

The Canadian Field-Naturalist

Book Reviews

Book Review Editor’s Note: *The Canadian Field-Naturalist* is a peer-reviewed scientific journal publishing papers on ecology, behaviour, taxonomy, conservation, and other topics relevant to Canadian natural history. In line with this mandate, we review books with a Canadian connection, including those on any species (native or non-native) that inhabits Canada, as well as books covering topics of global relevance, including climate change, biodiversity, species extinction, habitat loss, evolution, and field research experiences.

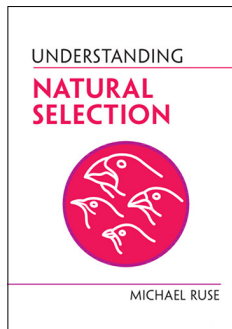
Currency Codes: CAD Canadian Dollars, USD United States Dollars, EUR Euros, AUD Australian Dollars, GBP British Pounds.

BIOLOGY

Understanding Natural Selection

By Michael Ruse. 2023. Understanding Life Series. Cambridge University Press. 188 pages, 56.95 CAD, Hardcover, 22.95 CAD, Paper.

Canadian philosopher of science Michael Ruse believes that the process of natural selection “strikes right to the heart of our being” (p. 149). His book, *Understanding Natural Selection*, while not always light reading, is a useful short outline of the theories, historical contexts, and disagreements within the field of evolutionary biology. It is opinionated and peppered with the occasional polemic and many entertaining quips. For instance, on the calculation of kin selection benefits for survival, Ruse reminds his readers of geneticist J.B.S. Haldane’s comment that “I would lay down my life for two brothers or eight cousins” (p. 98).



Charles Darwin’s centrality lies in his theory of evolution—laid out in *On the Origin of Species* (John Murray, First Edition 1859)—which today is accepted in biology as near fact. When Darwin first formed his theory, he borrowed from the social sciences, including economist Adam Smith’s ideas about the division of labour (p. 8). This perspective, Ruse suggests, was incorporated into Darwin’s theory that species will adapt to fill a variety of ecological niches and then spread (speciate) into a Tree of Life. Darwin “was ever a Lamarckian” (p. 4) and, although he found that approach an insufficient explanation for diversity with modification among species, he did believe acquired

characteristics could be inherited and passed on. He was also inspired by Thomas Malthus’s observations about exploding human population growth outpacing slower production of consumable resources. Darwin “incorporated this argument in its entirety into his theory” of the struggle for existence (p. 6).

In his studies of pigeons, and later barnacles, Darwin came to ask whether over “the course of thousands of generations” individuals having an “advantage, however slight, over others, would have the best chance of surviving and of procreating their kind?” (p. 7). Then his moment of clarity: “This preservation of favourable variations and the rejection of injurious variations, I call Natural Selection” (p. 7).

Ruse reminds us that Darwin, absent a gene-based Mendelian explanation (more on Mendel below), faced many obstacles proving his theory, such as trying to explain how sterile family members (certain insects, for example) could contribute to a community’s survival. More problematic was the “extreme imperfection of the geological record” (p. 14)—a problem that persists today. But, as for transitional forms, Darwin’s view was that if what was available in nature was good enough to afford an evolutionary advantage even if “not necessarily the best possible [structure] under all possible conditions” (Darwin 1872: 101) then it held explanatory power. He thought transitional forms were rare to begin with, and therefore hard to find. Yet, even this low expectation of the fossil record was unsatisfactory to him: “To the question why we do not find rich fossiliferous deposits belonging to these assumed earliest periods

prior to the Cambrian system, I can give no satisfactory answer" (Darwin 1872: 197).

This conundrum would continue to generate explanatory models from other theorists. One prominent proposal, punctuated equilibrium, was offered by Niles Eldredge and Stephen Jay Gould in 1972. They argued that the fossil record should be taken at face value. Fossil evidence of transitional forms is rare or absent because speciation often happens relatively suddenly, not gradually. "Speciation is a rare and difficult event that punctuates a system in homeostatic equilibrium" (Eldredge and Gould 1972: 115). Ruse writes that their theory "doesn't necessarily deny Darwinian forces" (wrongly implying, it seems to me, that this was the authors' intention; p. 92). In their view, rather, it was "extremely improbable that we shall be able to trace the gradual splitting of a lineage merely by following a certain species up through a local rock column" (Eldredge and Gould 1972: 94).

As he sailed on *The Beagle* around the globe, Darwin read Charles Lyell's recently published *Principles of Geology* (John Murray, 1830–1833), and it led him towards a more deistic (non-interventionist) explanation for species diversity (p. 30). (Darwin had studied theology at the University of Cambridge, but under the influence of biologist Thomas Huxley, he would turn towards agnostic views later in life.) Darwin had begun to pursue a "naturalistic solution to the origins question" (p. 30), and Lyell provided a uniformitarian (a continuous and unvarying process) approach to geological change. A significant inspiration also came from observing finches on the Galápagos Islands, where he noticed birds that were similar in appearance but also slightly different from each other. "Darwin did not know what causes variations, how frequent they are, what different kinds they are, and crucially what happens to variations during reproduction" (p. 37).

