A Small History of Some Big Evolution Ideas

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Evolution has been described as “Biology’s Biggest Idea”, a concept so fundamental that, as Theodosius Dobzhansky said, “*Nothing in biology makes sense except in the context of evolution*”. But where did this idea come from and how has it been shaped over time? And does it even matter anymore?

Throughout this series, we will explore some of the surprising, unexpected and sometimes alarming ways in which evolution impacts our daily lives. But in this first lecture, we are going to lift the lid on some landmark concepts in the history of evolutionary thinking. Along the way, we will meet some of the people who developed those ideas and discover that inspirational ideas often emerge from some rather less-than-inspirational individuals.

Evolution by Natural Selection

Unsurprisingly, our first stop on this short history of big thinkers is the grandfather of evolutionary theory and one of the most famous biologists of all time, Charles Darwin. The story of Darwin’s fortuitous role as ‘naturalist and captain’s companion’ on HMS Beagle, and his revelation that natural selection was the force that generated the startling diversity of finches on the Galapagos Islands, is something that is now taught to schoolchildren around the world. But Darwin’s ideas were also influenced by much less exotic observations, particularly regarding the impact of domestication on animals such as pigeons. Although ‘evolution by natural selection’ was far from universally accepted by Victorian England, it perhaps met with less resistance than might otherwise have been anticipated from a population whose minds had already been opened to the flood of new discoveries emerging from the Industrial Revolution.

Darwin was well aware that evolutionary forces must have shaped humans in the same way as they shaped all other living organisms, but – perhaps to avoid upsetting his deeply religious wife Emma – he shied away from discussing this in ‘*On the Origin of Species*…’. The only mention humans get is the famous and rather cryptic sentence, “*Light will be thrown on the origin of man*…”. The same, however, was not true of Darwin’s half-cousin, Francis Galton – our next port of call on this short history.

From Pigeons to People

Galton was a true polymath, with interests ranging from statistics to meteorology. An astute observer of the world around him, he was puzzled by the observation that the offspring of pedigree dogs of different breeds typically do not resemble either parent. Instead, they often appear more similar to what he described as ‘ancestral’ dogs; the classical mongrel or mix-breed. Galton wondered whether something similar may occur in humans and conducted a now-famous study in which he measured parents and their (adult) offspring. This revealed exactly the same pattern – the children of very tall or very short parents are rarely as tall or short. Instead, they tend to be much closer to the average height of the population as a whole. Thus Galton can lay claim to being one of the first people to apply evolutionary analysis to his own species.

If Galton had stopped there, then history might have recorded him as a hero of evolutionary theory. Unfortunately, however, he didn’t. A toxic combination of enthusiasm for this new science and a completely unsubstantiated belief that many of society’s ills must be heritable led Galton to propose a scheme to ‘improve’ the human race through selective breeding. Needless to say, Galton’s definition of ‘improvement’ meant striving towards a white, British, aristocratic elite – coincidentally, the group to which Galton himself belonged. He named this approach ‘eugenics’ and vigorously extolled the virtues of forced adoption and state-regulated reproduction. In doing so, Galton sowed the seeds of ‘scientific racism’ and led, albeit

indirectly, to some of the most appalling crimes of the 20th century.

Peas and Peacocks

Despite this dark legacy, Galton's approach to using mathematical tools to study heredity changed evolutionary thinking and influenced some of the key thinkers of the next century. Foremost amongst these was Ronald (RA) Fisher, a talented statistician who realised the power of the huge sets of data being accumulated at the time by experimental crop breeding programmes. Fisher developed a number of powerful statistical tools, in particular the 'Analysis of Variance' method which remains a lynchpin of quantitative biology today. He applied this, in particular, to the problem of sex in biology, addressing key questions such as "Why is the sex ratio in most species one-to-one?". And he mathematically demonstrated how sexual selection can lead to ever more extreme features, such as the peacock's tail – a phenomenon now known as the 'Fisher Runaway'.

But, like Galton, Fisher was a complex character. Although it remains unclear whether he believed in scientific racism per se, he nonetheless espoused the repugnant (and scientifically flawed) idea that different human races differ "*in their innate capacity for intellectual and emotional development*", later writing that marriage between people of different races "*can do nothing but harm*". There is a fitting irony that it is the statistical tools developed by Fisher himself which have proved beyond doubt that such ideas are fundamentally incorrect.

Social Insects and Selfish Genes

The 20th century saw a sequence of talented thinkers apply mathematics to biology and make major inroads into evolutionary theory in the process. Sewall Wright, JBS Haldane, Ernst Mayr, Hermann Muller and numerous others created a scientific framework in which theoretical models repeatedly explained evolutionary enigmas. Perhaps nowhere is this more apparent than in the work of our final character in this tour of evolutionary 'big thinkers' - William (Bill) Hamilton.

Hamilton was a mathematician who became interested in a paradox that had also puzzled Fisher, Haldane and many others - if evolution is driven by competition for limited resources and selection of the fittest individuals, then why do some species, such as bees or ants, exhibit apparently altruistic behaviours? What he eventually realised was that such 'self-sacrificing' behaviours can still be favoured by natural selection if they lead to an overall fitness gain for a related individual. This concept, now known as Hamilton's Rule, means that a behaviour will be selected if the cost (C) of an action to an individual is outweighed by the benefit (B) to a related individual, multiplied by their coefficient of relation (r):

$$C < B \times r$$

Put simply, it is, therefore, worth an individual risking their own life to save two siblings (because each sibling shares, on average, 50% of the individual's genes) or four half-siblings (because each shares 25% of their genes) and so forth – a concept now known as 'kin selection'.

Although Hamilton's work was published in 1964, it remained relatively obscure for over a decade. But in 1976 the concept of kin selection entered the public consciousness with a bang, following the publication of Richard Dawkin's "*The Selfish Gene*". Four editions and more than a million copies later, this book set out the argument that natural selection acts at the level of genes, rather than individuals. In doing so, it provided a framework for popular concepts such as 'selfish DNA' (genes which replicate within the genome even when this is disadvantageous to the organism itself) and 'memes' (ideas which – like genes – are selected to replicate and spread within a population).

Perhaps even more importantly, *The Selfish Gene* once again made evolution a topic for dinner table discussion, as it had been in Darwin's time, and led to a broad understanding that evolution was not just about dead dinosaurs and tropical finches, but rather was a force that continues to shape everyday life today – a subject we will return to in the next lecture.