured the survivors and the mummified carcasses of the dead that they found lying on the larva. The total mass of seeds had gone down while the average size and hardness increased. The surviving fortis finches were 5 to 6 percent larger than the dead. The average beak size of the new generation of fortis finches was 4-5% deeper than the beak of their ancestors before the drought.

For example, in 1976 the average beak depth of the juvenile fortis was 9 mm. Six months later the average beak depth of the same cohort of birds had decreased to 8.73 mm. The smaller birds with shallower beaks were surviving while the bigger birds with deeper beaks were not. The smaller beaks were able to peck and hunt only small soft seeds. Beak shape and strength made all the difference. They had seen natural selection in action After that, the Grants had to keep watching.

After the drought, during which females survived better than males. Because of a skewed sex ratio, the females chose only the largest males with the largest beaks, so the process of sexual selection worked in the same direction as natural selection and magnified it. Males all over the island languished without a mate.

In 1983 Daphne Major was saturated with heavy rain and the birds went crazy. Females produced as many as forty eggs and fledged twenty five chicks. By June the total mass of seeds was a dozen times greater than the previous year. It was too wet for cactus so the big seed crop crashed while the small seeds flourished. After the rains stopped, the number of finches was astonishing and for the first year or two there were still small seeds to support the population boom. But the finches had overshot the seed supply and their populations crashed. Big birds with big beaks were dying, while small birds with small beaks were flourishing. With far more small seeds the large finches had trouble finding large seeds. They had tools for large seeds and being big birds they had to eat many more small seeds to stay alive.

Let us now pause and look at the book by Michael Behe entitled “Darwin’s Black Box”. The best known experiment that supports Darwin’s theory t still does not explain the origin of life. Behe asks---can Darwin explain life’s foundation? Highly sophisticated molecular machines control every cellular process. Thus the details of life are finely calibrated and enormously complex. The complexity has paralyzed science’s attempt to account for it. With the invention of the electron microscope, new subcellular structures were discovered.

Biochemistry is the study of the molecules that make up cells and tissues. Highly sophisticated molecular machines control every cellular process and are enormously complex. Behe examines several of these molecular machines and asks whether they can be explained by random mutation/natural selection. Thus the primary question is, what is the origin of the cell? The same cell that looked so simple under a light microscope looked much different under the electron microscope. Darwin reasoned that gradually increasing complexity of the eye could be attained by natural selection. Asking the question of the eye’s ultimate origin, Behe considers the mechanism of the eye function as it is now known and covers five paragraphs to give a biochemical sketch of its operation. Each cellular function in the body must include its infinitely complex explanation. It is no longer enough for an evolutionary explanation to consider only anatomical structure hus, biochemistry offers a Lilliputian challenge to Darwin. Now the black box of the cell has been opened and the infinitesimal world that

stands revealed must be explained. In mid 20th century a series of interdisciplinary scientific meetings led to a coherent theory of evolution called "neo-Darwinism," the basis of evolutionary thought. The beginnings of biochemistry came only after neo-Darwinism had been launched. For the Darwinian theory to be true, It has to account for the molecular structure of life. The purpose of Behe's book was to show that it does not.

Leaves evolved 1.6 billion years ago when one cell, incapable of using the sun's energy, engulfed another cell—a cyanobacterium—that could. That cyanobacterium became the ancestor of every living chloroplast. If there is magic in the world, surely this is it: the descendents of tiny creatures in leaves, capable of ingesting the sun".

In what has come to be called the "Cambrian Explosion", careful searches show only a smattering of multicellular creatures in rocks older than 600 million years. But in rocks just a little bit younger is seen a profusion of fossilized animals with a host of widely different body plans. The estimated time over which this "explosion" took place is 50 to 10 million years, demanding a mechanism other than natural selection. It is not that Darwin was wrong, but that he got hold of only part of the truth. At the tiniest level of biology we have discovered a complex world that radically changes the grounds on which Darwinian debates must be connected.

Behe provides a fascinating example of biochemistry in the Bombardier Beetle. This beetle, only half an inch in length, squirts a boiling hot solution at its enemy using a concentrated mixture of hydrogen peroxide and hydroquinone Behe describes the complex details that indicate irreducible complexity.

The slightest alteration in the chemical balance would result immediately in a race of exploded beetles. Dawkins, an avid supporter of Darwin, points out that hydrogen peroxide and quinones are used for other purposes in body chemistry. "The beetle" he says simply pressed them into different service.

Darwin said "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous successive slight modifications, my theory would absolutely break down." Behe provides numerous examples of "irreducible complexity" defined as a single system composed of a number of well matched interacting parts that contribute to the basic function, wherein the removal of any one of these parts causes the system effectively to cease its function. As a model he uses a mouse trap in which every component is essential. If any one of the chemicals in those systems is missing, the whole system comes to a grinding halt.

Our cells need the energy currency known as ATP, derived from synthesis of AMP. Behe tells us that the construction of AMP takes 13 steps involving enormous complexity. He adds that "if we dissolved all these molecules in water and let them sit in a flask for, say a million years, no AMP would form because of the absence of the necessary enzymes."

AMP is required for life. The cell has no choice. Either it has an immediate way to produce it, obtain it, or it dies. It is difficult to believe that the intermediates could be obtained from the primordial soup. Complex chemical reactions are required and some of the intermediates in AMP synthesis are unstable and would quickly fall apart. Advances in biochemistry discourage the hypothesis that substance A to B to C to D could be perceived on neo-Darwinian reasoning. The root question remains unanswered----what has caused complex systems to form?

Behe addresses the subject of “intelligent design” first asking how we can detect evidence of design. It is mindful of the parable of the blind men and the elephant that illustrates the problem of detecting the big picture. Life on Earth is the product of intelligent activity, flowing from the data itself, not from sacred books or beliefs. The conclusion can be made independent of knowledge of the designer. Jesus actually claimed to be God. He was therefore “Lord, liar or lunatic” and was killed for what was seen as blasphemy, the normal Jewish punishment for blasphemy at that time.

Behe leaves the question of the designer relatively untouched. Darwin wrote “If anything is designed, certainly man must be. One’s inner consciousness (although a false guide) tells one so”. I feel most deeply that the subject is too profound for the human intellect. A dog might as well speculate on the mind of Newton. Let each man hope and believe what he can”.

Behe ends by saying “The result of these cumulative efforts to investigate the cell----to investigate life at the molecular level- is a loud, clear, piercing cry of ‘*design!*” The result is so unambiguous and so significant that it must be ranked as one of the greatest achievements in the history of science.