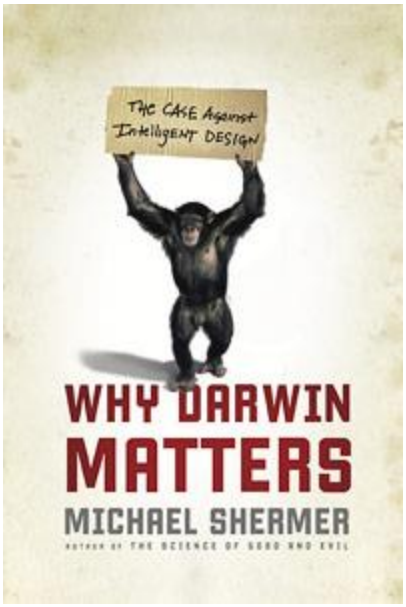
An excerpt from *Why Darwin Matters*, by Michael Shermer



Ever since Darwin, much has been written about what, exactly, evolution is. Ernst Mayr was arguably the greatest evolutionary theorist since Darwin. His extensive body of work and considerable longevity (when I phoned Ernst on his 100th birthday he was working on several articles and two more books) led to his authoritative history, theory, and synthesis of evolutionary thought. Mayr offers this technical definition: "Evolution is change in the adaptation and in the diversity of populations of organisms." This reveals the dual nature of evolution. "It deals, so to speak, both with the 'vertical' phenomenon of adaptive change and with the 'horizontal' phenomenon of populations, incipient species, and new species."[1] And I'll never forget Mayr's definition of a species, because I had to memorize it in my first course on evolutionary biology: "A species is a group of actually or potentially interbreeding natural populations reproductively isolated from other such populations."[2]

Mayr outlines five general tenets of evolution, followed by five specific points about how natural selection works.[3]

1. *Evolution:* Organisms change through time. Both the fossil record of life's history, and nature today document and reveal this change.
2. *Descent with modification:* Evolution proceeds via branching through common descent. Offspring are similar to but not exact replicas of their parents. This produces the necessary variation to allow for adaptation to an ever-changing environment.
3. *Gradualism:* Change is slow, steady, and stately. Given enough time, evolution accounts for species change.
4. *Multiplication of speciation:* Evolution does not just produce new species; it produces an increasing number of new species.
5. *Natural selection:* The process of evolutionary change, co-discovered by Darwin and Alfred Russel Wallace, which operates in the following manner:

    A. Populations tend to increase indefinitely in a geometric ratio: 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024…
    B. In a natural environment, however, population numbers stabilize at a certain level.
    C. Therefore, there must be a "struggle for existence" because not all of the organisms produced can survive.
    D. There is variation in every species.
    E. In the struggle for existence, those individuals with variations that are better adapted to the environment leave behind more offspring than individuals that are less well adapted. This is known as *differential reproductive success*.

This process of natural selection, when carried out over countless generations, gradually leads varieties of species to develop into new species. Within the natural selection paradigm, points A, B, and D are observations, C and E are inferences. C follows from A and B, and E follows from all three observations. In Darwin's own words, here are his observations that led to his inference:

A struggle for existence inevitably follows from the high rate at which all organic beings tend to increase. Every being, which during its natural lifetime produces several eggs or seeds, must suffer destruction during some period of its life, and during some season or occasional year, otherwise, on the principle of geometrical increase, its numbers would quickly become so inordinately great that no country could support the product. Hence, as more individuals are produced than can possibly survive, there must in every case be a struggle for existence, either one individual with another of the same species, or with the individuals of distinct species, or with the physical.[4]

And here is his inference:

It may be said that natural selection is daily and hourly scrutinizing, throughout the world, every variation, even the slightest; rejecting that which is bad, preserving and adding up all that is good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress, until the hand of time has marked the long lapses of ages, and then so imperfect is our view into long past geological ages, that we only see that the forms of life are now different from what they formerly were.[5]

Natural selection operates primarily at the local level. It is the process of organisms struggling to survive and reproduce in order to propagate their genes into the next generation. The Oxford evolutionary biologist Richard Dawkins succinctly defined evolution as "random mutation plus non-random cumulative selection."[6] Dawkins especially emphasizes the nonrandom element in the process in order to counter the myth that evolution is completely random, as in the creationists' specious argument that evolution is the equivalent of a warehouse full of parts randomly assorting themselves into a jumbo jet. If evolution were truly random there would be no biological jumbo jets. Genetic mutations and the mixing of parental genes in offspring may be random, but the selection of genes through the survival of their hosts is anything but random. Out of this process of self-organized directional selection emerges complexity and diversity.

Natural selection is a description of a process, not a force. No one is "selecting" organisms for survival or extinction, in the benign sense of dog breeders selecting for desirable traits in show breeds, or in the malignant sense of Nazis selecting prisoners at Auschwitz-Birkenau. Natural selection, and thus evolution, is unconscious and non-prescient — it cannot look forward to anticipate what changes are going to be needed for survival. The evolutionary watchmaker is blind, says Dawkins, pace Paley. By way of example, once when my young daughter inquired about how evolution works, I used the polar bear as an example of a "transitional species" between land mammals and marine mammals, because although they are land mammals they spend so much time in the water that they have acquired many adaptations to an aquatic life. But this is not correct, because it implies that polar bears are *on their way* (in transition) to becoming marine mammals. They aren't. Polar bears are not "becoming" anything. Polar bears are well adapted for their lifestyle. If global warming continues, perhaps polar bears will adapt to a full-time aquatic existence, or perhaps they will move south and become smaller brown bears, or perhaps they will go extinct. Who knows? No one.

References & Notes

1. Mayr, Ernst. 1988. *Toward a New Philosophy of Biology*. Cambridge, MA: Harvard University Press.
2. Ernst Mayr. 1957. "Species Concepts and Definitions," in *The Species Problem*. Washington D.C.: Amer. Assoc. Adv. Sci. Publ. no. 50. Mayr offers this expanded definition: "A species consists of a group of populations which replace each other geographically or ecologically and of which the neighboring ones intergrade or hybridize wherever they are in contact or which are potentially capable of doing so (with one or more of the populations) in those cases where contact is prevented by geographical or ecological barriers." See; Mayr, Ernst. 1976. *Evolution and the Diversity of Life*. Cambridge, MA: Harvard University Press.
3. Mayr, Ernst. 1982. *The Growth of Biological Thought*. Cambridge, MA: Harvard University Press.
4. Darwin, Charles. 1859. *On the Origin of Species by Means of Natural Selection: or The Preservation of Favoured Races in the Struggle for Life*. London: Charles Murray, p. 63.
5. Darwin, 1859. *On the Origin of Species*, p. 84.
6. Dawkins, Richard. 1976. *The Selfish Gene*. Oxford: Oxford University Press.