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Discussion

Darwinism, not mutationism, explains the design of organisms

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ABSTRACT

Shapiro claims that advances in molecular genetics have undermined Darwinism, leading him to advocate mutationism. However, this extreme view is bourne out of conceptual error. He has misunderstood the distinction between gradualism and saltationism, which do not concern the rate of genetic change, but rather the emergence of complex design. And he has misunderstood the relationship between the dynamics of natural selection and the agency of individual organisms: these are not competing hypotheses, but rather alternative conceptualizations of the same phenomenon.

Shapiro (2011, 2013) has reviewed a number of exciting developments in molecular biology that appear to have shaken the conceptual foundations of that field. However, he has greatly overestimated the significance of these discoveries for the field of evolutionary biology. In particular, Shapiro claims that Darwinism must now be replaced by mutationism. I suggest that this extreme view arises from two basic misconceptions. First, Shapiro rejects Darwinian gradualism in favour of saltationism, believing these to be competing hypotheses about the nature of genetic changes, when in fact they are competing hypotheses about the evolution of complex design. Second, he rejects natural selection in favour of individual agency, believing these to be competing hypotheses about adaptation, when in fact they are simply different ways of describing the same thing.

1. Gradualism versus saltationism

Darwinists recognize that natural selection is not the sole driver of evolutionary change (Fisher, 1930). Indeed, depending on the level of one's focus (e.g. molecular sequence data), it may not even be the main driver of evolutionary change (Kimura, 1983). Rather, natural selection receives special attention from evolutionary biologists because it is the ultimate driver of adaptation, the appearance of complex design in the biological world (Gardner, 2009). Under this Darwinian view, evolution may well proceed in fits and starts. For example, a sudden influx of migrants into a population may result in very rapid gene frequency change. But complex adaptation accumulates gradually, and does not appear *de novo* and fully-formed in a single mutational step (a "saltation"). Thus, Darwin wrote of adaptation:

> *If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down* (Darwin, 1859, p. 189).

However, Shapiro (2011, 2013) misinterprets this as a claim about genetic change in general. When he writes:

> *Do the sequences of contemporary genomes fit the predictions of change by "numerous, successive, slight variations* [sic]*," as Darwin stated, or do they contain evidence of other, more abrupt processes, as numerous other thinkers had asserted? The data are overwhelmingly in favor of the saltationist school that postulated major genomic changes at key moments in evolution.* (Shapiro, 2011, p. 89)

Shapiro is not referring to the *de novo* appearance of adaptive complexity, but rather to organisms modifying their genomes in routine, pre-defined ways. For example, trypanosome parasites shuffling "cassettes" of nucleic acid between expressed and non-expressed parts of the genome, as a means of changing their surface antigen profiles during the course of an infection (Borst and Greaves, 1987; Shapiro, 2011, p57). Whilst such molecular shuffling can reasonably be described as significant genomic change within the lifetime of the infection, it does not represent saltation, i.e. *de*

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novo adaptation on the part of the individual parasite. Rather, the capacity for this molecular shuffling is inherited, as are the cassettes and the adaptive information that they contain, and there is no reason to doubt that this remarkable design feature has been gradually perfected over the course of numerous parasite generations.

2. Natural selection versus individual agency

Natural selection explains not only the process of adaptation, but also its purpose (Gardner, 2009). Those heritable traits that are associated with greater individual fitness are expected to accumulate in natural populations, and hence individual organisms are expected to appear designed to maximize their fitness (more generally, their "inclusive fitness"; Hamilton, 1964). The formal links between the dynamics of natural selection and the optimization of fitness have been shown mathematically, by Grafen (2002, 2006). Consequently, evolutionary biologists may speak in dynamical terms about natural selection driving changes in gene frequency (e.g. population geneticists) or in teleological terms about individual organisms striving to maximize their fitness (e.g. behavioural ecologists). These are not competing hypotheses about how evolution works, but rather they are simply different ways of saying the same thing.

However, Shapiro (2011, 2013) mistakes natural selection and individual agency for competing scientific hypotheses. He outlines a mutationist hypothesis for the evolution of complex design, that attributes adaptive molecular change to teleological cells that are able to direct their own mutational future, and he rejects the notion that natural selection plays any important role in adaptive evolution. For example:

> [T]*he concept of cell-guided natural genetic engineering fits well inside the boundaries of 21st Century biological science. Despite widespread philosophical prejudices, cells are now reasonably seen to operate teleologically: their goals are survival, growth, and reproduction*. (Shapiro, 2011, p. 137)

> *Living cells and organisms are cognitive (sentient) entities that act and interact purposefully to ensure survival, growth, and proliferation*. (Shapiro, 2011, p. 143)

> *The role of selection is to eliminate evolutionary novelties that prove to be non-functional and interfere with adaptive needs. Selection operates as a purifying but not creative force*. (Shapiro, 2011, p. 144)

But natural selection provides the only scientific explanation for the teleological quality of living organisms. That is, a scientific appeal to teleology *is* an appeal to natural selection, and therefore cannot displace natural selection as an explanation for adaptation. The alternative is an unscientific appeal to teleology. That is, some sort of vitalism that views living organisms as manifesting a teleology unrelated to the action of natural selection. Thus, Shapiro's view of how adaptations arise in the course of evolution is either scientific and has natural selection at its core, or else is pseudo-scientific and truly non-Darwinian. Either way, Darwinism and Shapiroism do not represent competing scientific explanations for the adaptive design of living organisms.

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