Evidence for the Evolutionary Mechanisms

The third aspect of the contemporary evolutionary paradigm is the explanatory mechanisms behind evolutionary change. Recall that Ayala says that this third aspect of evolutionary biology remains incomplete and is a matter of controversy. He writes, "The mechanisms accounting for these changes are still undergoing investigation. . . . The evolution of organisms is universally accepted by biological scientists, while the mechanisms of evolution are still actively investigated and are the subject of debate among scientists."[1] Laymen may not appreciate the way in which evolutionary theory has itself evolved and continues to evolve. There really is no such thing as *the* theory of evolution.

4.611 Darwin's Theory

Leaving aside the theories of Darwin's predecessors, scientists have long realized that Darwin's own theory, laid out within the pages of *On the Origin of Species* (1859), was drastically incomplete and therefore deficient with respect to the explanatory mechanisms of evolutionary change. The theory aimed to explain why living organisms are so extraordinarily well-adapted to their environments. Darwin's theory of evolution comprised two fundamental theses: (i) descent with modification of all living organisms from one or a few common ancestors, and (ii) natural selection as the principal explanatory mechanism for evolutionary change.

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[1] Ayala, *Darwin's Gift,* p. 141.

Darwin's thesis of common ancestry quickly won the day, but for seventy years following the publication of *Origin of Species* Darwin's second thesis was widely regarded as explanatorily deficient. Ignorant of Gregor Mendel's genetics, Darwin could provide no account of the sources of the variability of hereditary traits nor how such traits were inherited. It has been justifiably quipped that Darwin's theory explained the *survival* of the fittest, but not the *arrival* of the fittest. Unaware of the revolution pioneered by his contemporary Gregor Mendel, Darwin could not exploit the resources of genetic variability in support of his theory. Hence, it remained explanatorily deficient.

4.612 The Modern Synthesis

That deficiency was remedied in large measure by the marriage of Darwinian evolution with Mendelian genetics during the mid-twentieth century in what is known as the Modern Synthesis. The chief contribution of the Modern Synthesis is the thesis that hereditary variability arises by genetic mutations, which, acted upon by natural selection, can be the source of new and advantageous characteristics over time. It thereby supplemented Darwin's theory with a genetic explanation of the source of heritable variations.

4.613 The Extended Evolutionary Synthesis

By the 1980s a new stage in evolutionary theorizing began to emerge and soon gained ground. In 2014 *Nature* published dueling editorials by two groups of scientists in response to the question: "Does evolutionary theory need a rethink?" Those who answered,

"Yes, urgently," maintained that "Without an extended evolutionary framework, the theory neglects key processes," while those answering, "No, all is well," contended that "Theory accommodates evidence through relentless synthesis."[2] It is striking that these two claims are perfectly consistent: without an extension the Modern Synthesis is explanatorily deficient, but it can be extended to accommodate the new evidence.

The Need for Re-thinking Evolutionary Theory

Those calling for a re-thinking of the Modern Synthesis complain that as a result of the Modern Synthesis, "mainstream evolutionary theory has come to focus almost exclusively on genetic inheritance and processes that change gene frequencies."[3] Yet new data pouring out of adjacent fields such as developmental biology [embryology], genomics, epigenetics, ecology, and social science now demand a wider Extended Evolutionary Synthesis. The authors calling for a re-think advocate "an alternative vision of evolution" that recognizes that "the processes by which organisms grow and develop" are also "causes of evolution."[4] It follows from this that the Modern Synthesis is, like Darwin's theory, causally incomplete and therefore explanatorily deficient unless extended.

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[2] Kevin Laland, Tobias Uller, Marc Feldman, Kim Sterelny, Gerd B. Müller, Armin Moczek, Eva Jablonka, and John Odling-Smee, "Does evolutionary theory need a rethink? Yes, urgently"; Gregory A. Wray, Hopi E. Hoekstra, Douglas J. Futuyma, Richard E. Lenski, Trudy F. C. Mackay, Dolph Schluter, and Joan E. Strassmann, "Does evolutionary theory need a rethink? No, all is well," *Nature* 514 (9 October 2014), pp. 161-64.

[3] Laland et al., "Does evolutionary theory need a rethink?," p. 161.

[4] Laland et al., "Does evolutionary theory need a rethink?," p. 161.

Massimo Pigliucci and Gerd Müller, two proponents of the Extended Evolutionary Synthesis, present the following figure (Fig. 20) to illustrate the relation between the Extended Evolutionary Synthesis, the Modern Synthesis, and Darwin's theory:

This is a far more accurate historical representation of evolutionary theory than the view promoted by die-hard advocates of the Modern Synthesis.

Evolutionary biologist Eugene Koonin pulls no punches: "In the post-genomic era, all major tenets of the Modern Synthesis are, if not outright overturned, replaced by a new and incomparably more complex vision of the key aspects of evolution. So, not to mince words, the Modern Synthesis is gone."[5]

Creationists and proponents of Intelligent Design have long complained about the explanatory deficits of the Modern Synthesis but were uniformly ignored, probably because they were able only to poke holes in the theory without offering a credible alternative. Today contemporary textbooks incorporate many of the new insights of the Extended Evolutionary Synthesis without candidly admitting the explanatory deficiencies of the Modern Synthesis thereby exposed.