Mendelian factors—which we now call genes—were the significant breakthrough in the mid-1860s that later revealed the primary source of species variation. (While friar Gregor Mendel knew of Darwin, the reverse wasn't true.) Mendel saw that species traits were not necessarily found blended in offspring, but dominant or recessive attributes offered by both parents could be retained and passed on even if not visibly expressed (p. 57). Population geneticists would come to the fore in the 1930s and begin the synthesis of Darwinian natural selection and Mendelian genetics (pp. 60–61). While mutations are the building blocks of evolutionary change, in Ruse's determined view the course of evolution is still directed by "natural selection or nothing" (p. 61).

Harder to follow is Ruse's outline of neo-Darwinian genetic drift, which doesn't rely on adaptive

advantage but dynamic equilibrium whereby there is primarily group and not individual selection. He finds wanting the idea that random genetic drift (rather than selective factors such as heat and humidity) could be a primary causal evolutionary mechanism, where "some form of group selection pass[es] the successful genes through the whole population" (p. 112).

Theodosius Dobzhansky's (1937) book *Genetics and the Origin of Species* is acknowledged by Ruse as "arguably the most important—certainly the most influential—book on evolutionary theory in the twentieth century" (pp. 70–72). Dobzhansky, through his work on fruit flies, showed how seasonal ecological conditions, such as food scarcity, forced genetic fluctuations and significantly influenced the life cycles of small, isolated populations.

A most interesting chapter in Ruse's book is devoted to whether Darwinian natural selection is the primary driver of evolution. Ruse explores whether that mechanism can lead to speciation (macroevolution) and not only variation within a species (microevolution). Darwin dismissed the term "species" (even in the sixth edition of *Origin*) as something "given, for the sake of convenience, to a set of individuals closely resembling each other, and that it does not essentially differ from the [similarly arbitrary] term variety which is given to less distinct and more fluctuating forms" (Darwin 1872: 37). Today, however, Maize (*Zea mays*), fruit fly, and Greenish Warbler (*Phylloscopus trochiloides*) examples provide more evidence of how new (reproductively isolated) species develop. Similarly, the rate of evolution can be sped up through species seclusion on remote islands (pp. 93–94). This is still a difficult thing to directly observe, except for in viruses, and much of the solid evidence is found fossilized in layers of rock or in gene sequence analysis. For Darwin, if a hypothesis "explains many phenomena it comes in time to be admitted as real" (p. 86). Ruse argues that newer studies of Galápagos finches, sticklebacks, mosquitoes, and the fruit fly species Apple Maggot (*Rhagoletis pomonella*) have provided further proof that "in short pieces of time, you can get changes that any reasonable person" will acknowledge to be speciation (p. 95).

Major Debate—The Spandrels Paper

While Ruse's own prominence rose during the anti-creationist battles in public schools in the 1980s, he only peripherally mentions this fight in the context of evolutionary biologists putting aside their disagreements to form a united front against evolution deniers. Then, about two-thirds into the book, Ruse enters the divisive debate over adaptationism. This is an important subject area because it illuminates how we interpret intermediary forms and functions in

evolution. Ruse refers to the very influential “Spandrels Paper” (Gould and Lewontin 1979). Its authors, Gould and Richard Lewontin, argued that some biological features are incidental by-products (like the ceiling spaces called spandrels formed by happenstance in domed cathedrals), which should not be confused with other functions that provide actual evolutionary adaptive advantages. They were appealing to evolutionists to provide more rigorous explanations for visible features and to avoid *ad hoc* ‘just-so stories’. (A well-known illustration of this is that the human nose did not evolve to hold eyeglasses, despite appearances, but for smell.)

Ruse is dismissive of Gould and Lewontin (1979). He sees their argument as a “general critique of Darwinism” and evidence that they were arguing against natural selection being primary in evolution (pp.108–109). Michael Rose and George Lauder were more generous (in 1996), describing the maligned Spandrels Paper as an important critique of the kind of adaptationist thinking that had become prevalent in biology:

All features of organisms are viewed *a priori* as optimal features produced by natural selection specifically for current function. Instead, Gould and Lewontin advocated for a more pluralistic view of evolutionary investigation, recognizing that traits *may arise* [my emphasis] by other means than natural selection. (Rose and Lauder 1996: 1)

This was also related to the “5% of a wing” problem. The adaptive advantage of wings (for flying) is obvious, but what about the intermediate stages of pre-wings—how do they provide adaptive advantage? This had been a challenge for Darwin, too, and he responded to critics in updated editions of *On the Origin of Species*. He said that there were intermediary functions for proto-wings other than flight. Redundancy provides both a capacity for each appendage or organ to work in more than one way (for example, the air sac of fish) and for functions to be performed by more than one functional element (Darwin 1872: 125).

