The Making of the Fittest: DNA and the Ultimate Forensic Record of Evolution

By Sean B. Carrol

Book Project

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Carrol put together a group of fascinating scientific stories that show us how DNA is "the ultimate record of evolution" (p.14) and how genomics increased the knowledge of the evolution of life. He brought to our attention that the changes that took place for organisms to adapt to the changing environments are coded in the DNA. He also talked about fossil genes – bits of DNA that once had a purpose in the life of the organism and that have stopped having a purpose during evolution. I find interesting that the author stated that evolution can and does repeats itself and that the outcomes would be the same.

Chapter 1: The Bloodless Fish of Bouvet Island

No, there is no bloodless fish on that island, but that is what the first biologist who discovered it called in 1928. After further examination, he observed that the fish had colorless blood. Forty years later someone else took over this discovery and showed the reason for this **anomaly**: no red blood cells in this species of cold water fish. The "where, when, and how" answer to the evolution of this kind of fish was found in its DNA. Two genes that were coding for the globin part of hemoglobin have gone extinct. (p.23). Over the last 55 million years, the temperature of the ocean where this fish is found has dropped from 68 degrees F to 30 degrees and the fish either gone extinct either adapted to the low temperatures by changing the blood composition. By reducing the number of circulating cells per volume, the viscosity is decreased, and so the blood circulation is still able to happen, instead of completely freeze. Another **anomaly** that helped this species survive is the "antifreeze: proteins. This story is also a good example of how **empirical** information stayed at the basis of a very interesting discovery.

Chapter 2: The Everyday Math of Evolution: Chance, Selection, and Time

This chapter brings to our attention big contributors to evolution and genetic inheritance (Darwin, Mendel, Punnett) and reminds us that evolution took place over "immense" amount of time (15-20 million years). It also talks about mutations and two (false) myths that are surrounding them: 1. All mutations are bad. 2. If mutations are random than the process cannot be accountable for the complexity and order that we see in living things (p.57).

Chapter 3: Immortal Genes: Running in Places for Eons

At the beginning of this chapter, we have an example of **tentative**: microbiologist Tom Brock and his student Hudson Freeze discovered in 1966 around the geysers and hot springs from Yellowstone National Park an organism that they classified as a thermophilic bacterium. A year later they discovered what they thought it is a bacterium that lives in even higher temperatures, of boiling water. The study of this hyperthermophiles led to the realization that those organisms, though similar to the bacteria, belong to a completely different domain: Archaea. Brock also discovered a heat stable enzyme that could copy DNA at high temperatures, which lead to a fast technique for the study of genes in any species (p.70) that led to a multi-hundred-million-dollar market in DNA diagnostics and forensics. Last but not the least, Brock's discovery of Archaea let to the study of the Archaean genome that showed evidence those organisms were one of our original genetic parents.

Chapter 4: Making the New from the Old

The author brings to us the story of the colobus monkey from Uganda and with it a **justification** of the evolutionary process: natural selection, sexual selection, and descent of species with modification. Colobus monkey is missing thumbs, but worry not, that is compensated by its trichromatic vision, unusual in most mammals, that will allow this monkey to see the light green leaves that are young and most nutritious and easier to digest. Another example is one of the birds that possess an ultraviolet vision that allows them to see the color that we don't. This ability is the result of a mutation that evolved over time bird's light receptors. This change allowed them to mate and continue genetic variation, as an adaptation to the environment.

Chapter 5: Fossil Genes: Broken Pieces of Yesterday's Life

Because what would science be without discovery stories, here is another one: in 1938, Marjorie Courtenay, a curator for East London Natural History Museum, while at the docks, had her yes caught by what she described as "the most beautiful fish I had ever seen" that she couldn't just pass by. She took it back with her to the museum, asked to be preserved by a taxidermist and studies by a chemistry lecturer friend who was passionate about ichthyology. This fish was thought to be extinct for over 65 million years ago. This fish was a coelacanth, a member of a group of fish that were closely related to the first four-legged vertebrates. This information is big but what is related to our topic is the fact that this fish has a fossil-gene. This fish doesn't need to see because it retreats to caves during the day and comes out to feed at night. Like in other nocturnal or subterranean mammals (owl monkeys, bush baby, slow loris, blind mole rat) the genes of this fish that are related to seeing are fossilized. In this chapter the author lets us know that the modern species are not necessarily better, just mostly different, an **empirical** observation that brings us more scientific knowledge.

