

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Evolution: Still a Theory in Crisis

By: Michael Denton

**EVOLUTION:
STILL A THEORY
IN CRISIS**



M I C H A E L D E N T O N

1. Introduction

- One is the term “homolog.” As I use it, this term refers to a unique biological characteristic or trait shared by all the members of a particular group such as the pentadactyl ground plan of the tetrapod limb shared by all tetrapods. A homolog is therefore a “taxa-defining novelty.” The term homolog is used frequently by researchers in evolutionary developmental biology (evo-devo) to describe such character traits.⁸ Systematists often describe homologs as “synapomorphies” or “apomorphies.”⁹ In the nineteenth century, Richard Owen termed them “primal patterns.”¹⁰ [8. Günter P. Wagner, *Homology, Genes, and Evolutionary Innovation* (Princeton: Princeton University Press, 2014). 9. Colin Patterson, “Morphological Characters and Homology,” in *Problems of Phylogenetic Reconstruction*, edited by Kenneth Alan Joysey and Adrian E. Friday (New York: Academic Press, 1982), 21–74; Patterson defined homology as synapomorphy, 29 (see reference to Patterson in Wagner, *Homology Genes and Evolutionary Innovation*, 74–75); a synapomorphy is a homolog shared by two or more taxonomic groups inherited from a common ancestor (the pentadactyl limb in various tetrapod groups); an apomorphy is a homolog shared by the members of a particular group but not present in an ancestral form (hair in mammals); Ian J. Kitching, Peter L. Forey, Christopher J. Humphries, and David M. Williams, *Cladistics: The Theory and Practice of Parsimony Analysis*, 2nd ed., The Systematics Association Publication No. II (New York: Oxford University Press, 1998), Chapter 1, 2–3. 10. Richard Owen, *On the Nature of Limbs* (London: John Van Voorst, 1849), <https://archive.org/details/Owen1849br46D>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 146-151). Discovery Institute Press. Kindle Edition.]
- The other word I need to define is “non-adaptive,” which I also employ throughout the book. I use this term to refer to any feature or characteristic of an organism which does not appear to serve any conceivable specific adaptive end—in other words, any feature that makes no contribution to the fitness of the organism. Such features are invisible to natural selection because natural selection only sees traits which serve some adaptive end. Examples might be the shape of a maple leaf (a non-adaptive feature

restricted to an individual species of plant) or the pentadactyl limb (an example shared by many thousands of different vertebrate species). [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 152-156). Discovery Institute Press. Kindle Edition.]

- My major goal in this new book is to review the challenge to Darwinian orthodoxy and the support for typology provided by the novelty and extraordinary invariance of the homologs. In addition, I will explore how the adaptive status of many homologs is clearly in doubt. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 157-158). Discovery Institute Press. Kindle Edition.]
- These two diametrically opposed conceptions of organic order were referred to by Stephen Jay Gould in his magisterial *The Structure of Evolutionary Theory*: Most organisms are well adapted to their immediate environments [conditions of existence], but also built on anatomical ground plans that transcend any particular circumstance. Yet the two principles [functionalism or structuralism] seem opposed in a curious sense—for why should structures adapted for particular ends root their basic structure in homologies that do not now express any common function (as in Darwin’s example of mammalian forelimbs)? The designation of one principle or the other as the causal foundation of biology virtually defines the position of any scientist towards the organic world and its causes of order... Shall we regard the plan of high-level taxonomic order as primary, with local adaptation viewed as a set of minor wrinkles... upon an abstract majesty? Or do local adaptations build the entire system from the bottom up? This dichotomy set the major debate of pre-Darwinian biology.¹² [11. Stephen Jay Gould, *The Structure of Evolutionary Theory* [henceforth SET] (Cambridge, MA: Belknap Press [Harvard], 2002), p252.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 161-170). Discovery Institute Press. Kindle Edition.]
- Structuralism: According to the structuralist paradigm, a significant fraction of the order of life and of every organism is the result of basic internal constraints or causal factors that arise out of the fundamental physical properties of biological systems and biomatter. In other words, biological order that does not result from adaptation to satisfy functional ends. [Michael

Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 171-173). Discovery Institute Press. Kindle Edition.]

- Functionalism: According to the opposing paradigm, often referred to as functionalism, the main or sole fundamental organizing principle of biology is adaptation. On this view, the main Type-defining homologs (pentadactyl limb, etc.) are adaptations built by cumulative selection during the course of evolution to serve various adaptive ends. Biological order built in this way is contingent in the sense that it is undetermined by natural law. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 242-246). Discovery Institute Press. Kindle Edition.]
- It is hard to imagine two scientific frameworks as diametrically opposed as structuralism and functionalism. Where functionalism suggests that function is prior and determines structure, structuralism suggests that structure is prior and constrains function. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 251-253). Discovery Institute Press. Kindle Edition.]
- Since *Evolution: A Theory in Crisis* was published, there have been massive advances and discoveries in many areas of biology, including paleontology, genomics, and developmental biology. In 1985 the genome project was just launched, and researchers in developmental biology were just beginning to apply the new genetic knowledge to provide a detailed molecular genetic description of development. The new field of “evo-devo” (evolutionary developmental biology) was just emerging, as were the first hints of a new epigenetic paradigm,⁵⁰ with the realization of the importance of self-organizational phenomena as a generator of emergent order beyond the genes, i.e., non-Darwinian “order for free.”⁵¹ [50. Charles David Allis, Thomas Jenuwein, Danny Reinberg, and Marie-Laure Caparros, *Epigenetics* (Cold Spring Harbor, NY: Cold Spring Laboratory Press, 2007); Pigliucci and Müller, op. cit., Chapter 7; Eva Jablonka and Marion J. Lamb, “Transgenerational Epi-genetic Inheritance,” in *Evolution—the Extended Synthesis*, and Chapter 12; Gerd Müller, “Epigenetic Innovation.” 51. Stuart A. Kauffman, *The Origins of Order: Self-Organization and Selection in Evolution* (New York: Oxford University Press, 1993) Note that Turing, as long ago as 1952, proposed a self-organizing mechanism capable of generating organic patterns; see Alan Turing, “The chemical basis of

morphogenesis,” *Philosophical Transactions of the Royal Society of London, Series B, Biological Sciences* 237, no. 641 (August 14, 1952): 37–72.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 330-335). Discovery Institute Press. Kindle Edition.]

- Richard Prum and Alan Brush, the researchers who elucidated the development of the feather, speak for many workers in the evo-devo field when they write: Recently, Wagner and colleagues... proposed that research on the origin of evolutionary novelties should be distinct from research on standard microevolutionary change, and should be restructured to ask fundamentally different questions that focus directly on the mechanisms of the origin of qualitative innovations. This view underscores why the traditional neo-Darwinian approaches to the origin of feathers, as exemplified by Bock (1965) and Feduccia (1985, 1993, 1999), have failed. By emphasizing the reconstruction of a series of functionally and microevolutionarily plausible intermediate transitional states, neo-Darwinian approaches to the origin of feathers have failed to appropriately recognize the novel features of feather development and morphology, and have thus failed to adequately explain their origins. This failure reveals an inherent weakness of neo-Darwinian attempts to synthesize micro and macroevolution. In contrast, the developmental theory of the origin of feathers focuses directly on the explanation of the actual developmental novelties involved in the origin and diversification of feathers (Prum 1999). Restructuring the inquiry to focus directly on the explanation of the origin of the evolutionary novelties of feathers yields a conceptually more appropriate and productive approach.⁵³ [53. Richard O. Prum and Alan H. Brush, “The Evolutionary Origin and Diversification of Feathers,” *Quarterly Review of Biology* 77, no. 3 (September 2002), 261-295, 289, emphasis added. For references cited in the passage, see the original article.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 346-357). Discovery Institute Press. Kindle Edition.]
- In the same vein, Douglas Erwin entitled one of his papers “Macro-evolution Is More than Repeated Rounds of Microevolution”;⁵⁴ and in another paper, Erwin and colleague Eric Davidson argued that micro-evolutionary changes are not able to account for the origins of or enact radical changes to what they termed core gene regulatory networks that are involved in generating the

basic morphological motifs in all organisms.⁵⁵ Jerry Coyne, a committed Darwinist, restates explicitly Erwin and Davidson’s rejection of the extrapolation from micro- to macroevolution in his review of their paper: Davidson and Erwin [propose] that the origin of higher level clades, such as phyla, involves mechanisms other than the normal micro-evolutionary processes thought to cause speciation. They claim that “classic evolutionary theory, based on selection of small incremental changes” cannot provide “an explanation of evolution in terms of mechanistic changes in the genetic regulatory program for development of the body plan.”⁵⁶ [54. Douglas H. Erwin, “Macroevolution Is More than Repeated Rounds of Microevolution,” *Evolution and Development* 2, no. 2 (March 2000): 78–84, doi:10.1046/j.1525-142x.2000.00045.x. 55. Eric H. Davidson and Douglas H. Erwin, “Gene Regulatory Networks and the Evolution of Animal Body Plans,” *Science* 311, no. 5762 (February 10, 2006): 796–800, doi:10.1126/science.1113832; Douglas H. Erwin and Eric H. Davidson, “The Evolution of Hierarchical Gene Regulatory Networks,” *Nature Reviews: Genetics* 10, no. 2 (February 2009): 141–48, doi:10.1038/nrg2499. 56. Jerry A. Coyne, “Comment on ‘Gene Regulatory Networks and the Evolution of Animal Body Plans,’” *Science* 313, no. 5788 (August 11, 2006): 761, doi:10.1126/science.1126454.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 358-366). Discovery Institute Press. Kindle Edition.]

- Günter Wagner, mentioned earlier, is equally skeptical of the micro-evolution to macroevolution extrapolation and claims that the origin of major novelties may be inexplicable via gradualistic, bit-by-bit, Darwinian steps. One of his main points in *Homology, Genes, and Evolutionary Innovation* is that while microevolutionary changes may throw light on the origin of small-scale novelties, they may do nothing to explain macroevolutionary novelties such as the major higher-taxa-defining novelties discussed in this book. Wagner writes: The question of how complex body plans arise is not within the reach of population genetics [defined as the change in gene frequencies in populations, i.e., microevolution] neither are the questions on how complex organisms can arise from random mutation and selection.⁵⁷ [57. Wagner, *Homology, Genes, and Evolutionary Innovation*, 11, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 367-

373). Discovery Institute Press. Kindle Edition.]

- Another key point in Wagner’s book is the claim (echoing Owen’s distinction between homologs or “primal patterns” and their adaptive masks) that the processes which lead to major evolutionary novelties are different from those that cause adaptive modifications. Wagner argues: Novelties likely require large scale reorganizations of the gene regulatory network. Gene regulatory network reorganization involves... the creation of novel cis-regulatory elements. In contrast adaptive modifications often involve only the modification of existing cis-regulatory elements.⁵⁸ [Wagner, *Homology, Genes, and Evolutionary Innovation*, 125.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 374-378). Discovery Institute Press. Kindle Edition.]
- Many recent publications touch on aspects of the current ferment, including Pigliucci and Müller’s *Evolution, the Extended Synthesis*,⁶⁰ Wallace Arthur’s *Evolution: A Developmental Approach*,⁶¹ Suzan Mazur’s *The Altenberg 16*, and Fodor and Piattelli-Palmarini’s *What Darwin Got Wrong*.⁶² [60. Pigliucci and Müller, *Evolution: the Extended Synthesis*. 61. Wallace Arthur, *Evolution: A Developmental Approach* (Oxford: Wiley-Blackwell, 2011). 62. Mazur, *The Altenberg 16*; Fodor and Piattelli-Palmarini, *What Darwin Got Wrong*.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 382-385). Discovery Institute Press. Kindle Edition.]
- The authors cite many current researchers in evo-devo to establish that there is widespread dissatisfaction with the micro- to macro- extrapolation, and argue that natural selection “can’t be the whole story about how phenotypes evolve.”⁶³ They go on to say: “In fact, as we read the current literature... that isn’t seriously in dispute these days.”⁶⁴ Basing their skepticism on the “evo-devo constraints paradigm” that informs so much research in evolutionary biology today, they write: Contrary to traditional opinion, it needs to be emphasized that natural selection among traits generated at random cannot by itself be the basic principle of evolution. Rather there must be strong, often decisive, endogenous constraints... on the phenotypic options that exogenous selection operates on.⁶⁵ [63. Fodor and Piattelli-Palmarini, *What Darwin Got Wrong*, 77. 64. *Ibid*, emphasis added. 65. *Ibid*.,

21.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 386-393). Discovery Institute Press. Kindle Edition.]

- Fodor and Piattelli-Palmarini conclude in words which echo the position I will defend throughout this work (also echoing Owen's distinction between homolog [the melody] and adaptive mask [tuning the piano]): "We think of natural selection as tuning the piano, not as composing the melodies. That's our story, and we think it's the story that modern biology tells when it's properly construed."⁶⁶ [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 394-397). Discovery Institute Press. Kindle Edition.]
- Admittedly, there are still many prominent figures such as Michael Ruse,⁶⁷ Jerry Coyne,⁶⁸ Daniel Dennett,⁶⁹ and Richard Dawkins⁷⁰ who strictly adhere to a pan-adaptational framework and to the notion that all macroevolutionary phenomena, from the origin of life to the origin of man, can be generally accounted for by the same mechanism, cumulative selection, that works at the microevolutionary level. [67. Michael Ruse, "Form and Function: Placing Brian Goodwin," in *The Intuitive Way of Knowing: A Tribute to Brian Goodwin*, edited by Chris Chetland, David Lambert, and Craig Millar (Edinburgh: Floris Books, 2013). In an excellent article reviewing and contrasting the structuralist functionalist paradigms, Ruse confesses his adherence to functionalism. 68. Jerry A. Coyne, *Why Evolution Is True* (New York: Oxford University Press, 2009). 69. Daniel Dennett, *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (New York: Simon & Schuster, 1995). 70. Richard Dawkins, *The Blind Watchmaker*, new edition (London: Penguin, 2006).] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 398-402). Discovery Institute Press. Kindle Edition.]
- I believe, along with Owen and many other nineteenth-century biologists, that life is an integral and lawful part of nature and that the basic forms of life are in some sense built into nature. I see this notion massively reinforced by the evidence of twentieth-century cosmology that the laws of nature are uniquely fine-tuned for life. Inevitably, therefore, this book is a defense of the typological world-view similar to that subscribed to by many nineteenth-century biologists: that the taxa-defining homologs represent a special set of natural forms which constitute the immutable building blocks of the

biological world. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 436-441). Discovery Institute Press. Kindle Edition.]

2. Galápagos

- Reflecting on this remarkable group of birds Darwin famously (and rightly) inferred: “Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends.”⁷ [7. Charles Darwin, *Voyage of the Beagle* (1845 edition), Chapter 17, 402.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 495-497). Discovery Institute Press. Kindle Edition.]
- In other words, species were not specially created. Existing species had descended with modification from pre-existing species. This realization was for Darwin, as he later described it, “like confessing to murder,”⁸ so entrenched was the then universally accepted doctrine of the fixity of species. [8. Letter from Darwin to J. D. Hooker, January 11, 1844, Darwin Correspondence Project, University of Cambridge, 2015, <https://www.darwinproject.ac.uk/letter/entry-729>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 499-502). Discovery Institute Press. Kindle Edition.]
- Darwin, perhaps more than any subsequent evolutionist, was committed to an extremely gradualistic model, insistent that evolution by natural selection can never take jumps,¹⁹ and that the individual variants upon which selection acts are very small. [19. On reading the *Origin*, Thomas H. Huxley cautioned against Darwin’s stress on such an intensely gradualistic approach [“Huxley, T. H. to Darwin, C. R., Nov. 23, 1859,” Darwin Correspondence Project, University of Cambridge, 2015, <http://www.darwinproject.ac.uk/letter/entry-2544>]; on many occasions in the *Origin*, Darwin stressed that evolution by natural selection is an extremely gradual process [1872: 114, 146, 156, 413–414]. He several times used the Latin aphorism *Natura non facit saltum* [1872: 156, 166, 234, 414].] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 549-551). Discovery Institute Press. Kindle Edition.]
- Because cumulative selection acts only to adapt an organism to its immediate

environmental conditions, without any concern for what the long-term consequences of any specific adaptation might be or where it might lead, it has no foresight.³⁰ And without foresight, the ends or designs it can achieve are those (to employ Dawkins's aptly-chosen analogy) of a "blind watchmaker."³¹ It is the absolute blindness of the process that is its hallmark and carries such radical implications.³² As Ernst Mayr put it, "The truly outstanding achievement of the principle of natural selection is that it makes unnecessary the invocation of 'final causes'—that is, any teleological forces leading to a particular end. In fact, nothing is predetermined. Furthermore, the objective of selection even may change from one generation to the next, as environmental circumstances vary."³³ [30. Ernst Mayr, "Darwin's Influence on Modern Thought," *Scientific American* (July 2000): 79–83. 31. Dawkins, *Blind Watchmaker*. 32. Mark Ryland, "Applying Natural Philosophy to a Modern Controversy: The Surprisingly Difficult Case of Darwinism, Transformism, and Intelligent Design," draft version 0.95 (July 2007) (substantially revised version of paper originally presented at the meeting of the American Maritain Association, November 2, 2006): "The standard, reductionist understanding of neo-Darwinian theory treats the obvious teleology of living things to be probably a complete illusion and at best a kind of basically inexplicable epiphenomenon true only of living things—"teleonomy" in the compromising word promoted by Ernst Mayr and others. It is this profound disconnect between our common experience of the purposive world of living beings and a reductionist, a-teleological theory that underlies the continuing doubts about the adequacy and completeness of neo-Darwinism. Indeed, the disconnect is worse than that: unlike most modern sciences, which explain via a-teleological 'laws' alone, neo-Darwinism explains primarily by chance. Thus, more than a-teleological (the normal status of Newtonian explanations) neo-Darwinism is anti-teleological due to the crucial—and relatively unique among modern sciences—role of chance as the basis for all innovation and "progress" in evolution: after all, the fittest must first "arrive" before they can "survive," and the "arrival of the fittest" is purely a chance event. Natural selection only comes into play as a winnowing process among already existing and reproducing biological entities." 33. Ernst Mayr, "Darwin's Influence on Modern Thought," 80.] [Michael Denton: *Evolution, Still a Theory in Crisis*

(Kindle Locations 607-614). Discovery Institute Press. Kindle Edition.]

- It is worth noting that the typologists of the nineteenth century, though seeing life's forms as the result of laws and hence "natural," also interpreted these laws as causal agents within a comprehensive teleological framework. Louis Agassiz, for example, saw the Types as ideas in the mind of God³⁶ and saw the whole taxonomic system as part of God's grand plan of creation. In his *Essay on Classification* he argued: "To me it appears indisputable, that this order... [is] in truth but translations into human language of the thoughts of the Creator."³⁷ Owen also viewed nature's order as the result of a Divine plan. He even went so far in his *On the Anatomy of Vertebrates* to declare "the Horse to have been pre-destined and prepared for man."³⁸ However, although Owen saw nature as the result of design, he believed that God had used natural laws to achieve His ends.³⁹ As Owen commented, one of his aims was "to show in these structures [i.e., "the parts and organs" of vertebrate animals] the evidence of a predetermining Will, producing them in reference to a final purpose."⁴⁰ [36. Gould, SET, Chapter 4, 272. 37. Louis Agassiz, *Essay on Classification* (Mineola: Dover, 2004), 9. 38. Richard Owen, *On the Anatomy of Vertebrates*, vol. 3 (London: Longmans, Green and Co., 1866), 796. 39. Nicolaas Adrianus Rupke, *Richard Owen: Biology without Darwin* (Chicago: University of Chicago Press, 2009), Chapter 5, 141. 40. Richard Owen, *On the Anatomy of Vertebrates*, Vol. I: Fishes and Reptiles (London: Longmans, Green, and Co., 1866), v–vi.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 621-631). Discovery Institute Press. Kindle Edition.]
- New forms of life are the outcome of the machinations of a "blind watchmaker." Daniel Dennett writes: "The fundamental core of contemporary Darwinism... is now beyond dispute among scientists... the hope that it will be 'refuted' by some shattering breakthrough is about as reasonable as the hope that we will return to a geocentric vision and discard Copernicus."⁴¹ [41. Dennett, *Darwin's Dangerous Idea*, 20.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 640-643). Discovery Institute Press. Kindle Edition.]
- Similarly, according to Richard Dawkins, "Darwinism is true, not just on this planet but all over the universe wherever there is life to be found."⁴²

[42. Dawkins, *Blind Watchmaker*, xvii.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 643-644). Discovery Institute Press. Kindle Edition.]