J. B. S. Haldane once remarked that "Theories pass through four stages of acceptance: (*i*) this is worthless nonsense; (*ii*) this is an

[5] Eugene V. Koonin, "The *Origin* at 150," *Trends in Genetics* 25/11 (2009): 474-475.

interesting, but perverse, point of view; (*iii*) this is true, but quite unimportant; (*iv*) I have always said so."[6]

The Current State

It should not be thought that with the Extended Evolutionary Synthesis, the evolution of the theory of evolution has come to an end, and we can breathe a sigh of relief that all is well. No, while the Extended Evolutionary Synthesis served to expose explanatory weaknesses in the prevailing evolutionary paradigm and so to open new avenues of research, many of the ideas of the Extended Evolutionary Synthesis remain unproven, poorly understood, and controversial, so that the quest for a final theory must continue. In a recent review, Jerry Fodor and Piatelli-Palmarini confess, "We don't know what the mechanism of evolution is. As far as we can make out, nobody knows exactly how phenotypes evolve."[7] Douglas Futuyma recurs to his distinction between the *fact* of evolution and the *theory* of evolution: "We cannot pretend to understand fully all the mechanisms of evolution, and there are many differences of opinion among evolutionary biologists concerning the relative importance of those mechanisms we do know about. However, the historical reality of evolution—the descent, with modification, of all organisms from common ancestors—has not been in question, among scientists, for well over a century."[8] This statement evinces a commendably tolerant attitude toward those who have reservations about the suggested explanatory mechanisms of evolutionary change. Let us highlight just three unsolved problems.

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[6] Cited in William A. Dembski, *The Design Revolution* (Downers Grove, Ill.: InterVarsity Press, 2004), p. 20.

[7] Fodor and Piatelli-Palmarini, *What Darwin Got Wrong*, p. 153.

[8] Futuyma, *Evolutionary Biology*, p. 759.

The Problem of Gradualism

This is the problem of explaining how complex organisms could have gradually evolved through a series of transitional, intermediate forms. This is the oldest objection to evolutionary theory, pressed already by the British biologist St. George Mivart against Darwin's theory of natural selection.[9] Arguably it remains unrelieved by the Modern and Extended Evolutionary Synthesis. Undoubtedly, the most famous Mivartian on the contemporary scene is the biochemist Michael Behe, who argues in his book *Darwin's Black Box* that Darwinian incrementalism cannot plausibly explain such features of cellular biology as the bacterial flagellum or the blood-clotting mechanisms.[10] Behe is quite willing to allow gradualistic explanations when a series of selectively advantageous transitional forms can be envisioned. Hence, he has no objection to the gradual evolution of the vertebrate eye by a step-wise process. But he denies that such a process is capable of being envisioned for many biological structures. An advocate of UCA, Behe apparently favors a saltational origin of such structures guided by an intelligent agent, though he offers no positive account of such, being content to press the argument against gradualism.

In his subsequent book, *The Edge of Evolution,* Behe argues on the basis of experiments with malaria and HIV that, in fact, sufficient generations have not elapsed to graduallyproduce a complex organ like the bacterial flagellum. He points out that malaria and the human immune system have been waging war against each other

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[9] St. George Mivart, "Difficulties of the Theory of Natural Selection," *The Month* 11 (1869): 35–53, 134–53, 274–89.

[10] Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: Free Press, 1996), pp. 69-73, 77-97.

for over 10,000 years. Unfortunately for us, the malarial population is huge. The average person infected with malaria has over one trillion malarial cells in his body. Therefore malaria mutates extremely rapidly and so has been able to develop resistance to every drug that we have thrown at it. Simple single point mutations are enough to make malaria drug-resistant. On the other hand, Behe points out, there is tremendous selective pressure for the human immune system to develop some sort of defense against malaria, but it has not been able to do so. Instead, what has happened is that a mutation has occurred in the human respiratory system that makes some people immune to malaria, namely, sickle hemoglobin. Unfortunately, the downside is that the mutation also produces sickle cell anemia, which is eventually deadly.

Here's the Interesting part! Despite its incredible mutation rate, which has enabled malaria to overcome every drug we have developed, malaria has never in all those thousands of years and trillions of mutations been able to overcome sickle hemoglobin. Molecular biology explains why. Resistance to a drug can result from a simple single-point mutation. But overcoming sickle hemoglobin would require multiple simultaneous mutations or else a sequence of mutations occurring blindly, and both are just too improbable to occur. So despite tens of thousands of generations and trillions of cells, malaria has never been able to mutate enough to overcome sickle hemoglobin.