While the Spandrels Paper has had supporters and detractors, Ruse’s dismissive critiques of Gould and Lewontin continues relentlessly throughout the book, right to the bitter end (pp. 105–109, 116, 135–138, and 152). On the last page he writes that, in the Spandrels Paper, Gould and Lewontin “notoriously” reduce natural selection “to a mere clean-up role. This is simply not true” (p. 152). A more conciliatory approach is that adaptation is not the sole determinant of evolution and does allow for structural restrictions. Pluralists (such as Gould and Lewontin) are also right to argue that “the correct evolutionary explanation may

not even include natural selection for the trait” (Stanford 2010). Similarly, Rasmus Nielsen wrote that while the Spandrels Paper “did not spell the end to adaptationist storytelling” much was learned (Nielsen 2009: 2487). Evolutionary biologists are “more reluctant to invent adaptive stories without direct evidence for natural selection acting on the traits in question” (Nielsen 2009: 2487). The last words go to Gould, who published in the final year of his life that Darwinian selection has been “overwhelmingly validated, both empirically and theoretically as a dominant mechanism of evolutionary change in populations at generational timescales” (Gould 2002: 1322).

The Idea of Progress

Seeing evolution as a linear progression from slug through chimp, with humans at the apex, is no longer in vogue. Although, as Ruse writes, denying any hierarchy is “taking animal rights activist Peter Singer too seriously” (p. 117). But, it is still presumptuous in biological terms to anoint humans as “superior to every possible virus that might strike” us (a reflection derived from our COVID-19 era; p. 117). Darwin had a mixed view about this subject, too. At one point he dismissed any “absolute tendency to progression” but did not deny that there were “higher animals”, nor specialization that led (for example) to advancement of the brain where “natural selection clearly leads towards highness” (pp. 117–118).

Ruse closes with an interesting discussion. Evolutionist Alfred Russel Wallace wrote to Darwin to recommend that he address the problem of the phrase “natural selection” being misinterpreted as meaning a kind of mastermind or higher intelligence that was in charge. Herbert Spencer’s term was proposed (and accepted) as an alternative, but “survival of the fittest” would forever face the charge of being a tautology. And besides, as Ruse notes, it is actually “*reproduction* that matters, not survival, and it is *fitter* that counts, not fittest” [my emphasis] (p. 130). Philosopher Karl Popper pointed out that the same goes for the word “adaptation”, another tautological suspect: to be adapted for is simply to not be eliminated in the survival Olympics (pp. 129–131). Another approach is to see natural selection not as a causal agent at all, but just the statistical way we see species living on or dying out. “Natural selection is simply keeping score” (p. 133). But causes aren’t real things either, Ruse muses. They only provide conceptualization that helps us explain the world to ourselves, which is why the phrase “natural selection” does so well in describing how evolution works.

Literature Cited

Darwin, C. 1872. On the Origin of Species by Means of Natural Selection. Sixth Edition. John Murray, London,

- United Kingdom. Accessed 21 July 2024. <https://www.fulltextarchive.com/book/On-the-Origin-of-Species-6th-Edition>.
- Dobzhansky, T.** 1937. *Genetics and the Origin of Species*. Columbia University Press, New York, New York, USA.
- Eldredge, N., and S.J. Gould.** 1972. Punctuated equilibria: an alternative to phyletic gradualism. Pages 82–115 in *Models in Paleobiology*. Edited by T.J.M. Schopf. Freeman, Cooper, & Company, San Francisco, California, USA.
- Gould, S.J.** 2002. *The Structure of Evolutionary Theory*. Belknap Press of Harvard University Press, Cambridge, Massachusetts, USA. <https://doi.org/10.2307/j.ctvjsf433>
- Gould, S.J., and R.C. Lewontin.** 1979. The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. *Proceedings of the Royal Society B: Biological Sciences* 205: 581–598. <https://doi.org/10.1098/rspb.1979.0086>
- Lyell, C.** 1830–1833. *Principles of Geology: Being an Attempt to Explain the Former Changes of the Earth's Surface, by Reference to Causes Now in Operation*. John Murray, London, United Kingdom.
- Nielsen, R.** 2009. Adaptionism—30 years after Gould and Lewontin. *Evolution* 63: 2487–2490. <https://doi.org/10.1111/j.1558-5646.2009.00799.x>
- Rose, M.R., and G.V. Lauder.** 1996. Post-spandrel adaptationism. Pages 1–10 in *Adaptation*. Edited by M.R. Rose and G.V. Lauder. Academic Press, San Diego, California, USA.
- Stanford.** 2010. Adaptationism, Stanford Encyclopedia of Philosophy Archive. Accessed 15 February 2024. <https://plato.stanford.edu/archives/spr2017/entries/adaptationism/>.

ROBIN COLLINS
OTTAWA, ON, CANADA