3. The Hierarchy of Nature

- The hierarchy of ever more inclusive Types defined by one or more novel homologs provides the basis for the natural system and is also reflected in the biology of each individual species. Man, for example, manifests in the design of his body the vertebrate Bauplan or primal pattern (shared by all vertebrates); in his arm and leg, the tetrapod homolog (shared by all terrestrial vertebrates); the amniotic membrane (shared by all higher vertebrates); and in his diaphragm, a defining mammalian homolog shared by all mammals. Each organism can be considered to be built up out a suite of basic homologs that constitute its anatomy. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 701-705). Discovery Institute Press. Kindle Edition.]
- The Pentadactyl Limb: All extant terrestrial vertebrates (and their aquatic descendants, such as whales, seals, and turtles) are grouped within the clade Tetrapoda, and possess a unique defining Bauplan known as the pentadactyl limb, consisting of one proximal bone (the humerus in man), two more distal bones (the radius and ulna in man), and five digits as well as other unique features. This basic pattern has been conserved in all tetrapods for 400 million years. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 716-720). Discovery Institute Press. Kindle Edition.]
- The Feather All modern birds, and some related groups of reptiles,10 possess closed pennaceous contour feathers consisting of a central shaft or rachis. (See Figure 3-2.) Fused to the rachis are barbs, and attached to each barb are hooked distal barbules pointing towards the tip of the feather and interlocking grooved proximal barbs pointing to the base of the feather. (See Figure 3-3.) All organisms possessed of this defining feature can be unambiguously assigned to a unique clade belonging to the more inclusive dinosaur clade Theropoda.¹¹ [10. There is controversy about whether there are “reptiles” with pennaceous feathers. Some researchers have argued that they are actually secondarily flightless birds and NOT reptiles/dinosaurs. For references see Casey Luskin, “Is the Latest ‘Feathered Dinosaur’ Actually a

Secondarily Flightless Bird?,” Evolution News & Views, Nov. 12, 2008, http://www.evolutionnews.org/2008/11/is_the_latest_feathered_dinosa013131.html. 11. “Dinosaur,” Wikipedia, accessed on August 18, 2015, <http://en.wikipedia.org/wiki/Dinosaur>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 720-726). Discovery Institute Press. Kindle Edition.]

- The Insect Body Plan All living insects possess a set of unique defining features. The insect body has three divisions: head, thorax, and abdomen. The thorax consists of three segments, each bearing a pair of legs, making a total of six legs altogether. Eleven segments can be recognized in the abdomen of most juvenile insects, and although some insect adults—including cole-optera (beetles) and hymenoptera (wasps, bees, ants, etc.)—have fewer than eleven segments, no insect has more than eleven. The legs of all insects consist of no more than five components: the coxa, the trochanter, the femur, the tibia, and the tarsus. (See Figures 3-4 and 3-5.) The tarsus itself is typically divided into five subsegments. The insect mouth, in all the diverse species, consists of four parts from front to back: the labrum, the mandibles, the maxillae, and the labium. Finally, all insects possess two antennae, which are mobile jointed appendages. Invertebrates that possess these defining features can be unambiguously assigned to the class Insecta. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 731-739). Discovery Institute Press. Kindle Edition.]
- Further, all wings in extant species of insect are based on the same underlying homologous taxon-defining venation pattern, and each order of insects has its own taxon-defining variation on this underlying theme. As Penelope Gullan and Peter Cranston point out in their well-known text, *The Insects*: “All winged insects share the same basic [venation pattern]... Wing venation patterns are consistent within groups (especially families and orders), but often differ between groups... [and are] major features used in insect classification and identification.”¹² [12. Penelope J. Gullan and Peter S. Cranston, *The Insects: An Outline of Entomology*, 4th ed. (Chichester, West Sussex: Wiley-Blackwell, 2010), section 2.42, page 46.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 741-745). Discovery Institute Press. Kindle Edition.]

- There is indeed something incongruous about the very notion of distinct taxa and genuine immutable “taxon-defining novelties”—more than 100,000 according to Rupert Riedl—in the context of the functionalist Darwinian framework, which implies that all taxa-defining traits should be led up to via long series of adaptive transitional forms! On such a Darwinian model, taxa-defining novelties should not exist; neither should distinct Types in which all members possess unique defining novelties not shared by the members of any other taxa. As I will try to clarify in Chapter 6, the apparent conflict between the widespread claim that there are many transitional forms³³ and the contrary claim that transitional forms are rare³⁴ or absent has arisen out of confusion of homologs with the Types they define. [33. Jerry Coyne, *Why Evolution Is True* (New York: Oxford University Press, 2009). 34. Stephen Jay Gould, *The Panda’s Thumb: More Reflections in Natural History* (New York: Norton, 1992), 189; Gould, “Evolution’s Erratic Pace,” *Natural History* 86, no. 5 (May 1977): 14.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 821-828). Discovery Institute Press. Kindle Edition.]
- Not surprisingly, there have been authors who have argued just this point: that the existence of taxon-defining characteristics is incompatible with the whole notion of gradual neo-Darwinian transformations. For example, Riedl has written: “If every character were free to change in every direction, the living world would appear as a random chaotic mixture of patterns, and the single relationship left among their representatives would not relate to common ancestry but only to common functions, such as analogous limbs, horns, wings, jaws and so forth.”³⁵ [35. Riedl, “A Systems-Analytical Approach to Macro- Evolutionary Phenomena,” 351–370, 354.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 828-832). Discovery Institute Press. Kindle Edition.]
- The same point was explicitly made by John Beatty in a critique of radical cladism in the early 1980s. He argued that “pattern cladistics is not, after all, evolutionarily neutral. Rather, it is at odds with evolutionary theorising.” He went on to argue that systematists are justified in abandoning the search for defining characters because if evolution occurs, taxa should have no “properties that are collectively necessary and sufficient for membership in

the group.³⁶ On such a view there should indeed be no taxa-defining novelties.³⁷ [36. John Beatty, “Classes and Cladists,” *Systematic Zoology* 31, no. 1 (March 1982): 25–34, emphasis added, accessible from <http://www.jstor.org/discover/10.2307/2413411?uid=3739136&uid=2129&uid=2&uid=70&uid=4&sid=21104215743803>. 37. See discussion in Chapter 6, section 6.1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 832-837). Discovery Institute Press. Kindle Edition.]

- Let me reiterate: If evolution has occurred as conceived of by Darwin, invariant taxa-defining novelties, not led up to via long sequences of transitional forms from some antecedent structure, should not exist. But exist they do! Riedl (a world authority on marine invertebrates and one of the foremost biological theorists in the last quarter of the twentieth century) was someone who definitely knew these facts, and he was moved to comment: Although such fixation [the invariance of the taxa-defining traits] may not be self-evident to some of my colleagues, I must emphasize that in accepting the evolutionary history of taxonomic groups the fixation of homologues is a logical necessity. Thus for example, the chorda remains a chorda in all chordates from ascidians to man; the backbone remains a backbone in all vertebrates, from frog to python; and a particular digit remains the same digit in all tetrapods from horses to bats.³⁸ [38. Riedl, “A Systems-Analytical Approach to Macro- Evolutionary Phenomena,” 351–370.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 837-844). Discovery Institute Press. Kindle Edition.]
- Unique invariant homologs which define the Types do exist, and it is their retention in invariant form in all the members of the Type they define which not only provides evidence of common descent but is at the basis of all biological classification schemes. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 849-851). Discovery Institute Press. Kindle Edition.]
- The testimony of a biologist of Riedl’s stature that there are indeed unique Type-defining invariant homologs and that many have been fixed for millions of years is no trivial matter. And Riedl is not alone. Gould similarly acknowledged that “taxonomists must base their hierarchical orderings on nested levels of homological retention among related taxa.”³⁹ [39. Gould,

SET, 1065, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 851-854). Discovery Institute Press. Kindle Edition.]

- Someone else who knows the facts is Norman Platnick, Curator Emeritus of the invertebrate zoology department of the American Museum of Natural History. He hit back with a rebuttal to Beatty in *Systematic Zoology* in a letter entitled “Defining Characters and Evolutionary Groups,”⁴⁰ insisting that defining characters do indeed exist and that the typological pattern they imply is compatible with evolution (or, as I prefer to term it, “descent with modification”; see my later discussion in Chapter 6 showing why distinct Types and descent with modification are compatible). [40. Norman I. Platnick, “Defining Characters and Evolutionary Groups,” *Systematic Zoology* 31, no. 3 (September 1982): 282–284, 282, accessible from <http://www.jstor.org/discover/10.2307/2413233?uid=3739136&uid=2&uid=4&sid=21104215660463>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 854-859). Discovery Institute Press. Kindle Edition.]
- In another, earlier landmark publication Nelson and Platnick defended vigorously the notion that taxa have defining traits and that it is the business of systematics to discover them: Since the advent of the so-called new Systematics, it has become popular to deprecate as “essentialistic” or “typological” the notions that species (and hence groups of them) have defining characters, and that it is the business of systematics to find them... The rationale for this deprecation seems to be that if evolution occurs, the characters of species (and hence groups) may change in the future; therefore, species and groups of species cannot be permanently characterized by means of a single character or set of characters such that the character or set is necessary and sufficient for membership in the species or group. The argument seems to rest on the misleading use of character states: it assumes that when a species is modified, and acquires a new apomorphic character (state), it is no longer recognizable as having, the original plesiomorphic character (state). In other words, according to this argument, we cannot use characters (such as fins) to define groups (such as Vertebrata), because some members of those groups (such as tetrapods) may acquire apomorphies (such as limbs). If one accepts the validity of ontogeny or outgroup comparison

(i.e., Parsimony) or any other possible test of hypotheses about character transformation, the argument is obviated. In this sense, systematists always have been, are, will be, and should be typologists.”⁴¹ [41. Gareth Nelson and Norman Platnick, *Systematics and Biogeography* (New York: Columbia University Press, 1981), 328, emphasis added. See also Denton, *Evolution: A Theory in Crisis*, chapter 5.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 859-870). Discovery Institute Press. Kindle Edition.]

- the testimony of Colin Patterson, Norman Platnick, Gareth Nelson, Don Rosen, and the other first-class biologists at two of the major biological research institutes in the English-speaking world⁴² still stands: There are taxa-defining novel homologs (the pentadactyl limb, the flower, the diaphragm, etc.); these homologs are not led up to via series of intermediates; and they do persist and exert their constraining powers in diverse lineages in different taxa for millions of years. In other words, typology is no anti-Darwinian fantasy. The testimony of these biologists has left a lasting mark on the evolutionary debate and left Darwinists with an uphill battle trying to perpetrate the illusion that there are no novel taxa-defining homologs in nature.⁴³ [43. As already mentioned in Chapter 1, for a review of the many controversies that surrounded the “rise of cladism” in the 1980s and 1990s, see David Williams, *Foundations of Systematics and Biogeography* (New York: Springer, 2008), Chapter 6.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 872-878). Discovery Institute Press. Kindle Edition.]
- Sean B. Carroll, perhaps one of the most committed Darwinists among researchers in evo-devo, gives a section of his lucid *Endless Forms Most Beautiful*⁴⁷ the title “On Novelties” and uses the term “innovation” over twenty-five times in the text. Further, he explicitly describes the ground plan of the butterfly wing, the insect wing, and the autopod (in man the autopod refers to the hand and foot, the distalmost component of the limb) as “innovations.” From his discussion of these and other “novelties,” it is quite clear that he makes no pretense that they are led up to via functional continuums. [47. Carroll, *Endless Forms Most Beautiful*, Chapter 11.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 899-904). Discovery Institute Press. Kindle Edition.]

- Even that doyen of Darwinists, Ernst Mayr, accepted that novelties do indeed exist, and he produced a well-known paper discussing the subject entitled “The Emergence of Evolutionary Novelties” for a conference celebrating the centenary of the publication of *Origin of Species*.⁴⁸ [48. Ernst Mayr, “The Emergence of Evolutionary Novelties,” in S. Tax, ed., *Evolution After Darwin* (Chicago: Chicago University Press, 1959), vol 1, 349-380. Available online:

http://archive.org/stream/evolutionafterda01taxs/evolutionafterda01taxs_djvu.txt. Mayr defines novelties (p. 351) as: “any newly arisen character, structural or otherwise, that differs more than quantitatively from the character that gave rise to it... Tentatively, one might restrict the designation ‘evolutionary novelty’ to any newly acquired structure or property that permits the assumption of a new function.” He advocated exaptation as a major route to novelties (p. 377): “The emergence of new structures is normally due to the acquisition of a new function by an existing structure.”] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 904-906). Discovery Institute Press. Kindle Edition.]

- The titles of many recent books and papers in evo-devo and in evolutionary biology generally also betray the fact that genuine novelties are a primal fact of the biological universe.⁴⁹ And as Massimo Pigliucci reminds us, novelties are not restricted to the defining traits of the major phyla: “[Novelties] span all levels of biological organization, from morphological to behavioral to molecular traits.”⁵⁰ [49. For examples, see: Matthew H. Nitecki, ed., *Evolutionary Innovations* (Chicago: University of Chicago Press, 1990); Arthur, “Intraspecific Variation in Developmental Characters: The Origin of Evolutionary Novelties,” 811–818; Günter P. Wagner, “What Is the Promise of Developmental Evolution? Part I: Why Is Developmental Biology Necessary to Explain Evolutionary Innovations?” *Journal of Experimental Zoology* 288, no. 2 (August 15, 2000): 95–98, doi:10.1002/1097-010X(20000815)288:2<95::AID-JEZ1>3.0.CO;2-5; Alan C. Love, “Evolutionary Morphology, Innovation, and the Synthesis of Evolutionary and Developmental Biology,” *Biology and Philosophy* 18, no. 2 (2003): 309–345; Richard O. Prum, “Evolution of the Morphological Innovations of Feathers,” *Journal of Experimental Zoology* 304B, no. 6 (2005): 570–579; Gerd B. Müller and Stuart A. Newman, “The Innovation Triad: An EvoDevo

Agenda,” *Journal of Experimental Zoology* 304B, no. 6 (2005): 487–503; Massimo Pigliucci, “What, If Anything, Is an Evolutionary Novelty?” *Philosophy of Science* 75, no. 5 (December 2008): 887–898, doi:10.1086/594532. See also Günter P. Wagner and Vincent J. Lynch, “Evolutionary Novelty,” *Current Biology* 20 (2010): R48–52. Wagner and Lynch describe a novelty as: “A novel body part that is neither homologous to any body part in the ancestral lineage nor serially homologous to any other body part of the same organism. To define novelty using the homology concept may sound like replacing one poorly defined term by another. In recent years, however, homology has re-emerged as a core organizing principle in evolutionary developmental biology. Applied to morphological structures the term homology, refers to quasi-independent, individualized body parts that have their own evolutionary history, i.e., are derived from the same body part in a common ancestor and which form lineages of descent with modification, as exemplified by the evolutionary history of tetrapod limbs and eyes.” For further examples, see Richard O. Prum and Alan H. Brush, who write of “many novelties involved in feather evolution” in their “The Evolutionary Origin and Diversification of Feathers,” *The Quarterly Review of Biology* 77, no. 3 (September 2002): 261–295; Gerd B. Müller and Günter P. Wagner “Novelty in Evolution: Restructuring the Concept,” *Annual Review of Ecology and Systematics* 22 (1991): 229–256; Mary Jane West-Eberhard, who in *Developmental Plasticity and Evolution* (Oxford University Press, 2003) defines a novel trait as “a novel trait [based on] a qualitatively distinct developmental variant” (page 198); Andreas Wagner, *The Origins of Evolutionary Innovations: A Theory of Transformative Change in Living Systems* (New York: Oxford University Press, 2011). The recently published book by Wagner, *Homology, Genes, and Evolutionary Innovation* contains several chapters (e.g., Chapter 4) devoted to defining evolutionary novelties. 50. Pigliucci, “What, If Anything, Is an Evolutionary Novelty?” 888.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 907-910). Discovery Institute Press. Kindle Edition.]

- Günter Wagner distinguishes two types of evolutionary novelty: those (Type I) without any antecedent (new homologs), and those (Type II) that involve a major character transformation of an existing homolog.⁵¹ This distinction is perfectly valid. However, in the argument I mount here, I am using the

term “novelty” or homolog to cover both Type I and Type II novelties, because systematists use both sorts of novelties as defining traits in classifying taxa. Moreover, both sorts of novelty are invariably difficult to account for in terms of Darwinian cumulative selection. [51. Wagner, Homology, Genes, and Evolutionary Innovation, Chapter 4, 126.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 911-915). Discovery Institute Press. Kindle Edition.]

- Not only is the existence of genuine novel homologs widely conceded; it is also widely acknowledged that explaining how novelties arise is one of the key problems that evolutionary biology must address.⁵² As Wagner comments: “The most promising areas for developmental evolution [are] the explanation of evolutionary innovations and the evolution of body plans. Indeed, the most exciting research in developmental evolution is directly or indirectly aiming at these questions, which proved to be out of the reach of the classical population genetics.”⁵³ [52. A recent series of papers in the *Journal of Experimental Zoology* was devoted entirely to the problem of evolutionary novelties and how they arise. See “Special Issue: Perspectives on Evolutionary Novelty and Evo-Devo,” *Journal of Experimental Zoology Part B: Molecular and Developmental Evolution* 318, no. 6 (September 2012): 417–517. 53. Günter P. Wagner, “What Is the Promise of Developmental Evolution? Part I: Why Is Developmental Biology Necessary to Explain Evolutionary Innovations?” 95.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 915-920). Discovery Institute Press. Kindle Edition.]
- In another recent paper, Wagner and Lynch explain that accounting for the origin of novelties involves a new research program focused “on the evolution of body plans of multicellular organisms” in which “researchers seek to explain the origin of flowers, feathers, and the turtle[']s shell.” They freely admit that “the study of these and other morphological novelties faces unique challenges, among the most important of which is explaining the origin and divergence of the novel gene regulatory networks that give morphological innovations their unique developmental and evolutionary identity.”⁵⁴ [54. Wagner and Lynch, “Evolutionary Novelties,” R48.-R49.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 920-924). Discovery Institute Press. Kindle Edition.]