Behe considers HIV as another case study. HIV mutates 10,000 times faster than malaria. In the last fifty years alone the AIDS virus has mutated as much as all the cells that have ever existed on this planet. It has tried out every possible combination of up to six-point simultaneous mutations and thus has become resistant to every drug that we have developed. But, Behe says, “through all that, there have been no significant basic biochemical changes in the virus at all.” “. . . on a functional biochemical level, the virus

has been a complete stick-in-the-mud."[11] Behe concludes, "Here we have genetic studies over thousands upon thousands of generations, of trillions and trillions of organisms, and little of biochemical significance to show for it. . . . Our experience with HIV [and malaria] gives good reason . . . to think that Darwinism doesn't do much—even with billions of years and all the cells in the world at its disposal."[12]

The revolution being wrought by the Extended Evolutionary Synthesis is ongoing. Michael Denton cautions, "it is going to be several decades before we have any real feel for the true complexity involved in the origin of any evolutionary novelty or anything like a full inventory of the causal factors involved."[13] Denton concludes that most of the new evolutionary mechanisms offered by the Extended Evolutionary Synthesis to account for the origin of evolutionary novelties are essentially conservative amendments to the Modern Synthesis. "Such amendments do not provide anything like an alternative *causal directing agency* to replace cumulative selection as a means of . . . crossing the great divides and accounting for . . . the origin of such homologs as the feather, human language, hair, the angiosperm flower, the insect body plan, and so forth."[14] Thus, Mivart's problem of transitional forms remains essentially unresolved.

The Problem of Organizational Form

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[11] Michael J. Behe, *The Edge of Evolution: The Search for the Limits of Darwinism* (New York: Free Press, 2008), p. 139.

[12] Behe, *Edge of Evolution*, pp. 140, 154-55.

[13] Denton, *Evolution: Still a Theory in Crisis*, pp. 89-90.

[14] Denton, *Evolution: Still a Theory in Crisis*, p. 278.

The revelation of the Extended Evolutionary Synthesis of the complex genetic regulatory networks underlying embryonic development highlights a further explanatory deficiency of current theory. We still have no explanation of the origin of the basic animal organizational forms which appear during the Cambrian explosion. No fundamentally new body plans have originated in the 500 million years since the Cambrian.[15] The challenge of explaining the origin of the basic animal organizational forms or body plans lies at the heart of Stephen Meyer's critique of the explanatory adequacy of standard evolutionary theory. Whereas Darwin wondered where the animals that first appeared in the Cambrian strata came from, Meyer's concern is not so much with the animals themselves as with their organizational forms and the functional information embodied therein.

Meyer emphasizes that the origin of such forms requires explanation. Of the 36 known animal phyla, fossils of twenty appear in the Cambrian and three in the Ediacaran. One measure of their complexity is the number of types of cell they embody. For over three billion years the only living forms on Earth were single-celled organisms, each composed of one kind of cell. The Ediacaran faunas constituted an enormous leap in complexity beyond these unicellular organisms. The Ediacaran sponges probably required about ten different types of cell. Then with the Cambrian explosion animals like trilobites appeared, requiring fifty or more types of cell. These are creatures with complex organizational forms. Even if there were ancestors of these faunas, whose remains have yet to be discovered in the pre-Cambrian rocks, what needs to be explained is how the complex organizational forms of these animals originated. The "central

[15] Mayr, *What Evolution Is*, p. 209. Indeed, Mayr thinks that the variety of realized body plans was greater in the Cambrian than it is now.

unsolved problem" posed by the Cambrian explosion "is the origin of novel biological form."[16]

The Problem of Genetic Information

A third explanatory deficiency of contemporary evolutionary theory concerns the origin of the genetic information stored in DNA, particularly the origin of the genetic code, which, as we have seen, is virtually universal among living things. Given that there are more than 10^{84} possible alternative codes, the fundamental question, Koonin and Novozhilov explain, is what factors could have produced the standard genetic code.[17] Koonin and Novozhilov's article culminates with a question instead of a conclusion: "How did the code evolve (and will we ever know)?"[18] They state, **"**In our opinion, despite extensive and, in many cases, elaborate attempts to model code optimization, ingenious theorizing . . . , and considerable experimentation, very little definitive progress has been made."[19]

So in answer to their question, they say, "Summarizing the state of the art in the study of the code evolution, we cannot escape considerable skepticism. It seems that the two-pronged fundamental question: 'why is the genetic code the way it is and how did it come to be?', that was asked over 50 years ago, at the dawn of molecular biology, might remain pertinent even in another

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[16] Meyer, *Darwin's Doubt*, p. 54.

[17] Koonin and Novozhilov, "Origin and evolution of the genetic code," p. 99.

[18] Koonin and Novozhilov, "Origin and evolution of the genetic code," p. 11***

[19] Koonin and Novozhilov, "Origin and evolution of the genetic code," p. 11***

50 years. Our consolation is that we cannot think of a more fundamental problem in biology."[20]

Thus, the genetic code that lies at the root(s) of life is not explained by contemporary evolutionary theory.

Summary

Our point is a modest one. The acknowledged explanatory deficits of original Darwinian theory and of the Modern Synthesis have not been fully rectified by the advances of the Extended Evolutionary Synthesis. We still have much to learn about the causal mechanisms underlying the evolutionary history of life. This conclusion is, as we have said, widely acknowledged and is hardly surprising.

[20] Koonin and Novozhilov, "Origin and evolution of the genetic code," p. 12***.