CILIPS COVID-19 Book Reviews – The Making of the Fittest

Reviewer name: Scott Main

Book title: The Making of the Fittest

Author name: Sean B. Carroll

Genre: Science – the theory of evolution

Overall Rating: Excellent

Brief summary: Just as fossils provide a window into the past, evolution leaves a footprint on DNA. In 'The Making of the Fittest', Sean B. Carroll (http://seanbcarroll.com/about/) sets out the overwhelming evidence for evolution provided in DNA.

Carroll offers examples from sequences of DNA that once coded for genes no longer used, remnants of ancestral lives, and thereby evidence of evolutionary change. As he explains, 'every evolutionary change between species, from physical form to digestive metabolism, is due to, and recorded in, changes in DNA' (p 14). Using this forensic evidence of evolution, Carroll reveals how these relics provide new 'sources of insights into traits and capabilities that have been abandoned as species evolved new lifestyles' (p 16).

Carroll's first example is of bloodless fishes in the cold waters of the Antarctic. The discovery of these fish challenged the working hypothesis that all vertebrates must have red blood cells, contingent on their requirement for the oxygen-carrying molecule haemoglobin. The fish actually turned out to have blood that lacked red blood cells, and this led to an investigation about how they came to develop a lifestyle without haemoglobin. The explanation, set out by Carroll in great detail, shows how bloodless ice fish have evolved in response to opportunity and necessity. This evolutionary narrative takes place over the past 55 million years, during which temperatures of the Antarctic seas have dropped, from about 20° C to less than 0° C in some locales. A cold environment presents challenges to living organisms, which have to adapt in response. For example, since fluids like blood move much more slowly in colder temperature, animals in such environments compensate by evolving less viscous blood and/or increasing the surface area for oxygen exchange.

The ice fish in the Antarctic have genes for hemoglobin, but the genes have accumulated mutations, and are now functionless. The presence of relict hemoglobin genes points to an ancestral way of life, no longer followed by the fish, and provides evidence for descent with modification. Moreover, the DNA sequence of the antifreeze glycoprotein (AFGP) informs us how the evolutionary change occurred. The notothenioid AFGPs (a family of at least eight different isoforms — various forms of the same protein) are composed of a simple glycotripeptide repeat, (Thr-Ala/Pro-Ala)n, with the disaccharide galactose-N-acytylglactosamine attached to each Thr, and the dipeptide Ala-Ala at the N terminus (Chen and others 1997). The smallest AFGP isoform consists of four repeats; the largest of 55 repeats. Variation abounds among these isoforms, and AFGP polyprotein precursors contain various combinations of these isoforms. Additionally, there are multiple genes and multiple AFGP copies per gene, which contribute to high levels of circulating proteins and suggest extensive duplications gave rise to this protein family (Chen and others 1997). The Making of the Fittest is full of similar compelling descriptions of evolution in action. Mutation, heritable variation, and differential survival in a changing environment provide an explanation of evolutionary change that is overwhelmingly consistent with, and supported by, our observations across all major groups of organisms.

A common misconception about evolution is that it proceeds by random chance. Carroll offers a clear description of the mathematical power of evolution to produce change. He uses everyday examples — winning the lottery, dying in various kinds of accidents, and saving money — to show that while mutations are random, selection determines what chance occurrences are retained. Given sufficient time, identical or equivalent mutations will arise repeatedly by chance and their fate (preservation or elimination) will be determined by the conditions of selection upon the traits they affect. Carroll draws an analogy between the power of natural selection and that of compound interest, explaining that 'small differences among individuals, when compounded by natural selection over time, really do add up to the large differences we see among species' (p 43).

What you liked: Science writing at its best for the general reader

Who should read this book?: Anyone interested in first rate science

Any additional comments?: 288 pages in W.W. Norton & Co.

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