- Again, Wagner and Lynch acknowledge in another recent article: “A fundamental challenge in biology is explaining the origin of novel phenotypic characters such as new cell types.”⁵⁵ Pigliucci comments in the same vein: “[E]volutionary novelties persist as a fascinating problem for theorists and experimentalists alike, a problem that has been taken seriously enough to become a major stated goal of a whole field of investigation, known as ‘evo-devo.’”⁵⁶ [55. Vincent J. Lynch, Robert D. Leclerc, Gemma May, and Günter P. Wagner, “Transposon-Mediated Rewiring of Gene Regulatory Networks Contributed to the Evolution of Pregnancy in Mammals,” *Nature Genetics* 43, no. 11 (September 25, 2011): 1154–1159, 1154, doi:10.1038/ng.917. 56. Pigliucci, “What, If Anything, Is an Evolutionary Novelty?” 887, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 925-929). Discovery Institute Press. Kindle Edition.]
- In short, nature is still very much an empirical discontinuum of invariant unique forms, and there is no direct evidence that the “gaps” were ever closed by the functional continuums demanded by Darwinian theory. The fact that nearly all the authors cited above who confess to the reality of taxon-defining novelties are confirmed evolutionists—and are therefore intellectually predisposed to seek transitional forms—only serves to highlight the fact that the homologs are genuine novelties and the divisions they define are real! [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 929-933). Discovery Institute Press. Kindle Edition.]
- This is not to claim that the Types were not actualized by natural processes. I believe they were and that the entire pattern of evolution was prefigured into the order of things from the beginning. Although I think the evidence is consistent with most of the novelties being achieved in a relatively saltational manner (as discussed in Chapter 6, section 6.4), typology does not demand absolute saltation, just that the Types (or more properly the homologs which define them) are a special set of robust natural forms or stable material systems, part of nature’s order from the moment of creation, to which the paths of evolution were inevitably drawn. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 933-938). Discovery Institute Press. Kindle Edition.]

- Thirty years later, despite the discovery of a huge number of new fossil forms and despite massive advances in every field of biology, especially evo-devo, it is still overwhelmingly true, as I insisted in *Evolution* and as Darwin confessed 150 years ago: “The distinctness of specific forms and their not being blended together by innumerable transitional links, is a very obvious difficulty.”⁵⁸ Evolutionary novelties do exist and accounting for their causation is one of the major unsolved challenges of evolutionary biology. [58. Darwin, *Origin of Species* (1872), 264 (Chapter 10).] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 945-949). Discovery Institute Press. Kindle Edition.]

4. Non-Adaptive Order

- Owen argued that many of these ground plans (like the pentadactyl ground plan of the tetrapod limb) do not appear to be adaptive. That is, they do not appear to have or to have ever had any role in fashioning actual organisms to meet specific adaptive ends.³ Such “primal patterns”—transcending “any particular circumstance” as Gould describes it⁴—therefore could not be the result of adaptive evolution as Darwin claimed. Owen believed, as mentioned in Chapter 1, that these deep homologous patterns were immanent aspects of the world order which arose in some way from the intrinsic physical properties of living things. [3. For a definition of non-adaptive see beginning of Chapter 1. 4. Stephen Jay Gould, *The Structure of Evolutionary Theory* (Cambridge, MA: Belknap Press [Harvard], 2002), 252; henceforth cited as Gould, SET.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 971-977). Discovery Institute Press. Kindle Edition.]
- To show that their adaptive status is indeed very much in doubt was the grand aim of Owen’s classic critique of functionalism in his landmark *On the Nature of Limbs*, which originated as a lecture before the Royal Institution in Great Britain.⁵ At the beginning of this classic, still one of the greatest anti-functionalist and anti-Darwinian documents ever composed in the English language, Owen makes a remark that has proved to be extraordinarily prophetic: It was not until I had written and erased two or three [titles for this lecture]... that I became fully conscious how foreign to English philosophy were those ideas or trains of thought [i.e., the structuralist

notion that not all aspects of morphology serve functional/adaptive ends] concerned in the discovery of anatomical truths, one of which I propose to explain on the present occasion in reference to the limbs or locomotive extremities.⁶ [5. The full text of *On the Nature of Limbs* is available at <https://archive.org/details/Owen1849br46D>. 6. Richard Owen, *On the Nature of Limbs* (London: John Van Voorst, 1849), 1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 984-991). Discovery Institute Press. Kindle Edition.]

- Riedl expressed a similar view in his *Order in Living Organisms*: In central Europe it has been believed that structural patterns could not be explained entirely in terms of immediate function; and the search for a deeper explanation, which began with Goethe and continued throughout the nineteenth century, became confused with German idealistic philosophy—a fact which made it both difficult and suspect for English speaking scientists... As a result the word ‘morphology’ became disreputable in English.⁸ [8. Rupert Riedl, *Order in Living Organisms* (New York: John Wiley and Son’s, 1978), xv.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 996-1001). Discovery Institute Press. Kindle Edition.]
- But what is very surprising is this: If the sole organizational principle of life is (as functionalists assert) adaptation, why should the adaptive forms of tetrapod limbs—what Owen terms “adaptive masks”—be based on the same underlying “primal pattern”? The problem for functionalists is that the underlying pattern cannot itself be construed to be serving any specific adaptive function—i.e., to fit any conceivable real organism to any conceivable actual environment. As Amundson succinctly comments: “Limbs are differently adapted, but they share common structure. His [Owen’s] point is that the commonality of structure is not traceable to function.”¹¹ [11. Ronald Amundson, *The Changing Role of the Embryo in Evolutionary Thought: Roots of Evo-Devo* (Cambridge: Cambridge University Press, 2005), 93.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1010-1015). Discovery Institute Press. Kindle Edition.]
- As Owen points out, mankind does not construct various machines for diverse

purposes on the same underlying plan: To break his ocean-bounds the islander fabricates his craft, and glides over the water by means of the oar, the sail, or the paddle-wheel. To quit the dull earth Man inflates the balloon, and soars aloft, and, perhaps, endeavours to steer or guide his course by the action of broad expanded sheets, like wings. With the arched shield and the spade or pick he bores the tunnel: and his modes of accelerating his speed in moving over the surface of the ground are many and various. But by whatever means or instruments Man aids, or supersedes, his natural locomotive organs, such instruments are adapted expressly and immediately to the end proposed. He does not fetter himself by the trammels of any common type of locomotive instrument, and increase his pains by having to adjust the parts and compensate their proportions so as best to perform the end required... There is no community of plan or structure between Stephenson's locomotive engine and Brunel's tunnelling machinery: a very remote analogy, if any, can be traced between the instruments devised by man to travel in the air and on the sea, through the earth or along its surface.¹² [Ronald Amundson, *The Changing Role of the Embryo in Evolutionary Thought: Roots of Evo-Devo* (Cambridge: Cambridge University Press, 2005), 9-10.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1015-1025). Discovery Institute Press. Kindle Edition.]

- And then Owen makes the decisive point: Nor should we anticipate, if animated in our researches by the quest for final causes [the adaptational paradigm] in the belief that they were the sole governing principle of organization, a much greater amount of conformity in the construction of the natural instruments by means of which those different elements are traversed by different animals. The teleologist [adaptationist] would rather expect to find the same direct and purposeful adaptation of the limb to its office as in the machine. A deep and pregnant principle in philosophy, therefore, is concerned in the issue of such dissections, and to these, therefore, I now pass, premising that the end in view will be attained without extending the comparison beyond the framework of the limbs, or the leverage of the bones and joints.¹³ [Ronald Amundson, *The Changing Role of the Embryo in Evolutionary Thought: Roots of Evo-Devo* (Cambridge: Cambridge University Press, 2005), 10.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1025-1032). Discovery Institute Press. Kindle

Edition.]

- Owen again stresses near the end of the monograph: “The Fallacy [of pan-adaptationism] perhaps lies in judging created organs by the analogy of man made machines.”¹⁴ [14. Owen, *On the Nature of Limbs*, 85. Owen is surely right; pan-adaptationalism does indeed arise at least partially from the fallacy of accepting the machine analogy. Machines such as a watch, Paley’s watch, are “bundles of adaptations” in which all parts are arranged to serve functions. If the analogy holds, then pan-adaptationism must also hold and organisms must also be bundles of adaptations. But Owen’s jibe, which was aimed specifically at natural theology (which has always emphasized the machine/organism analogy), may also be seen as aimed at Darwinism. Darwinism no less than natural theology sees organisms as machines i.e., contingent assemblages put together not by a Divine Watchmaker but by the Blind Watchmaker, bit by bit, by cumulative selection, to serve various adaptive purposes. Of course, because there is no objective grounds for assuming that organisms are machines, there is no objective reason for holding to the fallacy. If organisms are, as Owen believed (and I concur) at least in part, natural forms, then pan-adaptationalism is ruled out on first principles. And of course, as Owen asserts in the citations above, no human-constructed adaptation or machine is encumbered with constraints analogous to the Bauplans that underlie the adaptive diversity of life.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1032-1034). Discovery Institute Press. Kindle Edition.]
- Darwin was clearly impressed by Owen’s critique of pan-adaptationism in *Limbs*. In the *Origin* he concedes: What can be more curious than that the hand of a man, formed for grasping, that of a mole for digging, the leg of the horse, the paddle of the porpoise, and the wing of the bat, should all be constructed on the same pattern, and should include similar bones, in the same relative positions? How curious it is, to give a subordinate though striking instance, that the hind-feet of the kangaroo, which are so well fitted for bounding over the open plains,—those of the climbing, leaf-eating koala, equally well fitted for grasping the branches of trees,—those of the ground-dwelling, insect or root-eating, bandicoots,—and those of some other Australian marsupials,—should all be constructed on the same extraordinary type, namely with the bones of the second and third digits extremely slender

and enveloped within the same skin, so that they appear like a single toe furnished with two claws. Notwithstanding this similarity of pattern, it is obvious that the hind feet of these several animals are used for as widely different purposes as it is possible to conceive. The case is rendered all the more striking by the American opossums, which follow nearly the same habits of life as some of their Australian relatives, having feet constructed on the ordinary plan.¹⁶ [16. Darwin, *Origin of Species* (1972), 382.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1060-1070). Discovery Institute Press. Kindle Edition.]

- Darwin actually concedes that these formal patterns have no apparent specific adaptive utility: “Nothing can be more hopeless than to attempt to explain this similarity of pattern of members of the same class, by utility [to serve environmental constraints] or by the doctrine of final causes [teleology or design]. The hopelessness of the attempt has been expressly admitted by Owen in his most interesting work on the ‘Nature of Limbs.’”¹⁸ Darwin also specifically mentions Owen’s allusion to multiple centers of ossification in the vertebrate skull as being beyond adaptive explanation: “As Owen has remarked, the benefit derived from the yielding of the separate pieces in the act of parturition by mammals, will by no means explain the same construction in the skulls of birds and reptiles.”¹⁹ [Darwin, *Origin of Species* (1972), 384.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1075-1081). Discovery Institute Press. Kindle Edition.]
- Owen’s conclusion was simple and compelling: Functionalism cannot provide a comprehensive explanation for all organic order, and adaptation is not the only or even the primary organizational principle of biology.²⁰ Whatever else Limbs achieved, it rendered pan-adaptationism absurd. As Amundson comments: “Owen didn’t just ‘admit’ the failure of teleology [pan-adaptationism] ... in Limbs: he gleefully proved it!”²¹ [20. Owen, *On the Nature of Limbs*, 40. 21. Amundson, *The Changing Role of the Embryo*, 97.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1081-1085). Discovery Institute Press. Kindle Edition.]
- Nicolaas Rupke notes that Owen’s conception of the archetype or Bauplan did shift the evidence for design from special to general teleology: “Divine contrivance was to be recognized not so much anymore in the characteristics

of separate species but in their common ground plan. God was no longer the Supreme Watchmaker but the Supreme Architect, who had personally conceived the blueprint of nature, yet employed natural laws for the actual construction work.”²⁶ [26. Nicolaas Rupke, Richard Owen: *Biology Without Darwin*, revised edition (Chicago: University of Chicago Press, 2009), 141.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1105-1109). Discovery Institute Press. Kindle Edition.]

- In this context, it is worth considering Owen’s belief that the laws of nature are fully capable of doing God’s “constructional work” in actualizing design in nature. Consider the example of water. No one will deny that water exhibits myriads of adaptive features—including its various thermal properties, its solvation properties, its viscosity, its erosional properties, and so forth—which fit it perfectly and ideally to form the matrix of life on earth. But neither will anyone dispute the claim that water is the product of entirely natural processes. For example, no one doubts that the formula H₂O—two hydrogen atoms combined with one oxygen atom—is determined by the electronic structure of the hydrogen and oxygen atoms. No one doubts that the synthesis of the atoms of the periodic table including oxygen occurs by nuclear synthesis in stellar interiors and are scattered throughout the cosmos when stars die either sedately or in a supernova. No one doubts that the hydrogen atoms [H] were generated, also by nuclear synthesis but in the first few minutes following the creation of the universe. And no one doubts that wherever oxygen and hydrogen atoms are in contact at temperatures below several thousand degrees, two atoms of hydrogen combine with one atom of oxygen. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1109-1118). Discovery Institute Press. Kindle Edition.]
- Consider the geometrics of the wing venation patterns of particular groups of insects. In the case of the Nymphalid butterflies, the curious geometry includes the following elements as described in Charles Bingham’s classic text on the butterflies of south Asia: Fore wing: submedial vein or vein 1, simple, in one subfamily forked near base; medial vein with three branches, veins 2, 3, and 4; veins 5 and 6 arising from the points of junction of the discocellulars; subcostal vein and its continuation beyond apex of cell, vein 7, with never more than four branches, veins 8–11; 8 and 9 always arising from vein 7, 10, and also 11 sometimes from vein 7 but more often free, i.e.,

given off by the subcostal vein before apex of cell.³¹ What adaptive function can such extraordinarily complex highly conserved abstract patterns serve? [31. Charles T. Bingham, *The Fauna of British India, Including Ceylon and Burma: Butterflies, Volume 1* (London: Taylor and Francis, 1905), 22; Volume II available online here at <https://archive.org/details/faunaofbritishin025219mbp>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1139-1146). Discovery Institute Press. Kindle Edition.]

- To save his functionalist worldview, Darwin made what must be judged as one of the most unjustified legitimations in the history of science—the claim that many of the homologs that define the Types, which as we saw above he concedes have no conceivable utility in extant organisms, represent “leftovers,” or as Amundson describes them, “residues of evolution”—ancient adaptations no longer useful but incorporated into the genetic system and passed down through the generations.⁴³ [43. Amundson, *The Changing Role of the Embryo*, 8.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1183-1186). Discovery Institute Press. Kindle Edition.]
- This is surely one of the most remarkable examples of what Nagel terms “a heroic triumph of ideological theory over common sense,”⁴⁴ and of “looking away” from the actual empirical evidence.⁴⁵ Darwin gave the “leftover” legitimation for persistent homologous pattern in many places in *On the Origin of Species*. Here are some sample passages: The chief part of the organisation of every living creature is due to inheritance; and consequently, though each being assuredly is well fitted [adapted] for its place in nature, many structures [the underlying homologs] have now no very close and direct relation to present habits of life... [W]e cannot believe that the similar bones in the arm of the monkey, in the fore-leg of the horse, in the wing of the bat, and in the flipper of the seal, are of special use to these animals. We may safely attribute these structures to inheritance.⁴⁶ If we suppose that an early progenitor—the archetype as it may be called—of all mammals, birds, and reptiles, had its limbs constructed on the existing general pattern, for whatever purpose they served, we can at once perceive the plain signification of the homologous construction of the limbs throughout the class.⁴⁷ [44. Thomas Nagel, *Mind and Cosmos: Why the Materialist Neo-Darwinian Conception of Nature Is Almost Certainly False* (New York: Oxford, 2012),

Chapter 6, 126. 45. However, note that Darwin was aware that some cases of non-adaptive order might not be ancient adaptations but might be what Gould (SET, Chapter 11) refers to as “spandrels.” In Darwin’s words (Origin of Species [1872], 9): “if man goes on selecting, and thus augmenting, any peculiarity, he will almost certainly modify unintentionally other parts of the structure, owing to the mysterious laws of correlation.” 46. Darwin, Origin of Species (1872), 160. 47. Ibid., 383, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1187-1198). Discovery Institute Press. Kindle Edition.]

- Clearly, Darwin’s “explanation” that the homologs once served some purpose in some hypothetical ancestral form that he cannot specify is just an ad hoc legitimation.⁴⁸ Of course, it is an essential rationalization if Darwinism is to have any shred of credibility. But nowhere in the Origin does he attempt to provide any significant justification for this radical claim. [48. Darwin concurred with Owen regarding the non-adaptive nature of the homologs, see Amundson, *The Changing Role of the Embryo*, 100–101.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1199-1202). Discovery Institute Press. Kindle Edition.]
- Darwin, as is well known, appealed to common descent to explain the fact that all the members of a clade possessed the same suite of defining homologs. But even if common descent might explain the fact that all mammals possess hair or that all birds possess feathers, appealing to common descent does not provide a causal explanation of how the patterns originated in the first place in the “ancestral form.” Darwin and subsequent Darwinists are wrong—dead wrong—to assume that the common inheritance of the homolog from a common ancestor somehow provides a causal explanation for the origin and emergence of the homolog itself and of the Type it defines. Common descent may explain why all members of a clade share a homolog, but not that the homolog was adaptive in the common ancestor.⁵⁰ [50. Amundson, *The Changing Role of the Embryo*, 97.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1207-1213). Discovery Institute Press. Kindle Edition.]
- The Origin is based, I believe, on a fundamental misinterpretation of the nature of the homologs, on a basic failure to grasp the challenging

implication of Owen that there are no grounds for believing that “primal patterns” like the limb or insect Bauplan ever fashioned a particular (real) organism to meet a particular (real) functional end. In other words, the Origin effectively ignores the profoundly subversive fact that a great deal of order in living organisms has never been shown to be adaptive either in extant or in ancient forms. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1219-1223). Discovery Institute Press. Kindle Edition.]

- No matter how many times Darwinists reiterate the fairy story that the homologs were “once upon a time” adaptive in the ancestor of the clade they define, it is a claim without the slightest empirical or rational basis. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1223-1225). Discovery Institute Press. Kindle Edition.]
- Let us allow, for the sake of argument, that the evolution of the form of a homolog, say the pentadactyl limb design, came about in Darwinian fashion via incremental adaptive steps so that a fin gradually changed into the canonical tetrapod pentadactyl limb and that these intermediate forms were adaptive in the immediate environments in which the transitional forms lived. Common sense dictates in such a scenario that during its evolution the form of the fin/limb must have been fluid for millions of years while the form of the limb was gradually emerging in the late Devonian era. And if this is the case, we must assume that the fin or limb progenitor was a module able to undergo change, free from constraints imposed by the integrative complexity of the pre-existing body plan of the lobe-finned fish. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1267-1272). Discovery Institute Press. Kindle Edition.]
- But this explanation leads to further problems. If the homolog was “fluid” during the transition, why and how did it become fixed when the pentadactyl pattern finally emerged? Why should the canonical form have any special significance? What adaptive forces fixed a previously fluid pattern at a particular moment in evolutionary time? If adaptation can change one structure, the fin, why not its successor, the limb? The fixation of the pattern underlying all the adaptive modifications in diverse lines over the next 400 million years is all the more curious considering that the adaptive forms based upon the Bauplan did indeed change. What isolated the Bauplan—the

one, two, five, pattern—from its adaptive masks, imposing absolute invariance against any evolutionary change, while permitting vast evolutionary change in all the derived forms (the adaptive masks)? Self-evidently the initial fixation cannot be explained plausibly in Darwinian terms. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1273-1279). Discovery Institute Press. Kindle Edition.]

