Remote Learning Module for 27 April 2020

Lecture Notes for Fernando Espinoza's *The Nature of Science*, Chapters 9 & 10

— Charles Darwin —

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Last time we examined the life and times of René Descartes, who has often been called the Father of Modern Philosophy; and we took a quick tour of his most influential work, the *Meditations on First Philosophy*. Today we'll return our attention to the figure of Charles Darwin, whom we met early in our semester in Ron Giere's book, *Understanding Scientific Reasoning*. First, we'll train our focus on some historical considerations about Darwin's role in the history of biology; then we'll reflect briefly on his biography; and finally, we'll review the five theories he advanced in the *Origins of Species*.

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— The Darwinian Revolution —

(1) We can characterize the essential characteristics of the revolution Darwin ignited in the biological sciences under three headings: Naturalism, Mechanism, and Indeterminism.

(2) Naturalism. Darwin's account of the evolution of species decisively refuted the longstanding belief in "special creation." It was indeed a longstanding belief, having first appeared as a theologically inspired revision of Aristotle's biology. Aristotle, you'll recall, proposed to solve the problem of the chicken and the egg by supposing that species are eternal; thus, there have always been chickens who have always laid eggs. After his ideas were appropriated by the three great Semitic religions of Judaism, Christianity, and Islam, the dominant view was that each and every species on our planet was separately created, so, from the moment of creation, there have always been chickens and eggs ever since. Darwin also extended the contrary idea that speciation occurs via slow evolutionary change to include human beings: his contention was that we humans have evolved according to the very same processes that operate elsewhere in the living world.

(2) Mechanism. Darwin replaced the notion of the living world as having been purposefully and perfectly designed by a divine artificer with the struggle for survival by way of the simple mechanism of natural selection operating on minor variations over generations of offspring. Thus, he was able to show that change and adaptation not only occur in the world, but that such change and adaptation shows only progress, not perfection; but in any case, nothing even remotely resembling purposeful design.

(3) Indeterminism. Both metaphysically and methodologically, Darwin replaced notions of physical phenomena proceeding from precise, deterministic physical laws of nature with concepts of probability, chance, and uniqueness. His methodology in framing his "long

argument" in *Origin of Species* was, moreover, a weaving together of both theory and observation.

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— Who was Darwin? —

(1) Darwin was born on the 12th of February, 1809, in Shrewsbury, England. He was, by his own account, a "born naturalist." His early schooling apparently bored him to tears, with his interests rather trained on the natural countryside where he took note of the myriad forms of zoological and botanical life in rural England.

(2) In 1828, he went to Cambridge to study theology. One might today think that a strange course of study for a "born naturalist," but his reason for this choice was that in his day, theologians had a veritable monopoly on the business of studying nature—what was then called, Natural History—the study of God's many and wondrous creations. He took his Bachelor's Degree in 1831.

(3) After graduation, he happened to secure a position as an assistant to the Captain of the H.M.S. Beagle, and went to sea. He spent the next five years traveling the world's oceans, observing and classifying the varieties of plants and animals to be found wherever the Beagle took him. Among his many observations, those he made while visiting the Galapagos Islands in 1835 were the most significant, for they would eventually give him the seeds of his new theory of the evolution of species by way of natural selection. In 1837 Professor Gould identified the several varieties of mockingbirds that Darwin brought home to England as *distinct species*, and from this Darwin derived the kernel of his revolutionary ideas: the gradual origin of new species through geographic isolation.

(4) In addition to his own observations, Darwin took inspiration from two other important sources. The first was Charles Lyell's *Principles of Geology*, which he'd read on board the Beagle, and in which Lyell demonstrated conclusively that the Earth was millions of years older than the supposed time of creation (4004 BCE being one of the more common hypotheses). The second was the 1838 publication of Thomas Malthus' *Essay on Population*, which held that while natural resources multiply in arithmetic proportion, biological species, including human beings, multiply in geometric proportion, thus implying that population explosions must inevitably lead to mass starvation. From Malthus, Darwin derived the mechanism he needed to explain why the mockingbirds had evolved into distinct species: the struggle for survival in a world of scarce resources.

(5) Some twenty years later, after brooding over the implications of his research, Darwin received a letter from his friend and fellow naturalist, Alfred Russell Wallace who was then in the South Seas studying beetles, and who hit upon the very same idea: evolution by common descent via Natural Selection. Not to be outdone, Darwin assembled his notes and rushed to print. *On the Origin of Species* appeared shortly thereafter, on the 24th of November in 1859. Thereafter, Darwin revised the first edition of his *magnum opus* numerous times, and added to his arguments a number of additional treatises, most notably the *Descent of Man*, and the *Expression* of *Emotion in Man and Animals*. Charles Darwin died on April 19th in 1882.

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— One Long Argument —

(1) Darwin considered the entire text of *On the Origin of Species, or the Preservation of Favored Races in the Struggle for Life*, comprising fourteen chapters, as "one long argument." He began this argument with an observation concerning the enormous degrees of variation to be found among domesticated plants and animals:

> *When we look to the individuals of the same variety or sub-variety of our older cultivated plants and animals, one of the first points which strikes us, is, that they generally differ much more from each other, than do the individuals of any one species or variety in a state of nature. When we reflect on the vast diversity of the plants and animals which have been cultivated, and which have varied during all ages under the most different climates and treatment, I think we are driven to conclude that this greater variability is simply due to our domestic productions having been raised under conditions of life not so uniform as, and somewhat different from, those to which the parent-species have been exposed under nature.*

From this humble observation, Darwin proceeded, step by step, to argue that the variations among species that we find in nature have been shaped in precisely the same manner as domesticated species, only without the values of human preference or the efforts of human practice. He concluded his long argument with another observation:

> *It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the external conditions of life, and from use and disuse; a Ratio of Increase so high as to lead to a Struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved.*

(2) Although we commonly refer to this argument as articulating *the* "theory of evolution," Darwin's account of the origin of species not only involves, but requires, five distinct theories, without which the argument's cogency would be considerably diminished. These five theories were as follows.

- **(a) Evolution *per se*:** the world is neither constant, nor created, nor cyclic, but changing over time.
- **(b) Common Descent:** all life on Planet Earth has descended from a single common ancestor.

(c) Diversity: the numbers and varieties of distinct species multiply over time; the pattern displayed in the course of evolution is that of a recursion tree.

(d) Gradualism: all transitions from one species to another are tiny modifications of existing forms; there are no large-scale jumps from one whole type to another; type differentiation proceeds from small adaptive changes through generations of tokens.

(e) Natural Selection: from abundant variation in each succeeding generation, subject to competition for scarce resources, only the most well-adapted will survive to reach reproductive maturity.

(3) Taken together, these five theories can serve as a general model for all manner of phenomena in which crude beginnings eventually lead to refined endings (including, we might note in these days of pandemic plague, the evolution of immune responses to infectious disease entities). We might call this model a *Darwin Engine*:

[Pattern + Copy-Mechanism + Variation + Selection + Reproduction] = Evolution

What is perhaps the most striking aspect of this model is that insofar as it fits the real world, it makes the appearance of evolution inevitable.

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Next time, we'll conclude our term with an introduction to the philosophical reflections of Albert Einstein on the nature of scientific thinking. Be well everyone; stay safe, stay strong, and stay put. Let us nurture our immune systems.