Chapter 6: Déjà vu: How and Why Evolution Repeats Itself

Carroll made the information in this book accessible to the general reader, and in this chapter, he brings evolutionary theory in the first plan. He tells us how evolution needs sufficient time to take place, which identical or equivalent mutations will repeatedly arise by chance, and that fate (preservation or elimination) will be determined by the conditions of selection upon the traits they affect. (p.155) but what he brings new to the picture is "the centrality of DNA sequences to understanding the course of evolution" (McKinnon, 2007) This chapter is a good example of how the **empirical** NOS and process of **justification** relates to the **tentative**: observations of the natural world (monkeys who see better than other mammals, fish that can't see but can live in very hard conditions, etc.) and how scientists argued from evidence (Plutarch's Life of Sertorius) give us a perspective of how the mutations in DNA were not only made by chance but also by necessity.

Chapter 7: Our Flesh and Blood: Arms Races, the Human Race, and Natural Selection

While the author gives us an example of an arms race between the newt and a common garter snake, and this story is introduced with the first American who dies after he ate newt, mostly because of stupidity than the inevitability. This fish is eaten mostly in Japan, where a trained cook will to cut slices of unskinned meat and serve it for over $400 a person, and I think it doesn't only have to do with the Japanese people's love for fish but also something about their culture. The toxin in the skin of the newts can kill someone in less than 24 hours, but this fish didn't evolve to having a deadly toxin in its skin unlike other fish to give people reasons for high sensations but to save itself from this snake who became its enemy. In this chapter there is also discussed the genetic variation of human MC1R gene and its role in the diversity of the skin coloration and natural selection, the relationship between sickle cell anemia and malaria, the possible role of the cystic fibrosis mutation in resistance to pathogens, and the role of mutation and selection in cancer

progression and its relationship to the evolutionary process. All those are great examples of the **socio/cultural** aspects of NOS.

Chapter 8: The Making and Evolution of Complexity

By this far into the book I was not surprised to find out that a gene that encoded a protein, Pax-6, was found in the fruit fly, mammals, and human as well, with different involvement in eye development. This gene was also isolated from squid, planarian and ribbon worm. In some organisms when this gene was mutated, eye formation was abolished, but what it is interesting it that this gene had different functions in different organisms, that shows an immense distinction between the evolution of physiology and form, and how different genetic mechanisms work. This whole chapter was an ode to eye evolution**, multiple methods** to describe multiple species and with different scenarios of gene mutations, with the Pax-6 gene that was a common denominator.

Chapter 9: Seeing and Believing

A myth and an example of anti-**creative** aspect of NOS was debulked by French doctor Louis Pasteur who proved to the "skeptics" (other doctors and clergy that thought that women were dying of infections after childbirth as a punishment from God for the act of childbirth!!!!!) that the infections were spread by the unwashed hands of the doctors who were caring for those women. This was happening around 1879. Now we have microscopy and DNA technology that supports the science, not only educated guesses, a fact that didn't stop some people in power to contest the facts. A good example is a sticker that had to be attached to the textbooks in Cobb County, GA in 2005 that stated: "This textbook contains material on evolution. Evolution is a theory, not a fact, regarding the origin of living things. Etc." common denominator This matter was taken to court and considered unconstitutional.

Chapter 10: The Palm Trees of Wyoming

If the previous chapters were about making the fittest species, the last one is about the un-making, the decline of the species. The author presents us through **empirical** and **subjective** aspects of NOS, how some species either disappear, either become close to being extinct, or adapt to the new predator in town: the human. Trophy hunting of the bighorn sheep, overfishing, are only some of the human practices that led to the decline of many species.

I think the author made his point in this book by showing the amazing evolution and adaptation to the environment of so many species on this planet. The ethical dimension is touched in the last chapter when the adaptation of the species was heavily influenced by humans.

The way the facts were presented seemed to me the most characteristic aspect of NOS in this book, because the author presented the facts and how some of the facts changed over time, because of more knowledge being acquired, a clear example of tentative.

This book was also full of anomalies, which showed to us the way some of the species adapted to the new environment was in ways someone couldn't find predictable, yet they found a way to survived.

This book was easy to read and full of interesting things but also full of scientific knowledge. It is accessible to anyone who wants to understand aspects of the evolution of the species on Plant Earth.

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