- There is simply no way that fixity or invariance of any organic structure can ever be conceived to be adaptive in a world of ever-changing environmental contingencies. Would there be any advantage to a species of Galápagos finch in fixing its beak form for all subsequent evolutionary time? Such fixity would be profoundly non-adaptive. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1285-1287). Discovery Institute Press. Kindle Edition.]

5. Evo-Devo

- One of the major advances since *Evolution: A Theory in Crisis* has been the revolutionary increase in our understanding of development and especially the genetics of development,¹ about which little was known in 1985. These new advances in genetics and developmental biology have led to the emergence of a whole new field, nicknamed “evo-devo” (evolutionary developmental biology). [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1339-1342). Discovery Institute Press. Kindle Edition.]
- There is no doubt that evo-devo has demonstrated that the evolutionary origin of the taxa-defining novelties, whether adaptive (e.g., feathers), or apparently non-adaptive (e.g., the pentadactyl limb and probably many other Bauplans), has involved the reorganization and co-option of existing gene circuits and the reutilization of universal developmental mechanisms. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1404-1406). Discovery Institute Press. Kindle Edition.]
- The discovery of the universal “toolkit” consisting of very widely conserved genes (like *Distal-less*) and developmental pathways is seen by most evo-devo researchers to provide new, powerful support for the concept of common descent. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1413-1415). Discovery Institute Press. Kindle Edition.]

- But common descent, or “descent with modification,” has never been in doubt since Alfred R. Wallace’s famous “Sarawak Law Paper” (written in Borneo in February 1855), in which he concluded: “Every species has come into existence coincident both in space and time with a pre-existing closely allied species.”¹⁹ Given the facts that Alfred Wallace assembles in his Sarawak Law paper, descent with modification can hardly be doubted. Many instances of the coincidence could be cited. For example, the fish that most closely resemble the first amphibians lived in the same geographical region and at the same time (the late Devonian), which is highly suggestive of an ancestor-descendant relationship.²⁰ [19. Alfred Russel Wallace, “On the Law Which Has Regulated the Introduction of New Species,” *Annals and Magazine of Natural History* 16, no. 2 (September 1855). Text available at <http://www.nhm.ac.uk/nature-online/collections-at-the-museum/wallace-collection/item.jsp?itemID=138>. 20. Neil Shubin, *Your Inner Fish: A Journey into the 3.5-Billion-Year History of the Human Body*, see chapter 1; Jennifer A. Clack, *Gaining Ground: The Origin and Evolution of Tetra-pods* (Bloomington: Indiana University Press, 2012), see chapter 4 section headed “Location of the Transition.”] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1415-1421). Discovery Institute Press. Kindle Edition.]
- While the fact that the same toolkit is used universally to make eye spots, fins and limbs, etc., supports descent with modification, it tells us very little about how the actualization of the homologs came about during the course of evolution. The mere fact that the same atoms are combined to make a brain or a paramecium, or that different cell types are combined to make different organs, or that the same twenty amino acids are combined in different ways to make the myriads of different proteins tells us nothing about how the different combinations were actualized. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1422-1426). Discovery Institute Press. Kindle Edition.]
- And it certainly does not follow that, because organ A (an ancestral structure) arises out of a combination of a, b, c, d elements and novelty B (the descendant structure) arises out of another different combination of the same elements, that A was converted to B via a long series of tiny adaptive steps

(i.e., a Darwinian functional continuum). The fact that the same atoms, proteins, cell types, gene circuits, gradients, or Turing mechanisms are utilized to make fins and hands, reptile scales and feathers, or fir cones and flowers provides in itself no evidence that the origin of such novelties occurred incrementally rather than by saltation. Nor does it imply that the transition occurred via a series of functional forms, or invalidate in any sense the claim defended here that the homologs represent inbuilt natural forms. Describing the genetic changes associated with the transition from A to B is not the same as explaining how B was derived from A. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1426-1433). Discovery Institute Press. Kindle Edition.]

- Lewis Held’s recent book *How the Snake Lost Its Legs* (2014) describes the underlying developmental and genetic changes that accompanied the origin of well over fifty different novelties. Held labels his chapters and sections with titles such as “How the butterfly got its spots,” “How the snake lost its legs,” “How the angelfish got its stripes,” “Why the chordate flipped upside down,” “How insects lost their hindlegs,” “How the horse got its hooves,” “Why the centipede has odd segments,” and so forth. The impression these titles convey (although I am not sure that this was intentional) is that the newly discovered inventory of genetic changes that accompanied these innovations provides a causal explanation of how the novelties arose and how evolutionary gaps were closed. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1439-1445). Discovery Institute Press. Kindle Edition.]
- As Massimo Pigliucci cautions, descriptions of newly co-opted gene circuits and master switches, no matter how intricate, are not enough. As far as “how... major body plans evolved, or how evolution produced phenotypic novelties, a molecular study of master switches (which is most of what evo-devo has quickly become) can provide us with only a (very) partial answer.”²² [22. Massimo Pigliucci, *Making Sense of Evolution: The Conceptual Foundations of Evolutionary Biology* (Chicago: University of Chicago Press, 2006), 270.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1447-1450). Discovery Institute Press. Kindle Edition.]

- Flipping Over One of the most fundamental of all evolutionary innovations occurred when some ancestral chordate switched its body plan from the design previously shared by all other animal groups (in which the nerve chord is in a ventral position and the heart and main blood vessel are placed dor-sally) to a design which was the exact reverse (in which the nerve chord is placed dorsally and the heart placed ventrally), and which has remained invariant in all chordates ever since. The evidence for this dorsal-ventral inversion (D-V) was revealed when evo-devo studies showed that the signaling molecules that specify the back of an insect also specify the ventral side (the belly) of a vertebrate.²⁹ Before evo-devo had revealed that the same genes were involved in specifying the dorsal-ventral axis of chordates and non-chordates, no one took seriously Geoffroy's suggestion, made early in the nineteenth century, that all animals shared the same basic body plan.³⁰ [29. Held, *How the Snake Lost its Legs*, Chapter 1; for alternate scenarios, see "Inversion (evolutionary biology)," Wikipedia, accessed on August 19, 2015, http://en.wikipedia.org/wiki/Inversion_%28evolutionary_biology%29. 30. Held, *How the Snake Lost its Legs*, Chapter 1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1496-1504). Discovery Institute Press. Kindle Edition.]
- Self-evidently, Darwinian scenarios must confront the obvious question as to whether this transition was gradual or sudden. On the one hand, it is very hard to imagine how gradual cumulative selection could carry out such a radical re-engineering of the basic body plan. What mystifying adaptive path can be proposed along which the gradual transition might have occurred? On the other hand, if the change occurred suddenly in one massive macro-mutational saltation, then Darwinian causation is ruled out of court altogether. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1504-1508). Discovery Institute Press. Kindle Edition.]
- In these four representative taxa-defining homologs, it is self-evident that the emerging evo-devo picture provides no support whatsoever for the Darwinian claim that novelties came about during the course of evolution to serve a succession of functional ends. In these four cases, the structuralist inference that internal constraints and not cumulative selection played the

key role in their actualization is difficult to refuse. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1571-1574). Discovery Institute Press. Kindle Edition.]

- These four examples are not atypical. Evo-devo advances have revealed that in many, if not the great majority, of innovations in the history of life, internal causal factors have played a predominant role. Against all traditional expectations, Darwinian selection to serve adaptive ends could only have played, in most cases, a relatively peripheral causal role. Before evo-devo, no one would have imagined that a vast amount of organic order arises from internal constraints and causal factors within organisms themselves and is not imposed by selection. What was heresy only three decades ago is now accepted doctrine. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1574-1578). Discovery Institute Press. Kindle Edition.]
- following in their celebrated “Spandrels” paper: “If development occurs in integrated packages and cannot be pulled apart piece by piece in evolution, then the adaptational programme cannot explain the alteration of developmental programmes underlying nearly all changes of Bauplan.”⁴¹ [41. Stephen Jay Gould and Richard C. Lewontin, “The Spandrels of San Marco and the Panglossian Paradigm: A Critique of the Adaptationist Programme,” *Proceedings of the Royal Society of London, Series B* 205, No. 1161 (1979): 581–598; the quoted passage can be found on page 15 of the reformatted online version of the article at <http://faculty.washington.edu/lynnhank/GouldLewontin.pdf>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1597-1599). Discovery Institute Press. Kindle Edition.]
- Echoing the same sentiment, Lindsay Craig argued that “The foundation of the Modern Synthesis framework, theoretical population genetics [the basis of classical neo-Darwinism], faces significant, perhaps insurmountable challenges from the concepts highlighted by EvoDevo.”⁴⁷ Wallace Arthur, a leader in the field, likewise acknowledges that “Many scientists working in evo-devo today, whether in its molecular, organismic, or paleontological ‘wings,’ believe that novelties and body plans do require some special explanation” beyond incremental functionalism.⁴⁸ And as noted in Chapter 1, Fodor and Piattelli-Palmarini concur.⁴⁹ [47. Lindsay Craig, “The So-

Called Extended Synthesis and Population Genetics,” *Biological Theory* 5, no. 2 (2010): 117–123. 48. Arthur, *Evolution: A Developmental Approach*, Chapter Twenty, 334, emphasis added. 49. Fodor and Piattelli-Palmarini, *What Darwin got Wrong.*] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1613-1619). Discovery Institute Press. Kindle Edition.]

7. Bridging Gaps: Cells and Proteins

- To validate typology, it is necessary to clearly establish that the “gaps” are real, i.e., that no conceivable adaptive continuums are known that can plausibly bridge the discontinuities and account for the origin of the taxa-defining novelties. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1920-1921). Discovery Institute Press. Kindle Edition.]
- Consider the most inclusive of all ground plans in the biological realm, one that has not changed for 4,000 million years: The Bauplan or “ground plan” of the cell, the basic unit of all life on earth. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1922-1924). Discovery Institute Press. Kindle Edition.]
- As with other taxa-defining novelties, there is no evidence that any fundamental changes have occurred in the basic design of the cell system since its origination. The cell membrane, the basic metabolic paths, the ribosome, the genetic code, etc., are essentially invariant in all life forms on earth. And absolutely no plausible well-developed hypothetical evolutionary sequence has ever been presented showing how the cell might have evolved via a series of simpler cell-like systems. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1924-1927). Discovery Institute Press. Kindle Edition.]
- Thirty years on, the situation is entirely unchanged. Despite a vast increase in knowledge of supra-molecular chemistry and of cell and molecular biology; the unexpected discovery of ribozymes; and an enormous effort, both experimental and hypothetical, devoted to providing a gradualistic functionalist account of the origin of life in terms of a long series of less complex functional replicating systems (e.g., the much-touted “RNA world”) leading from “chemistry” to the cell, no one has provided even the vaguest outlines of a feasible scenario, let alone a convincing one.⁷ A yawning gap

still persists—empirical and theoretical. [7. Stephen C. Meyer, *Signature in the Cell: DNA and the Evidence for Intelligent Design*, 1st ed. (New York: Harper One, 2009).] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1929-1934). Discovery Institute Press. Kindle Edition.]

- A major unsolved problem in the origin-of-life field is what Gerald Joyce referred to as the “clutter problem”: the problem that prebiotic syntheses invariably generate very heterogeneous solutions of organic compounds. This makes it very difficult to imagine how ordered linear polymers, made of only the canonical monomers, amino acids, or nucleotides, could ever have been assembled.⁸ [8. Gerald F. Joyce, “The Antiquity of RNA-Based Evolution,” *Nature* 418 (2002): 214–221.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1935-1938). Discovery Institute Press. Kindle Edition.]
- As Steven Benner commented: Prebiotic chemistry could produce a wealth of biomolecules from nonliving precursors. But the wealth soon became overwhelming, with the “prebiotic soups” having the chemical complexity of asphalt (useful, perhaps, for paving roads but not particularly promising as a wellspring for life). Classical prebiotic chemistry not only failed to constrain the contents of the prebiotic soup, but also raised a new paradox: How would life (or any organized chemical process) emerge from such a mess?⁹ [9. Steven A. Benner, “Origins of Life: Old Views of Ancient Events,” *Science* 283 (1999): 2026.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1938-1942). Discovery Institute Press. Kindle Edition.]
- Joyce says this about the problem: Ribose, phosphate, purines and pyrimidines all may have been available... These may have combined to form nucleotides in very low yield, complicated by the presence of a much larger amount of various nucleotide analogues. The nucleotides (and their analogues) may even have joined to form polymers, with a combinatorial mixture of 2',5'-, 3',5'- and 5',5'-phosphodiester linkages, a variable number of phosphates between the sugars, D- and L- stereoisomers of the sugars, α - and β -monomers of the glycosidic bond, and assorted modifications of the sugars, phosphates and bases... It is difficult to visualize a mechanism for

self-replication that... would be impartial to these compositional differences... The chief obstacle to understanding the origin of RNA-based life [but the same applies to protein–DNA based life] is identifying a plausible mechanism for overcoming the clutter problem wrought by prebiotic chemistry.¹⁰ [10. Joyce, “Antiquity of RNA-Based Evolution,” 215.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1943-1950). Discovery Institute Press. Kindle Edition.]

- Assuming that the basic building blocks—sugars, amino acids, lipids and nucleotides—could have accumulated somewhere on the early earth, in Darwin’s “warm little pond,”¹¹ and assuming that the clutter problem could be overcome, the question then arises: How were the polymers assembled into the first replicating system? Currently, two very different models of how self-replication might have been first achieved are on offer.¹² [11. Charles Darwin, letter to J. D. Hooker, February 1, 1871, found at “Darwin’s ‘warm little pond,’” Natural Selections: News and views from the Darwin Correspondence Project editors, University of Cambridge, February 15, 2012, <https://www.darwinproject.ac.uk/editors-blog/2012/02/15/darwins-warm-little-pond/>. 12. Vera Vasas, Chrisantha Fernando, Mauro Santos, Stuart Kauffman, and Eörs Szathmáry, “Evolution before Genes,” *Biology Direct* 7, no. 1 (January 2012): 1, doi:10.1186/1745-6150-7-1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1952-1956). Discovery Institute Press. Kindle Edition.]
- One, the “metabolism-first” model,¹³ envisages that the first self-replicating system consisted of what Stuart Kauffman calls a “collectively autocatalytic set” (CAS): a large set of molecules that have the collective ability to synthesize every member of the set.¹⁴ As described by Kauffman, in a CAS “every member of the autocatalytic set has at least one of the possible last steps in its formation catalyzed by some member of the set, and... connected sequences of catalyzed reactions lead from the maintained ‘food set’ to all members of the autocatalytic set.”¹⁵ As Vera Vasas et al. comment: “The central thesis in this scenario was that template replication is not required to achieve an autocatalytic set.”¹⁶ [13. Robert Shapiro, “A Simpler Origin for Life,” *Scientific American* 296, no. 6 (June 2007): 46–53. 14. Stuart A. Kauffman, “Approaches to the Origin of Life on Earth,” *Life* 1, no. 1 (November 18, 2011): 34–48, doi:10.3390/life1010034. 15. Vasas et al.,

“Evolution before Genes,” 2. 16. Ibid., 1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1956-1963). Discovery Institute Press. Kindle Edition.]

- The alternative conception of the first self-replicating system is an RNA ribozyme (an RNA polymer capable of carrying out enzymatic syntheses) that can synthesize other ribozymes as well as itself.¹⁷ [17. Michael P. Robertson and Gerald F. Joyce, “The Origins of the RNA World,” *Cold Spring Harbor Perspectives in Biology* 4, no. 5 (May 1, 2012): a003608–a003608, doi:10.1101/ cshperspect.a003608.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1963-1965). Discovery Institute Press. Kindle Edition.]
- Thus, as things stand today, there is no universally-agreed-upon route to the first replicating system. No one has synthesized a self-replicating RNA molecule or assembled a collectively autocatalytic set. The verdict is still out on these two competing hypotheses. No one knows if either of them is possible and would actually work. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1982-1984). Discovery Institute Press. Kindle Edition.]
- Even if self-replication could have been achieved either via a CAS or RNA template route, no plausible scenario for the evolution of the modern DNA-protein genetic code, via gradual functional continuums of increasingly more complex cellular forms, has ever been developed. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1985-1986). Discovery Institute Press. Kindle Edition.]
- In a recent critical paper summarizing this current impasse in the origin-of-life field, Eugene Koonin and Artem Novozhilov comment: At the heart of this problem is a dreary vicious circle: what would be the selective force behind the evolution of the extremely complex translation system before there were functional proteins? And, of course, there could be no proteins without a sufficiently effective translation system. A variety of hypotheses have been proposed in attempts to break the circle... but so far none of these seems to be sufficiently coherent or enjoys sufficient support to claim the status of a real theory.²⁶ [26. Eugene V. Koonin and Artem S. Novozhilov, “Origin and Evolution of the Genetic Code: The Universal Enigma,” IUBMB

Life 61, no. 2 (February 2009): 108, doi:10.1002/iub.146.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1986-1991). Discovery Institute Press. Kindle Edition.]

- About proto-protein synthesizing systems halfway to the modern cell they comment: Nevertheless, these and other theoretical approaches lack the ability to take the reconstruction of the evolutionary past beyond the complexity threshold that is required to yield functional proteins, and we must admit that concrete ways to cross that horizon are not currently known.²⁷ [26. Eugene V. Koonin and Artem S. Novozhilov, “Origin and Evolution of the Genetic Code: The Universal Enigma,” IUBMB Life 61, no. 2 (February 2009): 108, doi:10.1002/iub.146.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1992-1995). Discovery Institute Press. Kindle Edition.]
- About the RNA world and the origin of the genetic code, Koonin and Novozhilov comment: On the experimental front, findings on the catalytic capabilities of selected ribozymes are impressive... In particular, highly efficient self-aminoacylating ribozymes and ribozymes that catalyze the peptidyltransferase reaction have been obtained... Moreover, ribozymes whose catalytic activity is stimulated by peptides have been selected... hinting at the possible origins of the RNA-protein connection... Nevertheless, in a close analogy to the situation with theoretical approaches, we are unaware of any experiments that would have the potential to actually reconstruct the origin of coding, not even at the stage of serious planning.²⁹ Summarizing the state of the art, they conclude: 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 50 years. Our consolation is that we cannot think of a more fundamental problem in biology.³⁰ [Koonin and Novozhilov, “Origin and Evolution of the Genetic Code: The Universal Enigma,” 108.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 1999-2009). Discovery Institute Press. Kindle Edition.]
- That nature may indeed have “lent a hand” is conceded by Gerald Joyce, who, in discussing how the “clutter problem” might be overcome, speculates that

the solution can only lie in special conditions or special synthetic paths which facilitated the route to the protocell: Perhaps there were special conditions that led to the preferential synthesis of activated β -D- nucleotides or the preferential incorporation of these monomers into polymers. For example, the prebiotic synthesis of sugars from formaldehyde can be biased by starting from glyceraldehyde phosphate, leading to ribose 2,4-diphosphate as the predominant pentose sugar... The polymerization of adenylate, activated as 5'-phosphorimidazolid, yields 2',5'-linked products in solution, but mostly 3',5'-linked products in the presence of a montmorillonite clay. Thus through a series of biased syntheses, fractionations and other enrichment processes, there may have been a special route to a warm little pond of RNA.³² [32. Joyce, "The Antiquity of RNA-Based Evolution," 215.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2014-2022). Discovery Institute Press. Kindle Edition.]

- Joyce is surely right. There has to be a "facilitated natural path"; there have to be unique elements of fitness in nature to call forth life from chemistry. Time and chance and the currently known laws of chemistry and physics alone are certainly insufficient. In a similar vein, Itay Budin and Jack Szostak describe the ability of unexpected physical processes to facilitate the self-assembly and self-replication of the first biological systems: Laboratory efforts have uncovered novel physical mechanisms for the emergence of homochirality; the concentration and purification of prebiotic building blocks; and the ability of the first cells to assemble, grow, divide, and acquire greater complexity. In the absence of evolved biochemical capabilities, such physical processes likely played an essential role in early biology.³³ [33. Itay Budin and Jack W. Szostak, "Expanding Roles for Diverse Physical Phenomena During the Origin of Life," *Annual Review of Biophysics* 39, no. 1 (April 2010): 245–263, 245, doi:10.1146/annurev.biophys.050708.133753.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2022-2029). Discovery Institute Press. Kindle Edition.]
- In a recent paper, pointedly entitled "Origin of Life Scenarios: Between Fantastic Luck and Marvelous Fine-Tuning," the authors comment on the "RNA world" hypothesis: The proposed picture points to the existence of

molecules capable of an amazing cascade of pairing, stacking, and self-association in ordered structures prone to chemical ligation, a set of properties that enabled self replication and hence life information storage. Certainly some of these properties were crucial in the selection of nucleic acids as the carrier of genetic information. The very existence of molecules embodying all these properties is not obviously deducible from the basic knowledge of organic chemistry. Furthermore, if this was indeed the pathway for the emergence of life, it was necessary that these properties were not shared by many other molecular species, so that RNA could have emerged without too strong a competition from molecules sharing similar properties. Hence, the proposed scenario points to a delicate fine-tuning of factors that we could name “marvelous” because (i) there is, rather surprisingly, a molecular species that shows all of them and (ii) because they are so delicately balanced to be extremely rare within the vast realm of molecular species. Both factors are certainly, but subtly, necessarily implied by the basic structure of matter (electron charge, proton mass etc.) and hence related to the basic architecture of the Universe.³⁸ [38. Tommaso Bellini, Marco Buscaglia, Andrea Soranno, and Giuliano Zanchetta, “Origin of Life Scenarios: Between Fantastic Luck and Marvelous Fine-Tuning,” *Euresis* 2 (2012): 113–139.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2059-2069). Discovery Institute Press. Kindle Edition.]

- This particular homolog holds a personal fascination for me reaching back to my days as a doctoral student. My PhD thesis in the Biochemistry Department of King’s College, London, was on the development of the mammalian red blood cell.⁴⁶ The fact that the enucleation could hardly be explained by cumulative selection was very apparent to me as I was completing my doctorate. It struck me then, and still does now, that it is very difficult to envisage how the enucleate final state could have been achieved gradually by any sort of Galápagos-type, incremental adaptive change. [46. Michael J. Denton, Neill Spencer, and Henry R. V. Arnstein, “Biochemical and Enzymic Changes during Red Cell Differentiation: The Significance of the Final Cell Division,” *Biochemical Journal* 146 (1975): 205–211.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2102-2106). Discovery Institute Press. Kindle Edition.]
- In addition, the process is extremely complex.⁴⁷ Narla Mohandas, a leading

researcher on the biology of the red cell, recently commented: Enucleation is a multistep process... that requires displacement of the nucleus in the erythroblast to one side during the preparatory stage. This is followed by formation of a contractile actin ring, pinching off the nascent reticulocyte from the nucleus, and subsequent redistribution of membrane between the 2 lobes of the dividing cell by vesicle shuttling to restrict the area of contact between the 2 emerging cells. The coordinated execution of these diverse events during a period of 8 to 10 minutes requires complex machinery embracing a number of distinct cytoskeletal proteins and signaling interventions.⁴⁸ [48. Mohandas et al., “Exit Strategy: One That Works.”] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2110-2116). Discovery Institute Press. Kindle Edition.]

- As the authors of a recent PLoS Genetics Perspective comment: “For a long time the answer to that question [where do new genes come from] has simply been ‘from other genes’... [by] gene duplication in all its guises: exon shuffling, tandem duplication, retrocopying, segmental duplication, and genome duplication.”⁷⁵ [75. Daniele Guerzoni and Aoife McLysaght, “De Novo Origins of Human Genes,” PLoS Genetics 7, no. 11 (November 10, 2011): e1002381, 1, doi:10.1371/journal.pgen.1002381; see also Dong-Dong Wu, David M. Irwin, and Ya-Ping Zhang, “De Novo Origin of Human Protein-Coding Genes,” PLoS Genetics 7, no. 11 (November 10, 2011): e1002379, doi:10.1371/journal.pgen.1002379.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2291-2294). Discovery Institute Press. Kindle Edition.]
- This was the paradigm until a few years ago. As recently as 2003, papers were still extolling the notion: It can be expected that, with an explosive increase in genomic data and rapid advances in molecular genetic technology, the manifold and fundamental roles of gene duplication will become even more evident and the once imaginative idea of evolution by gene duplication will be established as one of the cornerstones of [Darwinian] evolutionary biology.⁷⁶ [76. Jianzhi Zhang, “Evolution by Gene Duplication: An Update,” Trends in Ecology & Evolution 18, no. 6 (June 2003): 297, doi:10.1016/S0169-5347(03)00033-8, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2294-2298). Discovery Institute Press. Kindle Edition.]

- The alternative notion of de novo gene origination had been deemed very unlikely because of the seeming vast improbability of a functional gene sequence emerging from a random sequence. Adam Siepel listed some of the complex changes necessary to transform a non-coding sequence into a protein-coding sequence: While a single gene is not as complex as a complete organ, such as an eye or even a feather, it still has a series of nontrivial requirements for functionality, for instance, an ORF [open reading frame], an encoded protein that serves some useful purpose, a promoter capable of initiating transcription, and presence in a region of open chromatin structure that permits transcription to occur. How could all of these pieces fall into place through the random processes of mutation, recombination, and neutral drift—or at least enough of these pieces to produce a protogene that was sufficiently useful for selection to take hold?⁷⁷ [77. Siepel, Adam, “Darwinian Alchemy: Human Genes from Noncoding DNA,” *Genome Research* 19 (2009): 1694, doi: 10.1101/gr.098376.109.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2299-2306). Discovery Institute Press. Kindle Edition.]
- Consequently, the origination of protein-coding genes de novo from nonrepetitive, noncoding DNA has been thought to occur only as an exceptionally rare event during evolution. Indeed, the emergence of complete, functional genes—with promoters, open reading frames (ORFs), and functional proteins—from “junk” DNA would seem highly improbable, almost like the elusive transmutation of lead into gold that was sought by medieval alchemists.⁷⁸ [Siepel, Adam, “Darwinian Alchemy: Human Genes from Noncoding DNA,” *Genome Research* 19 (2009): 1693, doi: 10.1101/gr.098376.109.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2306-2310). Discovery Institute Press. Kindle Edition.]
- Other researchers have alluded to further changes that would have to be made: Conversion from noncoding to coding seems too unlikely an event to happen in a single evolutionary step. The sequence in question must be transcribed, escape degradation at the nuclear exosome, associate with ribosomes, be translated, and again escape degradation by the proteasome. Finally, it must avoid toxic conformations such as amyloid, for example, in favor of a stable

protein fold.⁷⁹ [79. Benjamin A. Wilson and Joanna Masel, “Putatively Noncoding Transcripts Show Extensive Association with Ribosomes,” *Genome Biology and Evolution* 3 (2011): 1245.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2311-2315). Discovery Institute Press. Kindle Edition.]

- That new protein-coding genes can originate de novo is certainly one of the most “unexpected tales” of the new era of genomics. Moreover, as genomic comparisons become ever more sophisticated and as more and more genomes are sequenced, it is increasingly apparent that de novo origination may have been a major route to new genes throughout the history of life. The terms used by researchers in the field—terms such as “enigmatic,”⁸⁷ “mystery,”⁸⁸ “unclear,”⁸⁹ and other such expressions of amazement—capture something of the challenge the ORFans are seen to pose to traditional gradualistic notions of gene evolution. [87. Tomislav Domazet-Loso and Diethard Tautz, “An Evolutionary Analysis of Orphan Genes in *Drosophila*,” *Genome Research* 13, no. 10 (October 2003): 2213–2219, see page 2213, doi:10.1101/gr.1311003. 88. Igor Merkeev, Pavel Novichkov, and Andrey Mironov, “PHOG: A Database of Supergenomes Built from Proteome Complements,” *BMC Evolutionary Biology* 6, no. 1 (2006): 52, see page 6. 89. Diethard Tautz and Tomislav Domazet-Lošo, “The Evolutionary Origin of Orphan Genes,” *Nature Reviews Genetics* 12, no. 10 (August 31, 2011): 692–702, see page 692, doi:10.1038/nrg3053.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2339-2345). Discovery Institute Press. Kindle Edition.]
- No matter how anomalous it may seem in the context of an evolutionary worldview firmly wedded to the notion of continuity, in the case of the enucleate red cell, the ESC, and ORFan genes, there is not the slightest evidence that they were actualized gradually via functional continuums as Darwinism demands. And while selection may have played some role in the actualization of these novelties, on any consideration of the evidence available, it surely cannot have been the main or even a major generative causal factor. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2346-2349). Discovery Institute Press. Kindle Edition.]
- On the contrary, the evidence reviewed above provides overwhelming support

for the radical structuralist notion that a considerable degree of organic order is the result of internal causal factors intrinsic to living systems. And in the case of the first self-replicating system and of the genetic code, again there is no evidence for believing that they came about gradually via adaptive continuums. The structuralist notion that natural organizational properties of matter may have played a crucial role is again impossible to refuse. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2350-2353). Discovery Institute Press. Kindle Edition.]

8. Bridging Gaps: Flowering Plants

- The beautiful configurations produced by the orderly arrangement of leaves or florets on a stem have long been an object of admiration and curiosity... The spiral leaf-order has been regarded by many learned botanists as involving a fundamental law of growth, of the deepest and most far-reaching importance... We come then without more ado to the conclusion that while the Fibonacci series stares us in the face in the fir cone, it does so for mathematical reasons; and its supposed usefulness, and the hypothesis of its introduction into plant structure through natural selection, are matters which deserve no place in the plain study of botanical phenomena. [D. W. Thompson, *On Growth and Form* (1945), Chapter 14.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2355-2360). Discovery Institute Press. Kindle Edition.]
- As one author conceded, despite many recent paleontological and molecular advances, the evolutionary pathway which led from the putative ancestral seed-plant to the first angiosperms is still obscure: “No taxon [is] universally accepted as transitional between angiosperms and any other group.”⁵ And speaking for many researchers in this area, Peter Endress and James Doyle commented in a recent review: The question of the structure and biology of the ancestral angiosperms, and especially their flowers, is an enduring riddle. Although we are continually gaining new insights from new fossils and new studies on phylogeny, morphology, and developmental genetics in extant plants, we are still far from a final answer. There are gaps at different levels. First is the uncertainty concerning which other seed plants are the closest relatives of angiosperms, particularly extinct groups because most molecular analyses indicate that no living group of gymnosperms is any closer to

angiosperms than any other. Second, even if known fossils can be recognized as angiosperm stem relatives, all such groups are morphologically well removed from angiosperms, so there is still a major gap that can only be filled by the discovery of closer stem relatives. Third is the problem of the original morphology and early evolutionary differentiation of crown group angiosperms.⁶ [5. William L. Crepet, “Progress in Understanding Angiosperm History, Success, and Relationships: Darwin’s Abominably ‘Perplexing Phenomenon,’” *Proceedings of the National Academy of Sciences* 97, no. 24 (November 21, 2000): 12939-12941,12941, doi:10.1073/pnas.97.24.12939. 6. Endress and Doyle, “Reconstructing the Ancestral Angiosperm Flower and Its Initial Specializations,” 22, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2366-2377). Discovery Institute Press. Kindle Edition.]

- The absence of any transitional forms linking the angiosperms to any putative ancestral clade and the absence of any plausible functionalist narrative explaining how the angiosperm Bauplan originated is only the beginning of the challenge to Darwinian notions posed by this wonderfully diverse group of plants. Since the angiosperms first emerged about 140 million years ago, they have diversified into a vast number of subgroups comprising about 250,000 different species.¹² And as Michael Sanderson reminds us, it is not just the origin of the angiosperms which is still an abominable mystery: “A number of much more recent clades of angiosperms could be interpreted as mini-abominations: That is, they have poor fossil records at their base, novel innovations with unclear transitional forms among related taxa.”¹³ [12. Louis P. Ronse De Craene, *Floral Diagrams: An Aid to Understanding Flower Morphology and Evolution* (Cambridge; New York: Cambridge University Press, 2010), Preface, viii. 13. Michael J. Sanderson, “Back to the past: a new take on the timing of flowering plant diversification,” *New Phytologist* 207, no. 2 (2015): 257–259, see page 258.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2400-2406). Discovery Institute Press. Kindle Edition.]
- The conception that the flower Bauplan originated as the result of intrinsic self-organizing processes and not as the result of external environmental functional constraints is by no means heterodox. It is widely acknowledged that the alternative spiral and whorled phyllotactic patterns witnessed in the

positioning of leaves around a stem or shoot are the result of “laws of form” and arise spontaneously out of spacing of primordia and rates of growth.¹⁷ [17. Stéphane Douady and Yves Couder, “Phyllotaxis as a Dynamical Self Organizing Process, Part 1: The Spiral Modes Resulting from Time-Periodic Iteration,” *J Theor Biol* 178 (1996): 255–274; Henrik Jönsson, Marcus G. Heisler, Bruce E. Shapiro, Elliot M. Meyerowitz, and Eric Mjolsness, “An Auxin-Driven Polarized Transport Model for Phyllotaxis,” *Proceedings of the National Academy of Sciences* 103, no. 5 (January 31, 2006): 1633–1638, doi:10.1073/pnas.0509839103.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2434-2437). Discovery Institute Press. Kindle Edition.]

- Henrik Jönsson et al. comment: The beautiful symmetries apparent in phyllotaxis and its connection to mathematics have inspired scientists to create theories and models to explain these patterns. One important finding from mathematical analysis and physical simulation... is that many of the seemingly complex phyllotactic patterns and transitions found in plants can probably be explained to a large degree by any regular spacing mechanism superimposed on a gradually enlarging generative region.¹⁸ [18. Jönsson et al., “An Auxin-Driven Polarized Transport Model for Phyllotaxis,” 1633.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2438-2442). Discovery Institute Press. Kindle Edition.]
- As the authors summarize their view: We propose a development-based model of floral organ-number determination, improving upon earlier models of plant phyllotaxis that assumed two developmental processes: the sequential initiation of primordia in the least crowded space around the meristem and the constant growth of the tip of the stem. By introducing mutual repulsion among primordia into the growth process, we numerically and analytically show that the whorled arrangement emerges spontaneously from the sequential initiation of primordia... These results suggest that the temporal decay of initiation inhibition and the mutual repulsion among growing organs determine the particular organ number during eudicot floral development.¹⁹ [19. Miho S. Kitazawa and Koichi Fujimoto, “Dynamical Phyllotaxis Model to Determine Floral Organ Number,” *PLoS Computational Biology* 11, no. 5 (May 7, 2015): e1004145, quote from abstract and author summary, doi: 10.1371/journal.pcbi.1004145.] [Michael

Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2446-2452). Discovery Institute Press. Kindle Edition.]

- Some idea of their complexity is conveyed in this passage from Raghavan’s review: The journey of the two sperm deposited in the degenerating synergid to align with the egg and the polar fusion nucleus [the two nuclei in the center of the egg sac] respectively, is considered an arduous one and some attention has been paid to the mechanism by which this is accomplished. It is well-established that only the sperm nuclei fuse with their female reproductive targets; the rest of the pollen tube discharge and the sperm cytoplasm remain trapped in the milieu of the synergid. Two aggregates of actin filaments designated as “coronas” that presumably guide the pathway of the male gametes have been identified within the embryo sac of tobacco. One of the actin aggregates forms at the chalazal end of the degenerating synergid, extending from its middle lateral region to the region of the egg. The second band occurs in the interface between the egg and the central cell and extends from the side of the egg to the region of the polar nuclei.²⁸ [Valayamghat Raghavan, “Some Reflections on Double Fertilization, from Its Discovery to the Present: Tansley Review,” *New Phytologist* 159, no. 3 (July 25, 2003): 565–583, doi:10.1046/j.1469-8137.2003.00846.x.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2518-2526). Discovery Institute Press. Kindle Edition.]
- In the end, no plausible Darwinian narrative can be invented to account for the origin and diversification of the angiosperms. It is simply impossible to believe that either the merism of the flower Bauplans or the weird dance of the nuclei in the formation of the egg sac arose to serve specific environmental constraints. The patterns actualized in this remarkable clade are far more readily explained in terms of intrinsic or internal self-organizing processes, even if at present the “laws of form” which generated this universe of beautiful patterns remain to be elucidated. To explain the numeric and geometric patterns which permeate all aspects of angiosperm biology in terms of incremental functionalism, i.e., “Darwinian order imposed from without,” leads only, as in so many other instances, to William Bateson’s “endless absurdities.” [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2532-2538). Discovery Institute Press. Kindle Edition.]

9. Bridging Gaps: Limbs, Feathers, Wings, and Eels

- In her book *Gaining Ground*,⁵ Jennifer Clack mentions a number of early amphibians found since *Evolution* was published: *Acanthostega*, *Tulerpeton*, *Ventostega*, and several more. Further, several fossil fish close to the fish-amphibian boundary, including the celebrated *Tiktaalik*, have also been found. But the gap between the tetrapod limb and the fin remains. [5. Jennifer A. Clack, *Gaining Ground: The Origin and Evolution of Tetrapods*, 2nd ed. (Bloomington, IN: Indiana University Press, 2012). For earlier depictions of the transformation see Chapter 6 and see Erik Jarvik, “Specializations in Early Vertebrates,” *Annales de la Société royale zoologique de Belgique* 94 (1964): 11–95.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2580-2583). Discovery Institute Press. Kindle Edition.]
- As Clack commented on the recent discovery of *Tiktaalik*, much touted as a transitional form: “There remains a large morphological gap [see Figure 9-1 above] between them [the distal bones of the fin] and digits as seen in, for example, *Acanthostega*: if the digits evolved from these distal bones, the process must have involved considerable developmental repatterning.”⁶ [6. Per Erik Ahlberg and Jennifer A. Clack, “Palaeontology: A Firm Step from Water to Land,” *Nature* 440, no. 7085 (April 6, 2006): 747–749, doi:10.1038/440747a.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2583-2586). Discovery Institute Press. Kindle Edition.]
- Moreover, the recent discovery in Poland of very obvious tetrapod tracks with developed digits, eighteen million years earlier than the previously earliest identified amphibian and ten million years earlier than the best transitional candidate (*Tiktaalik*),⁷ has complicated the issue further. [7. Clack, *Gaining Ground*, Chapter 4; Niedźwiedzki Grzegorz, Piotr Szrek, Katarzyna Narkiewicz, Marek Narkiewicz, and Per E. Ahlberg, “Tetrapod Trackways from the Early Middle Devonian Period of Poland,” *Nature* 463, no. 7277 (January 7, 2010): 43–48, doi:10.1038/nature08623. See also “9. The first tetrapods,” *Earth History: a new approach*, March 7, 2012, <http://www.earthhistory.org.uk/recolonisation/first-amphibians>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2586-2589). Discovery Institute Press. Kindle Edition.]

- No matter what Darwinian evolutionary “spin” is put on the gap between fin and hand, there is no avoiding the fact that a significant break does exist in the natural order, and the new evo-devo picture provides no support for any sort of Darwinian gradualist, functionalist scenario. Moreover, irrespective of the empirical evidence, fossil and evo-devo, which suggests that the limb homolog was put together in either a series of leaps, or a single major leap, trying to envisage the process as occurring under the direction of gradual natural selection poses herculean challenges. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2681-2685). Discovery Institute Press. Kindle Edition.]
- Explaining how all the digits came to have the same basic ground plan in adaptive terms is highly problematic, but equally problematic is how digit identity was first imposed by cumulative selection. The catch is this: Until digit identity is imposed, none of the digits can acquire a different morphology, yet digit identity only has adaptive utility when the digits exhibit a different morphology. This is another classic chicken-and-egg problem. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2722-2725). Discovery Institute Press. Kindle Edition.]
- I have so far argued that no Darwinian account of the origin of this defining homolog (or of its various constitutive homologs) can be given. But there is a potentially greater problem for Darwinism: The imposition of the same ground plan on fore and hind limb may not only be of dubious adaptive utility, but actually maladaptive. Owen hints darkly at this in *On the Nature of Limbs*. Given that fore and hind limb difference is the adaptive state for terrestrial vertebrates, the redeployment of the pentadactyl pattern from fore to hind or hind to fore must be viewed “formally” as maladaptive. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2744-2749). Discovery Institute Press. Kindle Edition.]
- Since I wrote *Evolution: A Theory in Crisis*, no forms illustrating a genuinely transitional state between a fin and limb have come to light. Further, nothing gained through the extensive genetic and developmental studies of limbs provides any support for the notion that the autopod was acquired gradually via a vast number of tiny microevolutionary adaptive steps over hundreds of thousands of generations. [Michael Denton: *Evolution, Still a Theory in*

Crisis (Kindle Locations 2749-2752). Discovery Institute Press. Kindle Edition.]

- The fact that no Devonian vertebrate has been found with a partly evolved auto-pod (with fin rays and digits) and that none has been found with a pectoral fin and a tetrapod hind limb, point, in conjunction with the developmental evidence, to the origin of the limb as a saltational event. Apart from the developmental constraint of pentadactyly, perhaps the entire suite of developmental mechanisms involved in making the hand and foot were present in the very earliest tetrapods. As things stand, I believe that the evidence supports the structuralist interpretation of the origin of the tetrapod limb—i.e., that it represents a robust emergent natural form or composite form which was actualized relatively suddenly at a particular moment in vertebrate evolution as a result of internal causal factors rather than by cumulative selection to serve functional ends. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2755-2761). Discovery Institute Press. Kindle Edition.]
- One of the adaptive wonders of nature is the wing of the bird. In *The World of Life*, Alfred Russel Wallace praised it as follows: Looking at it as a whole, the bird's wing seems to me to be, of all the mere mechanical organs of any living thing, that which most clearly implies the working out of a preconceived design in a new and apparently most complex and difficult manner, yet so as to produce a marvellously successful result.³⁷ [37. Wallace, *The World of Life: A Manifestation of Creative Power, Directive Mind and Ultimate Purpose*, Chapter 14, 287–288; available at Internet Archive, <https://archive.org/stream/worldoflifemanif00walliala#page/287/mode/2up>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2764-2767). Discovery Institute Press. Kindle Edition.]
- Wallace realized that in the design of the bird's wing the crucial element was the feather: The idea worked out was to reduce the jointed bony framework of the wings to a compact minimum of size and maximum of strength in proportion to the muscular power employed; to enlarge the breastbone so as to give room for greatly increased power of pectoral muscles; and to construct that part of the wing used in flight in such a manner as to combine

great strength with extreme lightness and the most perfect flexibility. In order to produce this more perfect instrument for flight the plan of a continuous membrane, as in the flying reptiles (whose origin was probably contemporaneous with that of the earliest birds) and flying mammals, to be developed at a much later period, was rejected, and its place was taken by a series of broad overlapping oars or vanes, formed by a central rib of extreme strength, elasticity, and lightness, with a web on each side made up of myriads of parts or outgrowths so wonderfully attached and interlocked as to form a self-supporting, highly elastic structure of almost inconceivable delicacy, very easily pierced or ruptured by the impact of solid substances, yet able to sustain almost any amount of air-pressure without injury.³⁸ [Wallace, *The World of Life: A Manifestation of Creative Power, Directive Mind and Ultimate Purpose*, Chapter 14, 287–288; available at Internet Archive,

<https://archive.org/stream/worldoflifemanif00walliala#page/287/mode/2up>]

[Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2768-2777). Discovery Institute Press. Kindle Edition.]

- In a landmark article in the *Quarterly Review of Biology*, Prum and Alan Brush comment: Over the last half of the 20th century, neo-Darwinian approaches to the origin of feathers, exemplified by Bock (1965), have hypothesized a microevolutionary and functional continuum between feathers and a hypothesized antecedent structure (usually an elongate scale). Feathers, however, are hierarchically complex assemblages of numerous evolutionary novelties—the feather follicle, tubular feather germ, feather branched structure, interacting differentiated barbules—that have no homolog in any antecedent structures.⁴⁵ [45. Prum and Brush, “The Evolutionary Origin and Diversification of Feathers,” 265. The internal reference is to Walter J. Bock, “The Role of Adaptive Mechanisms in the Origin of Higher Levels of Organization,” *Systematic Zoology* 14 (1965): 272–287, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2806-2811). Discovery Institute Press. Kindle Edition.]
- Although the origin of the feather occurred via a succession of novelties (see Figure 9-2), the new evo-devo picture provides not the slightest evidence that any of the novelties leading to the feather were actualized by cumulative

selection. As Prum and Brush comment: “Although evolutionary theory provides a robust explanation for the appearance of minor variations in the size and shape of creatures and their component parts, it does not yet give as much guidance for understanding the emergence of entirely new structures, including digits, limbs, eyes and feathers.”⁴⁶ [46. Prum and Brush, “Which Came First, the Feather or the Bird?” 86.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2811-2816). Discovery Institute Press. Kindle Edition.]

- The first key innovation in the evolution of the feather was the feather follicle. This first novelty is without any antecedent structure in any reptile scale or any other vertebrate skin appendage. It is a unique epidermal invagination that leads to the growth of a hollow tube—a tube that Prum calls “the defining feature of the feather.” Without this primal innovation, there would be no subsequent development of barbs, no helical growth pattern generating the rachis, and no closed pennaceous feather. The tubular nature of the feather is therefore the primary novelty upon which all the subsequent innovations leading to the modern pennaceous feather are built.⁵¹ [Prum and Brush, “The Evolutionary Origin and Diversification of Feathers.”, 283.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2826-2831). Discovery Institute Press. Kindle Edition.]
- Prum commented to Thor Hanson, “Without the [tubular] follicle, a feather would basically be like a wart.”⁵² And in response to Hanson’s question, “[W]hen do you call a feather a feather?” Prum replied: “If it’s a hollow tube, it’s a feather... One thing I keep saying again and again is that there is no such thing as a ‘protofeather.’ No one talks about a ‘protolimb.’ You either have a limb or you don’t. Why should feathers be any different? If it’s a tube, it’s a feather. Period.”⁵³ [52. Thor Hanson, *Feathers: The Evolution of a Natural Miracle* (New York: Basic Books, 2011), 56. 53. *Ibid.*, 56.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2832-2836). Discovery Institute Press. Kindle Edition.]
- Prum’s recognition of the fundamental tubular nature of feathers came to him in a moment of epiphany while lecturing students on the old frayed-scale-to-feather theory.⁵⁴ Suddenly he recognized a very fundamental difference in the way scales and feathers grow.⁵⁵ In Hanson’s words: There is a

fundamental structural difference between scales and feathers and how they grow. Scales form like plates, flat ridges protruding outwards as extensions of the epidermis. It's like the contrast between a napkin and a straw. Fold the napkin and you have a scale, with the outer surface—the epidermis—covering both top and bottom... [But in the case of feathers they]... flatten by opening up. The outer surface becomes the top and the inside is revealed to become the bottom. So while a mature feather and a scale may both appear flat, their surfaces simply don't correspond.⁵⁶ [54. For the frayed-scale theory, see Heilmann, *The Origin of Birds*, and Regal, "The Evolutionary Origin of Feathers," both cited above. 55. Hanson, *Feathers*, 37. 56. *Ibid.*, 37.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2836-2844). Discovery Institute Press. Kindle Edition.]

- Following the establishment of the follicle (Figure 9-2, first image), the mature feather results from a succession of fascinating novel developmental mechanisms, which have, as mentioned above, no homolog in any reptilian scale or indeed any vertebrate integumental structure. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2856-2858). Discovery Institute Press. Kindle Edition.]
- As mentioned above, it is not just the feather follicle that is without any antecedent; so are the other successive novelties described above. In Prum and Brush's words: Müller and Wagner defined a morphological novelty as a structure that is neither homologous to any ancestral structure nor homonomous (i.e., serially homologous) with any other structure in that organism. Many features of feathers and feather helical development meet this definition and qualify as evolutionary novelties. The follicle, the differentiated sheath and feather germ, differentiated barb ridges, barb rami, barbules, differentiated pennulae of the proximal and distal barbules, and the rachis are all evolutionary novelties.⁶² [62. Prum and Brush, "The Evolutionary Origin and Diversification of Feathers," 287–288, emphasis added and all internal references removed.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2868-2873). Discovery Institute Press. Kindle Edition.]
- The origin of the various feather novelties and the developmental processes that actualize them are enigmatic in classic Darwinian terms. Prum and Brush

conclude: By emphasizing the reconstruction of a series of functionally and microevolutionarily plausible intermediate transitional states, neo-Darwinian approaches to the origin of feathers have failed to appropriately recognize the novel features of feather development and morphology, and have thus failed to adequately explain their origins.⁶⁸ [68. Prum and Brush, “The Evolutionary Origin and Diversification of Feathers,” 289.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2919-2923). Discovery Institute Press. Kindle Edition.]

- On any common-sense assessment of the evidence now available, it would seem that the feather arose (like the limb Bauplan) because of internal causal factors and not to serve functional constraints. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2929-2930). Discovery Institute Press. Kindle Edition.]
- Another classic taxon-defining novelty is the wing of the bat. The traditional Darwinian view explains the origin of this novelty by positing the adaptive utility of intermediate forms with partly developed wings. In *Evolution: A Theory in Crisis*, I quoted Glenn Jepson’s rebuttal of this view: “No one has successfully proposed any kind of selection pressure that would be effective in the change from one niche to the other; whether the bridging group would be pulled by advantages in the new milieu or pushed by disadvantages to the old.”⁷³ [73. Glenn Jepson, “Bat Origins and Evolution,” *Biology of Bats*, edited by William A. Wimsatt, vol. 1 (New York: Academic Press, 1970), 1–64, see page 54; Denton, *Evolution: A Theory in Crisis*, 216.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2940-2944). Discovery Institute Press. Kindle Edition.]
- As to the likelihood of going from a “gliding wing” to a wing capable of powered flight, Jepson further remarked: Morphologically and genetically and phylogenetically the distance from a gliding habit to a bat-flying habit among known mammals is so immense that a development of the former may almost be said to preclude the probability of further development in the same phyletic line to the latter.⁷⁴ [74. Jepson, “Bat Origins and Evolution,” 44.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 2944-2948). Discovery Institute Press. Kindle Edition.]
- As the study implies, the origin of the bat’s wing was much more complex

than the mere evolution of a new enhancer [genetic switch]—such as may have played a significant role in the origin of some simpler novelties (see Carroll on the evolution of eye spots⁹²)—or the modulation of existing gene circuits which sculpted the beak shapes of the Galápagos finches. In a more recent paper summarizing their results, the same authors comment: These results suggest multiple genetic changes occurred independently during the evolution of bat wings to elongate the hand digits, promote membrane growth and keep other digits short. Our findings also indicate that the evolution of limb morphology depends on the complex integration of multiple gene regulatory networks and biological processes that control digit formation and identity, chondrogenesis, and interdigital regression or retention.⁹³ [92. Carroll, *Endless Forms Most Beautiful*, Chapter 8. 93. Zhe Wang, Mengyao Dai, Yao Wang, Kimberly L. Cooper, Tengzeng Zhu, Dong Dong, Junpeng Zhang, and Shuyi Zhang, “Unique Expression Patterns of Multiple Key Genes Associated with the Evolution of Mammalian Flight,” from the abstract, *Proceedings of the Royal Society B: Biological Sciences* 281, no. 1783 (2014): 20133133, abstract, doi:10.1098/ rspb.2013.3133.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3007-3014). Discovery Institute Press. Kindle Edition.]

- To date there is no evidence that these novel gene circuits and expression patterns were acquired successively, in conformity with Darwinian gradualism and its assumption that macroevolution is a mere extrapolation of microevolution.⁹⁴ Commenting on the likely underlying genetic complexity of the hand-to-wing transformation and the question whether microevolution can be extrapolated to macroevolution, Kimberly Cooper and Clifford Tabin remark: It has long been debated whether the processes and mechanisms responsible for phenotypic variation within a population or between closely related populations can be extrapolated to explain... the generation of novel structures. Although there has been great progress in recent years in addressing the genetic basis for micro-evolutionary changes, for the most part these efforts have done little to address this debate... While it is still unclear whether modern bats arose rapidly or gradually from their quadrupedal ancestor, it does seem certain that their evolution required many molecular changes to dramatically alter morphology from a limb to a wing.⁹⁵ [94. The idea that macroevolution cannot be a mere extension of

microevolution was promoted vigorously and notoriously by Richard Goldschmidt and is now defended by recent authors. See Chapter 1. 95. Kimberly L. Cooper and Clifford J. Tabin, “Understanding of Bat Wing Evolution Takes Flight,” *Genes & Development* 22, no. 2 (January 15, 2008): 121–124, doi:10.1101/ gad.1639108.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3015-3023). Discovery Institute Press. Kindle Edition.]

- As remarked in Chapter 5 in the discussion of “evo-devo,” the mere listing of an inventory of changes that accompanied the actualization of a taxon-defining novelty, like the bat’s wing, provides not the slightest support for Darwinian gradualism. Only by showing that the developmental genetic changes occurred successively, and by identifying and listing the successive changes (one, two, three, four, five, six, etc.), can the Darwinian thesis be confirmed. The fact that we have a description of some of the developmental changes that accompanied the origin of the bat’s wing provides very little insight into how the transition occurred. But one obvious implication of the emerging evo-devo description is that to cross what seems to be on morphological grounds a functional dis-continuum¹⁰¹ (from gliding to powered flight) necessitated coordinated and compensatory changes in many different gene circuits, some of which must have occurred simultaneously—an implication that points away from gradualism to saltation; and this is where the fossil evidence also seems to point. From the complexity of the required changes, and from the fact that some may have had to occur simultaneously, it seems clear why only one lineage of mammals managed to convert a standard hand into a wing capable of powered flight.¹⁰² [101. Kristin L. Bishop, “The Evolution of Flight in Bats: Narrowing the Field of Plausible Hypotheses,” *The Quarterly Review of Biology* 83, no. 2 (June 2008): 153–169. 102. Giannini, “Toward an Integrative Theory on the Origin of Bat Flight,” 376–377.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3050-3059). Discovery Institute Press. Kindle Edition.]
- The possibility that the bat hand-wing emerged relatively suddenly is conceded by the authors of a recent paper who speculate that “rapid change from arm to wing morphology may have resulted from many independently arising predispositions toward longer limbs accumulating in a population

over a long period of time. Each of these modifications would individually cause minor or transient effects on limb phenotype due to the buffering effect on phenotypic output by canalization of developmental mechanisms. Once combined in a bat ancestor, however, the cumulative effect could override genetic capacitance to produce a large and seemingly instantaneous change at the morphological level.”¹⁰³ [103. C. J. Cretekos, Y. Wang, E. D. Green, NISC Comparative Sequencing Program, J. F. Martin, J. J. Rasweiler, and R. R. Behringer, “Regulatory Divergence Modifies Limb Length between Mammals,” *Genes & Development* 22, no. 2 (January 15, 2008): 141–51, 147, doi:10.1101/gad.1620408, emphasis added.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3060-3065). Discovery Institute Press. Kindle Edition.]

- Here is how things stand at present: The empirical gap (in the fossil record) between the bat’s wing and the standard mammalian forelimb is every bit as obvious as in 1985. Further, conceiving how the morphological changes might have come about gradually, in terms of a long sequence of adaptive intermediates, was always problematical, and the new evo-devo evidence, which shows that the changes involved complex rewiring and integration of novel gene circuits to coordinate the necessary changes in the developing wing, provides no evidence whatsoever for the gradualistic scenario. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3065-3069). Discovery Institute Press. Kindle Edition.]
- Of course, the gradualistic scenario is not “disproved,” and the majority of students of bat evolution—including Norberto Giannini, whom I have cited and quoted extensively above, and most of the other authors in the collection in which his paper appears (*The Evolutionary History of Bats*)—are committed to the gradualist Darwinian scenario. A great deal of further work, to document the full inventory of developmental changes necessary to convert a mouse’s foot into a bat’s wing, will be necessary to determine whether or not the transition could plausibly have come about via a series of tiny adaptive steps. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3069-3074). Discovery Institute Press. Kindle Edition.]
- No matter how incongruous it might seem to the defenders of the Darwinian faith, the evidence as it stands, both fossil and evo-devo, is entirely consistent

with a saltational scenario. One cannot dismiss the possibility that the bats acquired their wings relatively suddenly, as seems to be the case with the evolutionary novelties discussed above: the enucleate red cell, the tetrapod limb, the feather, the angiosperm Bau-plan, etc. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3074-3077). Discovery Institute Press. Kindle Edition.]

10. Bridging Gaps: The Origin of Language

- You are mesmerized, not simply by the subtlety of these marvelous engravings... For this is not in any sense crude art; it is art as refined in its own way—and certainly as powerful—as anything achieved since. Any preconceptions you may have had of the “primitiveness” of “cavemen” are instantly dispelled... This remarkable art... we can instinctively recognize... as something profoundly human. Not only is it humans, uniquely, who create art, but it is only we who indulge in behaviors as mysterious and unfathomable as this. [Ian Tattersall, *Becoming Human: Evolution and Human Uniqueness* (1999), Prologue.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3185-3190). Discovery Institute Press. Kindle Edition.]
- On our own kind, *Homo Sapiens*, slipped suddenly into being on the rich, game-laden African grasslands of the late Pleistocene, and spread rapidly over the next 200,000 years to every corner of the world. Here was the greatest of novelties, a new type of being—for the first time a creator and molder of the world—a speaking and thinking being, knowing, insightful, artistic, and religious. As well as a hunter, here was a storyteller, a mystic, a seer, and a dreamer.¹ [Ian Tattersall, *Becoming Human: Evolution and Human Uniqueness* (Orlando: Houghton Mifflin Harcourt, 1999), Chapter 1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3190-3194). Discovery Institute Press. Kindle Edition.]
- Nothing before in evolution had hinted at the possibility of such a novel organism. The radical nature of this mysterious happening, and the unprecedented intellectual advance it entailed, is shown graphically in the marvelous frescoes of cave art of the upper Paleolithic in Europe.² [Ian Tattersall, *Becoming Human: Evolution and Human Uniqueness* (Orlando: Houghton Mifflin Harcourt, 1999), Chapter 1.] [Michael Denton: *Evolution,*

Still a Theory in Crisis (Kindle Locations 3194-3196). Discovery Institute Press. Kindle Edition.]

- In his essay, “The Limits of Natural Selection as Applied to Man,” Wallace stressed that natural selection cannot bring about any adaptation unless “it is for the good of the being so modified.”⁴ So how, he asks, did a “surplusage” of intellectual powers, far beyond the need of ancient man, come about by natural selection? How could it have brought into being the mathematical abilities of an Einstein or the musical abilities of a Mozart, extraordinary talents which remained latent for vast periods of time, only to become manifest in modern times? In his words: It is evident... that the absolute bulk of the brain is not necessarily much less in savage than in civilised man... But what is still more extraordinary, the few remains yet known of pre-historic man do not indicate any material diminution in the size of the brain case.⁵ We are... driven to the conclusion that in his large and well-developed brain he possesses an organ quite disproportionate to his actual requirements—an organ that seems prepared in advance, only to be fully utilized as he progresses in civilization.⁶ [4. Alfred Russel Wallace, “The Limits of Nature Selection as Applied to Man,” in *Contributions to the Theory of Natural Selection*, second edition (New York: MacMillan, 1871), Chapter 10. This work is available online at <https://archive.org/details/contributionsto01wallgoog>. 5. *Ibid.*, 336. 6. *Ibid.*, 343.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3206-3216). Discovery Institute Press. Kindle Edition.]
- As Noam Chomsky recently commented: “[Wallace] recognized that mathematical capacities [for example] could not have developed by natural selection; it’s impossible, because everybody’s got them, and nobody’s ever used them, except for some very tiny fringe of people in very recent times. Plainly, they developed in some other way.”⁷ [7. Noam Chomsky, *The Science of Language: Interviews with James McGilvray* (New York: Cambridge University Press, 2012), 15.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3216-3219). Discovery Institute Press. Kindle Edition.]
- From an evolutionary point of view, the origin of man’s higher intellectual abilities is one of the greatest of all mysteries, of all facts to be explained. It

would certainly seem, in light of these preliminary observations, that the origin and evolution of our intellectual powers must have involved causal factors beyond natural selection. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3226-3228). Discovery Institute Press. Kindle Edition.]

- On the grounds of the normal definition of a species as an interbreeding population of organisms, Neanderthals and Denisovans must be classed as subspecies or races of *Homo sapiens*, and this would suggest that they may also have had language and relatively high intelligence. Although it is controversial, the most recent evidence points in this direction.⁸ And if indeed Neanderthals had language and an intelligence level comparable with that of modern humans, it must be inferred that at least some of our mental and perhaps also our linguistic abilities predate the last common ancestor of modern and archaic humans about 500,000 years ago.⁹ [8. “Neanderthal,” Wikipedia, accessed on September 9, 2015, <http://en.wikipedia.org/wiki/Neanderthal>; Paola Villa and Wil Roebroeks, “Neandertal Demise: An Archaeological Analysis of the Modern Human Superiority Complex,” *PLoS ONE* 9, no. 4 (April 30, 2014): e96424, doi:10.1371/journal.pone.0096424; Ruggero D’Anastasio, Stephen Wroe, Claudio Tuniz, Lucia Mancini, Deneb T. Cesana, Diego Dreossi, Mayoorendra Ravichandiran, Marie Attard, William C. H. Parr, Anne Agur, and Luigi Capasso, “Micro-Biomechanics of the Kebara 2 Hyoid and Its Implications for Speech in Neanderthals,” *PloS One* 8, no. 12 (2013): e82261, doi:10.1371/journal.pone.0082261. 9. Richard E. Green, Johannes Krause, Susan E. Ptak, Adrian W. Briggs, Michael T. Ronan, Jan F. Simons, Lei Du, Michael Egholm, Jonathan M. Rothberg, Maja Paunovic, and Svante Pääbo, “Analysis of One Million Base Pairs of Neanderthal DNA,” *Nature* 444, no. 7117 (November 16, 2006): 330–336, doi:10.1038/nature05336.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3232-3237). Discovery Institute Press. Kindle Edition.]
- Further support for the claim that Neanderthals were fully human is the fact that their technology was more complex than that of some isolated modern human groups. They built houses, made clothes, used fire, made bone and stone tools, buried their dead, and constructed boats.¹¹ In these arts they were probably in advance of modern Andaman islanders and Tasmanian

aborigines.¹² We are thus faced with the possibility that humans with fully modern linguistic capacity emerged as far back as 500,000 years ago. [11. “Neanderthal,” <http://en.wikipedia.org/wiki/Neanderthal>. 12. As Jared Diamond points out in *Guns, Germs, and Steel: The Fates of Human Societies* (New York: W. W. Norton, 1997), “The Tasmanians had one of the simplest material cultures of any people in the modern world... [They lacked] barbed spears, bone tools of any type, boomerangs, ground or polished stone tools, hafted stone tools, hooks, nets, pronged spears, traps, and the practices of catching and eating fish, sewing, and starting a fire.” (312)] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3242-3247). Discovery Institute Press. Kindle Edition.]

- Some of our mental abilities and emotional traits are certainly shared to some degree by other species,¹³ but language, as Chomsky comments, is without any homolog in any other species.¹⁴ Language is a Type-defining homolog, restricted to an individual species, an autapomorphy in cladistic terminology, and like other such homologs, it is not led up to by any empirically known sequence (e.g., starting with simple “grunts and gestures” and progressing through more and more complex communication systems till we reach human language). And again—a recurring theme of this book—no plausible hypothetical evolutionary series has ever been proposed.¹⁵ Thus, just as in the case of the other defining novelties discussed above, the evidence is consistent with a saltational origin. [13. Carl Safina, *Beyond Words: What Animals Think and Feel* (New York: Henry Holt and Company, 2015) 14. Chomsky, *The Science of Language*, 47; Marc D. Hauser, Charles Yang, Robert C. Berwick, Ian Tattersall, Michael J. Ryan, Jeffrey Watumull, Noam Chomsky, and Richard C. Lewontin, “The Mystery of Language Evolution,” *Frontiers in Psychology* 5, no. 401 (May 7, 2014): doi:10.3389/fpsyg.2014.00401. 15. Hauser et al., “The Mystery of Language Evolution.”] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3248-3255). Discovery Institute Press. Kindle Edition.]
- Because of the lack of homology and the lack of plausible adaptive evolutionary steps, the origin of language remains an abiding mystery. The authors of a recent paper comment: Understanding the evolution of language requires evidence regarding origins and processes that led to change. In the last 40 years, there has been an explosion of research on this problem as well

as a sense that considerable progress has been made. We argue instead that the richness of ideas is accompanied by a poverty of evidence, with essentially no explanation of how and why our linguistic computations and representations evolved.¹⁶ [Hauser et al., “The Mystery of Language Evolution.”, abstract.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3255-3260). Discovery Institute Press. Kindle Edition.]

- In the early 1960s, in one of the landmark advances in twentieth-century science, Noam Chomsky showed that all human languages share a deep invariant structure. Despite their very different “surface” grammars, they all share a deep set of syntactic rules and organizing principles. All have rules limiting sentence length and structure and all exhibit the phenomenon of recursion—the embedding of one sentence in another.¹⁷ Chomsky has postulated that this deep “universal grammar” is innate and is embedded somewhere in the neuronal circuitry of the human brain in a language organ. Children learn [human] languages so easily, despite “the poverty of stimulus,”¹⁸ because they possess innate knowledge of the deep rules and principles of human language and can select, from all the sentences that come to their minds, only those that conform to a “deep structure” encoded in the brain’s circuits.¹⁹ [17. “[Chomsky’s] approach thus remains radically opposed to that of Skinner or Piaget, for whom language is constructed solely through simple interaction with the environment. This latter, behaviourist model, in which the acquisition of language is nothing but a by-product of general cognitive development based on sensorimotor interaction with the world, would appear to have been abandoned as the result of Chomsky’s theories.” Bruno Dubuc, “Tool Module: Chomsky’s Universal Grammar,” *The Brain from Top to Bottom*, translated by Al Daigen, http://thebrain.mcgill.ca/flash/capsules/outil_rouge06.html. 18. Chomsky, *The Science of Language*, 5. 19. *Ibid.*, part 1.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3261-3269). Discovery Institute Press. Kindle Edition.]
- As Chomsky puts it: What we call “primitive people”... to all intents and purposes are identical to us. There’s no cognitively significant genetic difference anyone can tell. If they happened to be here, they would become one of us, and they would speak English; if we were there, we would speak their languages. So far as anyone knows, there is virtually no detectable

genetic difference across the species that is language-related.²² [22. Chomsky, *The Science of Language*, 13.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3279-3283). Discovery Institute Press. Kindle Edition.]

- One aspect of language that no one will dispute is that linguistic competence depends on a set of extraordinarily complex neural circuits in the brain. Some idea of the very great complexity that underlies language processing is conveyed with great clarity in Stephen Pinker's *The Language Instinct*. In his words: [Language processing involves] many parts: syntax, with its discrete combinatorial system building phrase structures; morphology, a second combinatorial system building words; a capacious lexicon; a revamped vocal tract; phonological rules and structures; speech perception; parsing algorithms; learning algorithms. Those parts are physically realized as intricately structured neural circuits... What these circuits make possible is an extraordinary gift: the ability to dispatch an infinite number of precisely structured thoughts from head to head by modulating exhaled breath.²³ [23. Steven Pinker, *The Language Instinct*, 1st ed. (New York: W. Morrow and Co., 1994), 373.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3292-3299). Discovery Institute Press. Kindle Edition.]
- As Pinker points out, "There must be portions of the cortex which carry out circumscribed tasks, because brain damage can lead to language deficits [aphasias] which are startlingly specific."²⁴ Pinker gives some examples, such as the "pure word" syndrome: The patients can read and speak, and can recognize environmental sounds like music, slamming doors, and animal cries, but cannot recognize spoken words; words are as meaningless as if they were from a foreign language. Among patients with problems in grammar, some do not display the halting articulation of Broca's aphasia but produce fluent ungrammatical speech. Some aphasics leave out verbs, inflections, and function words; others use the wrong ones. Some cannot comprehend complicated sentences involving traces (like *The man who the woman kissed* (trace) *hugged the child*) but can comprehend complex sentences involving reflexives (like *The girl said that the woman washed herself*). Other patients do the reverse.²⁵ [24. *Ibid.*, 319. Most medical interns will have witnessed the extraordinary specificity of functional loss in patients with CNS lesions. 25. *Ibid.*, 320–321.] [Michael Denton: *Evolution, Still a Theory in Crisis*

(Kindle Locations 3301-3309). Discovery Institute Press. Kindle Edition.]

- The failure to simulate linguistic competence in a computer not only underlines just how complex the underlying processing machinery must be, but at the same time raises a curious Darwinian paradox. How could blind unintelligent cumulative selection, the blind watchmaker, have assembled a device—the language organ—of such complexity and sophistication that intelligent humans cannot “intelligently” simulate these unique abilities in a machine? [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3329-3332). Discovery Institute Press. Kindle Edition.]
- As is well known, Chomsky sees the origin of language in strikingly internalist and saltational terms, as the result of the sudden self-organization of the brain’s neuronal circuits. He writes: “There was a sudden ‘great leap’ forward... some small mutation took place... in a single person. Something happened in a person that that person transmitted to its offspring. And... in a very short time, it dominated the group.”³⁰ [30. Chomsky, *The Science of Language*, 13.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3333-3336). Discovery Institute Press. Kindle Edition.]
- Ian Tattersall was also inclined to an emergentist, saltational view of human origins, especially of our artistic and intellectual abilities. In *Becoming Human* he comments on human uniqueness: The “human capacity” is not simply an extrapolation of the earlier trends in our lineage... It is more akin to an “emergent quality,” whereby... a new combination of features produces totally unexpected results. The classic example of such a quality is water, whose remarkable characteristics, so essential for life, are entirely unpredicted by those of either hydrogen or oxygen atoms alone.³³ [33. Tattersall, *Becoming Human*, 189.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3344-3348). Discovery Institute Press. Kindle Edition.]
- Even Gould was inclined to the emergentist, internalist view. In *The Richness of Life* he speculates: Complex objects often display the interesting and paradoxical property of major effect for apparently trifling input... Perhaps... the origin of human consciousness, required little more than an increase of brain power to a level where internal connections became rich and varied enough to force this seminal transition.³⁶ [36. Stephen J. Gould,

Paul McGarr, and Steven P. R. Rose, *The Richness of Life: The Essential Stephen Jay Gould* (New York: W. W. Norton, 2007), 153–154. The saltational emergentist strictly non-Darwinian model of origins (Chomsky, Tattersall, Gould) that I am defending here and throughout the book implies that the transitions are programmed into nature and arise in particular organism that were at particular moments in evolutionary history pre-adapted or prefigured for them to occur. But just because nature is prefigured for the leaps does not mean that the emergent leaps do not represent major discontinuities in the order of things, such as between a subhuman primate brain and the human brain; between a dumb ape and a talkative human. The prefiguring of the primate brain for the emergent leap (which I assume was the case) does not necessarily imply that there was any continuity in linguistic competence between ape and man. Consider: liquid water and solid ice. Ice can only form from water [H₂O] and in that sense we may consider water as prefigured for the formation of ice but there is no continuity of forms between water and ice. Or consider oxygen [O] and hydrogen [H] and water [H₂O]. Water can only be formed by uniquely combining the two pre-existing material forms oxygen and hydrogen. But there is absolutely not the slightest continuity in the properties of O and H and H₂O. Note also a crucial fact: Although these (ice and liquid water; O and H and H₂O) are hugely different material forms and the discontinuities are absolute, the triggers which initiates the dramatic phase transitions are essentially trivial—in one case merely cooling water from one to zero degrees, to get ice; in another case, merely the bringing hydrogen and oxygen into close proximity in a gaseous mixture which results in the explosive formation of water. In the case of the origin of language, just because the trigger that caused the leap to language might have been very minor does not mean that the gap was trivial or that there is no real discontinuity. The fact that the change was minor which triggered the self-organization of the primate brain into the new human configuration possessed of linguistic ability has no bearing on the potential enormity of the gap. On any theory of human origins, we are clearly modified hominids. The fact is we do share a vast suit of homologs with our higher primate cousins, from menstruation to the vermiform appendix. Our unique biological attributes are additional “add ons” to a basic primate design, and I think it must be assumed that they could only have been instantiated in

prefigured “primate matter.” [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3355-3359). Discovery Institute Press. Kindle Edition.]

- How quickly language and our higher intellectual abilities were acquired is of course unknown, and Chomsky’s saltational/emergentist view is very controversial. Most researchers in this area believe, in conformity with the Darwinian framework, that language came about gradually, by cumulative natural selection.³⁷ Against this, Chomsky remarks: The overwhelming assumption is that language evolved slowly through natural selection. Yet that doesn’t seem at all consistent with even the most basic facts. If you look at the literature on the evolution of language, it’s all about how language could have evolved from gestures, or from throwing, or something like chewing, or whatever. None of which makes any sense.³⁸ [37. Terrence W. Deacon, *The Symbolic Species: The Co-Evolution of Language and the Brain* (New York: W. W. Norton, 1998); Pinker, *The Language Instinct*. 38. Chomsky, *The Science of Language*, 49.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3360-3366). Discovery Institute Press. Kindle Edition.]
- David Premack is skeptical: I challenge the reader to reconstruct the scenario that would confer selective fitness on recursiveness. Language evolved, it is conjectured, at a time when humans or protohumans were hunting mastodons... Would it be a great advantage for one of our ancestors squatting alongside the embers, to be able to remark, “Beware of the short beast whose front hoof Bob cracked when, having forgotten his own spear back at camp, he got in a glancing blow with the dull spear he borrowed from Jack”? Human language is an embarrassment for evolutionary theory because it is vastly more powerful than one can account for in terms of selective fitness. A semantic language with simple mapping rules, of a kind one might suppose that the chimpanzee would have, appears to confer all the advantages one normally associates with discussions of mastodon hunting or the like. For discussions of that kind, syntactical classes, structure-dependent rules, recursion and the rest, are overly powerful devices, absurdly so.³⁹ [39. David Premack, “Gavagai! Or the future of the animal language controversy,” *Cognition* 19: 207–296, see pages 281–282.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3374-3382). Discovery Institute

Press. Kindle Edition.]

- One reason to be very skeptical of the Darwinian claim that the deep structure of human language came about as a result of bit-by-bit, incremental selection of tiny advantageous mutations over millions of generations is its mysterious invariance in all human lineages since it emerged 200,000 years ago (and as far as we can tell the invariance of all the higher intellectual traits and characteristics which make every living human instantly recognizable as belonging to our species). [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3383-3386). Discovery Institute Press. Kindle Edition.]
- Overall, the constraints of population genetics point strongly away from the Darwinian conception of language competence as a product of hard-earned adaptive evolution and away from the existence of a bank of genes specifically devoted to assembling the language organ in the brain. They provide powerful support for Alfred Wallace's and Noam Chomsky's inference that internal factors, in addition to selection for functional ends, were responsible for the origin of our linguistic and cognitive abilities. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3458-3461). Discovery Institute Press. Kindle Edition.]
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- First, as pointed out by Wallace, our current intellectual abilities (mathematical, musical, artistic, etc.) could not have possessed any utility on the ancient Pleistocene savanna. Second, no explanation for why such extraordinary powers should have remained latent for millennia after their origination, 500,000 to 200,000 years ago, has ever been provided. Third,

our linguistic evolution had to occur in a short period of time in small populations in which adaptive mutations were bound to have been very rare, and in which drift would have predominated over selection as the major cause of mutational substitution. Fourth, there is the discovery that of the very few genes that were under positive selection along the line leading to modern humans, very few if any can be construed as being language genes or having any direct influence on our higher mental abilities. Finally, there is the fact that in ontogeny, self-organization rather than detailed genetic specification would seem to be the major process responsible for the generation of the language organ. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3594-3602). Discovery Institute Press. Kindle Edition.]

- Finally, there is the overriding definitional challenge to the Darwinian narrative arising from the fact that many of the taxa-defining homologs and ground plans—such as the pentadactyl limb, angiosperm flower, and the floral formulae of the angiosperm sub-clades—have never been shown to have any specific utility in any actual organism in any actual environment. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3667-3669). Discovery Institute Press. Kindle Edition.]
- The enormous advances in knowledge since 1985 have only confirmed my claim in *Evolution* that the Types are distinct and isolated and not led up to via long series of functional transitional forms as Darwinism demands. On the contrary, the evidence pointed then and points even more emphatically today to discontinuity and to the ultimate Darwinian nightmare—that the gaps were crossed per saltum or at least in a series of jumps, a mode of sudden emergence which eliminates any possibility of attributing agency to natural selection, even in those cases where the homolog is clearly adaptive. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3675-3679). Discovery Institute Press. Kindle Edition.]
- In his much-maligned book, *The Material Basis of Evolution*, geneticist Richard Goldschmidt argued that an accumulation of microevolutionary changes could never have summed up to macroevolutionary innovations, and he offered a challenge: I may challenge the adherents of the strictly Darwinian view, which we are discussing here, to try to explain the evolution

of the following features by accumulation and selection of small mutants: hair in mammals, feathers in birds, segmentation of arthropods and vertebrates, the transformation of the gill arches in phylogeny including the aortic arches, muscles, nerves etc.; further, teeth, shells of mollusks, ectoskeletons, compound eyes, blood circulation, alternation of generations, statocysts, ambulacral system of echinoderms, pedicellaria of the same, cnidocysts, poison apparatus of snakes, whale-bone... corresponding examples from plants could be given.⁸⁵ [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3680-3686). Discovery Institute Press. Kindle Edition.]

- Goldschmidt's challenge has never been met. And we can add to his list the many additional novelties discussed in the previous chapters, and those mentioned in *Evolution: A Theory in Crisis*, including the bacterial flagellum,⁸⁶ and the absolutely unique copulatory organ of the male dragonfly (one of my personal favourites), which is described by Robert Tillyard in his classic, *The Biology of Dragonflies*, as "not homologous with any known organ in the Animal Kingdom; it is not derived from any pre-existing organ; and its origin, therefore, is as complete a mystery as it well could be."⁸⁷ [86. Denton, *Evolution*, 223–225. 87. R. J. Tillyard, *The Biology of Dragonflies* (Cambridge: Cambridge University Press, 1917), 215.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3687-3692). Discovery Institute Press. Kindle Edition.]

11. Beyond Chance: Natura Non Facit Saltum

- According to Fred Hoyle's famous calculation,⁸ the probability of the evolution of cellular life by chance is about one in 1040,000. He illustrated the probability thus: A junkyard contains all the bits and pieces of a Boeing 747, dismembered and in disarray. A whirlwind happens to blow through the yard. What is the chance that after its passage a fully assembled 747, ready to fly, will be found standing there? So small as to be negligible, even if a tornado were to blow through enough junkyards to fill the whole Universe.⁹ [8. Fred Hoyle and Chandra Wickramasinghe, *Evolution from Space: A Theory of Cosmic Creationism* (New York: Simon and Schuster, 1984), 24. 9. Fred Hoyle, *The Intelligent Universe*, 1st American ed. (New York: Holt, Rinehart, and Winston, 1984), 19; quoted from "Junkyard Tornado,"

Wikipedia, accessed on September 11, 2015, http://en.wikipedia.org/wiki/Junkyard_tornado#cite_note-5.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3746-3751). Discovery Institute Press. Kindle Edition.]

- As Darwin bluntly put it in the Origin: He who believes that some ancient form was transformed suddenly through an internal force or tendency... will further be compelled to believe that many structures beautifully adapted to all the other parts of the same creature and to the surrounding conditions, have been suddenly produced; and of such complex and wonderful co-adaptations, he will not be able to assign a shadow of an explanation... To admit all this is, as it seems to me, to enter into the realms of miracle, and to leave those of Science.¹⁰ [10. Charles Darwin, *Origin of Species*, 6th ed. (London: John Murray 1872), 204, Chapter 7.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3754-3759). Discovery Institute Press. Kindle Edition.]

12. Fossils: Long-Term Non-Adaptive Trends

- Natural selection acts exclusively by the preservation and accumulation of variations, which are beneficial under the organic and inorganic conditions to which each creature is exposed at all periods of life. The ultimate result is that each creature tends to become more and more improved in relation to its conditions. [Charles Darwin, *On the Origin of Species* (1872), Chapter 4.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 3794-3797). Discovery Institute Press. Kindle Edition.]
- Whether the fossil record documents any genuinely long-term trends towards maladaptive ends is controversial. But it does document long-term, unidirectional trends that appear to have no immediate adaptive utility to the successive species in the lineage concerned. Such trends suggest strongly that macroevolution does indeed involve, as evo-devo also implies, internal causal factors in addition to cumulative selection for functional ends.⁷ [7. For a review of the area, see Stephen Jay Gould, “Eternal Metaphors of Paleontology,” in *Patterns of Evolution as Illustrated by the Fossil Record*, edited by Anthony Hallam (New York: Elsevier Scientific Publishing Company, 1977), 1–26, and *Structure of Evolutionary Theory*, Chapters Five and Seven.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle

Locations 3825-3829). Discovery Institute Press. Kindle Edition.]

13. Typology Redux

- As Darwin himself said in a celebrated letter to Henry Fawcett, “All observation must be for or against some view if it is to be of any service.”¹
[1. Charles Darwin, letter to Henry Fawcett, 18 September 1861, quoted in *The Autobiography of Charles Darwin: 1809–1882*, edited by Nora Barlow (New York: Norton, 1969), Appendix, Part One, page 130. Text on line: <https://www.darwinproject.ac.uk/letter/entry-3257>.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4047-4048). Discovery Institute Press. Kindle Edition.]
- Given the fading plausibility of the neo-Darwinian worldview, this is perhaps a propitious time to mount a defense of the structuralist/typological view. It is propitious also because a number of recent developments provide novel support for the pre-Darwinian structuralist belief that much organic order is the result of intrinsic physical properties of living systems and that the Types are, as Geoffroy² and Owen³ and many other nineteenth-century biologists conceived of them, integral parts of nature. [2. Edward Stuart Russell, *Form and Function* (London: Murray, 1916), 78. Russell asked: “If there be an irreducible element of unity, is there any truth in Geoffroy’s suggestion that this unity [of the Type] results from a power which is exercised in the world of atoms where are elements of inalterable character?” 3. Richard Owen, *On the Anatomy of Vertebrates* (London: Longmans, Green and Co., 1866). See concluding paragraphs where Owen talks of “laws” which have caused the progression of life forms from fish to man. See also discussion of Owen’s views in Chapter 1 and Chapter 4.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4049-4053). Discovery Institute Press. Kindle Edition.]
- The twentieth-century cosmological evidence that the universe is fine-tuned for life is based on the observation that if the various fundamental forces and constants which determine the structure of the cosmos and the properties of its constituents did not have precisely the values they do, there would be no stars, no supernovae, no planets, no atoms, and certainly no life.⁸ [8. Paul Davies, *The Accidental Universe* (New York: Cambridge University Press, 1982); John D. Barrow and Frank Tipler, *The Anthropic Cosmological*

Principle (New York: Oxford University Press, 1988); John Gribbin and Martin Rees, *Cosmic Coincidences: Dark Matter, Mankind, and Anthropic Cosmology* (Golden, CO: ReAnimus Press, 2015); Paul Davies, *The Cosmic Blueprint: New Discoveries in Nature's Creative Ability to Order the Universe* (Philadelphia: Templeton Foundation Press, 2004).] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4069-4072). Discovery Institute Press. Kindle Edition.]

- As Paul Davies summarizes: The numerical values that nature has assigned to the fundamental constants, such as the charge on the electron, the mass of the proton, and the Newtonian gravitational constant, may be mysterious, but they are crucially relevant to the structure of the universe that we perceive. As more and more physical systems, from nuclei to galaxies, have become better understood, scientists have begun to realize that many characteristics of these systems are remarkably sensitive to the precise values of the fundamental constants. Had nature opted for a slightly different set of numbers, the world would be a very different place. Probably we would not be here to see it.⁹ [9. Davies, *The Accidental Universe*, vii.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4072-4077). Discovery Institute Press. Kindle Edition.]
- On the fine-tuning necessary to generate carbon and the higher elements in the stars, Fred Hoyle famously commented: “A commonsense interpretation of the facts suggests that a superintellect has monkeyed with physics, as well as with chemistry and biology, and that there are no blind forces worth speaking about in nature.”¹⁰ [10. Fred Hoyle, “The Universe: Past and Present Reflections,” *Engineering and Science* (November, 1981), 8–12, 12.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4078-4080). Discovery Institute Press. Kindle Edition.]
- There is no doubt that cosmological fine-tuning for life as it exists on earth provides a very powerful line of circumstantial evidence, drawn ironically from outside the biological sciences, for a return to a structuralist biology and the notion that life's origin and evolution were built into the order of nature from the moment of the “big bang.” [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4113-4116). Discovery Institute Press. Kindle Edition.]

- As I pointed out in a previous paper: An inevitable consequence of adopting the functionalist paradigm, and the notion that organic forms are ultimately contingent mechanical assemblages of matter [machines], is the need to postulate a genetic blueprint in the genes (analogous to the blueprint which specifies a machine) that specifies in detail the mature form. This is because contingent order, unlike natural form, cannot arise spontaneously as the result of natural law or from the self-organization of matter. If the types are indeed (as structuralists insist) natural forms like crystals, there is no need to specify in detail the higher order of the organic system in a detailed blueprint, because, as in the case of a crystal or any other natural form, “nature” takes the basic components (atoms, molecules, categories of biological matter) and organizes them into their native forms. Functionalism demands preformism (a detailed blueprint [in the DNA] specifying the final form), while structuralism implies epigenesis (emergent form based on self-organizational principles apart from any blueprint).²⁰ [20. Michael J. Denton, “The Types: A Persistent Structuralist Challenge to Darwinian Pan- Selectionism,” *BIO-Complexity* 2013, no. 3 (August 19, 2013), 1–18, 8–9.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4130-4138). Discovery Institute Press. Kindle Edition.]
- In another recent paper Newman describes “three examples of morphological motifs of vertebrate bodies and organs, the somites, the skeletons of the paired limbs, and musculoskeletal novelties distinctive to birds, for which evolutionary origination and transformation can be understood on the basis of the physiological and biophysical determinants of their development.”⁶⁹ And in a comment that is supportive of the whole structuralist thrust of this book, he concludes: I have argued that newer evidence from experimental embryology, interpreted in the light of concepts from condensed matter physics and physiology unknown at the time of Darwin and his early 20th century successors, challenges this tenet [Darwinism] and each of its components. This challenge does not outright abolish gradualist natural selection, but it does relegate it to a role in the fine-tuning and refining of heritable modifications that arise by other, often physiologically based, means.⁷⁰ [69. Stuart Newman, “Form and Function Remixed: Developmental Physiology in the Evolution of Vertebrate Body Plans,” *Journal of Physiology* 592 (2014): 2403–2413, see page 2403, doi:

10.1113/jphysiol.2014.271437, emphasis added. 70. Ibid., 2410.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4321-4329). Discovery Institute Press. Kindle Edition.]

- Many other papers might be cited. Perhaps one additional very striking report is worth a mention, since it brings home with great force just how far embryonic sculpting is from the genes. The paper is again pointedly entitled: “The Role of Mechanical Forces in Dextral Rotation during Cardiac Looping in the Chick Embryo.”⁷¹ The subject is somewhat esoteric, but nonetheless the paper is indicative of the profoundly epigenetic direction in which biology is moving. From their study the authors conclude: The results suggest that (1) the heart contains little or no intrinsic ability to rotate, as external forces exerted by the splanchnopleure (SPL) and the omphalomesenteric veins (OVs) drive rotation; (2) unbalanced forces in the [OVs] play a role in left–right looping directionality; and (3) in addition to ventral bending and rightward rotation, the heart tube also bends slightly toward the right... We feel that these results provide a better understanding of the biophysical mechanisms that regulate cardiac c-looping.⁷² [71. Dmitry A. Voronov, Patrick W. Alford, Gang Xu, and Larry A. Taber, “The Role of Mechanical Forces in Dextral Rotation during Cardiac Looping in the Chick Embryo,” *Developmental Biology* 272, no. 2 (August 2004): 339–350, doi:10.1016/j.ydbio.2004.04.033, emphasis added. 72. Ibid., 339. Early in cardiac development the straight heart tube deforms into a c-shaped tube that is normally curved towards the right side of the embryo.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4330-4338). Discovery Institute Press. Kindle Edition.]
- Another case of conservation of form in the face of radical changes in lower-level gene circuits and developmental mechanisms is witnessed in the generation of the chordate body plan in vertebrates and their closest invertebrate chordate cousins, the tunicates. As Tanguy Chouard comments in a *Nature* article: Tunicates—also known as sea squirts—are humans’ closest invertebrate cousins. They have tadpole-like larvae that closely resemble miniature vertebrate embryos and so were expected to build their bodies in the same way. But they don’t. Most of the “organizer genes” are there in the tunicate genome, but they are expressed elsewhere in the embryo and do dramatically different things. It’s as if you had found a car in which

components of the engine were scattered all over the back seat—but the car still worked.¹⁰⁵ [105. Tanguy Chouard, “Darwin 200: Beneath the Surface,” *Nature* 456, no. 7220 (November 2008): 300–303, see p. 300.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4482-4488). Discovery Institute Press. Kindle Edition.]

- These extraordinary revelations of the stability of homologs or novelties in the face of different generative processes in different species constitute only a tiny fraction of the growing inventory of cases that support the notion that the homologs are indeed robust, emergent, natural kinds. Günter Wagner, whose research agenda is focused on the ontological status of the homologs, comments: Developmental mechanisms and pathways have a tendency to shift under the continuing presence of the “developmental” type. For instance, the genetic machinery that produces segments in grasshoppers is in important ways different from that in a fruit fly. Genes which are essential for fruit fly segmentation are not even expressed during segmentation in grasshoppers, e.g., *even-skipped* and *ftz*.¹⁰⁶ [106. Wagner, “How Wide and How Deep Is the Divide between Population Genetics and Developmental Evolution?” 148. In *Evolution: A Theory in Crisis* (Maryland: Adler & Adler, 1986), Chapter 7, I cited Gavin de Beer’s monograph, *Homology: The Unsolved Problem* (Oxford: Oxford University Press, 1971), to argue that homology is not explained by assuming that homologous structures are inherited from a common ancestor. Nearly three decades later, I think de Beer’s comments and the thrust of Chapter 7 have been entirely vindicated.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4489-4495). Discovery Institute Press. Kindle Edition.]
- Wagner concludes: “There is no explanation for the phylogenetic stability of developmental types... This is, according to Amundson, and I follow him in his argumentation, the most urgent theoretical problem in the re-unification of development and evolution.”¹⁰⁷ [107. Wagner, “How Wide and How Deep Is the Divide between Population Genetics and Developmental Evolution?” 148, emphasis added. It was always apparent that the adaptations built upon the homologies—Owen’s adaptive masks (like the various vertebrate limbs built upon the underlying pentadactyl pattern)—are far more variable than the underlying homology itself. From the advances in developmental genetics it is now clear that in many instances the homologous

patterns also are more robust than the underlying generative process and gene circuits responsible for their assembly during development. This is truly remarkable. There is variation above (the various adaptive forms built upon the homology in different species) and variation below (the variable generative processes by which the homologous pattern is derived in development in different species), while the homologous pattern itself remains invariant across the many lineages in which it is conserved.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4496-4498). Discovery Institute Press. Kindle Edition.]

- So here is a deep enigma. The homologs are “generated” in different ways involving different genes, different gene circuits, etc., and at the same time they are adapted in many diverse ways to serve different adaptive purposes. They persist unchanged in the face of generative changes “below” and adaptive changes “above.” What explanation can be offered for this primal observation other than that the homologs are some type of natural form? Surely they are more like natural forms than the “contingent assemblages of matter” that Darwinism implies? [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4498-4502). Discovery Institute Press. Kindle Edition.]
- In an intriguing comparison of the views of Owen and Darwin in his preface to Richard Owen: *Biology without Darwin*, Rupke captures the opposing components of their respective worldviews and the great dichotomy between structuralist and functionalist thinking: Owen represented “biology without Darwin” in more than one sense. The two great naturalists differed above all about the nature of organic evolution. They held opposing views on the origin of life from lifeless matter (Owen postulated multiple spontaneous “emergences”; Darwin kept the issue at arm’s length), on the mechanism of species development (Owen stressed an inner, “genetic” cause, Darwin external, natural selection), on the pattern of evolution through geologic time (Owen saw in it a structural logic, Darwin the haphazardness of contingency), and on “man’s place in nature” (Owen stressed the unity of humanity and its distance from the apes; the Darwinians constructed close racialist links between “lower humans” and “higher apes”). In addition, Owen tried, much more than Darwin, to bring processes of morphogenesis to bear on the origin of species, and as such he was an early representative of

what today we refer to as evo-devo, the field of evolutionary biology that integrates the study of how individual organisms develop with the development of species.¹¹¹ [111. Rupke, Richard Owen: *Biology without Darwin*, Preface.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4540-4550). Discovery Institute Press. Kindle Edition.]

- In this chapter, I have presented three lines of evidence which support the structuralist and typological view that the basic forms of life on earth are part of the order of nature and that the novelties which define the Types are robust natural forms: (1) the discovery of the cosmic and chemical fine-tuning of the laws of nature for life as it exists on earth; (2) evidence that much of the order of life is self-organized and epigenetic, generated by emergent biophysical and biomechanical forces which are beyond computation from the genes; and (3) the extraordinary robustness of the homologs. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4551-4555). Discovery Institute Press. Kindle Edition.]

14. The Priority of the Paradigm

- Despite its obvious failure, Darwinism has retained its hypnotic hold on the biological mind primarily because cumulative selection has been “the only game in town.” As Thomas Kuhn pointed out, without an alternative framework, scientific communities are forced to regard evidence that to anyone outside the circle of belief may appear to be profoundly hostile as mere anomalies.¹ [1. See Thomas Kuhn, *The Structure of Scientific Revolutions*, 4th ed. (Chicago: The University of Chicago Press, 2012); Michael Denton, *Evolution: A Theory in Crisis* (Maryland: Adler & Adler, 1986), Chapter Fifteen.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4567-4570). Discovery Institute Press. Kindle Edition.]
- Fortunately, it now seems that after a slumber of more than 150 years, a consilience of evidence is emerging that is supportive of the alternative paradigm of natural law. There is the deep hint—arising from the cosmological discovery of the fitness of nature for life—that the life forms on earth may be, after all, an integral part of the cosmic order. There are tantalizing hints that an explanation of life’s origin may lie within the fitness-structuralist framework, i.e. hints that nature lent a hand over this first great

divide! There is increasing evidence—perfectly consonant with the structuralist view—that a great deal of organic order is emergent, the result of the self-organization of different categories of biomatter and not specified in the genes as the alternative Darwinian contingent model predicts. There is the evidence of evo-devo that the paths of evolution have been constrained by deep homologies, shared in some cases by all metazoan organisms, and that the specific taxa-defining novelties themselves have been shaped largely by internal causal factors rather than cumulative selection. Finally, there is the existential challenge to Darwinian functionalism posed by the non-adaptive nature of so many of the homologs and Bauplans. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4593-4602). Discovery Institute Press. Kindle Edition.]

- This is obvious on any reading of Fodor and Piattelli-Palmarini's *What Darwin Got Wrong*. The authors argue fervently—along with many others—that Darwinism cannot be the answer. But they end their book with a whimper with these massively disappointing words: “OK; if Darwin got it wrong, what do you guys think is the mechanism of evolution?” Short answer: we don't know what the mechanism of evolution is.”⁶ [6. Jerry Fodor and Massimo Piattelli-Palmarini, *What Darwin Got Wrong* (New York: Pica-dor, 2010), 153.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4609-4612). Discovery Institute Press. Kindle Edition.]
- There is no doubt that, as Fodor and his co-author insist, Darwin got it wrong. But although the Darwinian dragon is fatally wounded, to account for the “third infinity” and the novel homologs without the slightest hint of teleology, the beast must be maintained on life support by evolutionary biologists. This is why Pigliucci and Kaplan end their critical book *Making Sense of Evolution* with the claim, diametrically opposed to that of Fodor and Piattelli-Palmarini, that Darwin “was (largely) right after all.”⁷ Indeed, Darwinism will have to be right after all, will always be resuscitated, will have to be resuscitated, even in the face of Bateson's “endless absurdities” and Owen's non-adaptive Bauplans, even when it is so obvious that “he got it wrong,” until evolutionary biologists put aside their metaphysical commitment to a contingent worldview, and biology finally embraces the realm of law—a realm whose only defect in the eyes of the agnostic

mainstream is that it might be construed as supporting a return to a more teleological view of life and its place in the cosmos. [7. Massimo Pigliucci and Jonathan Kaplan, *Making Sense of Evolution: The Conceptual Foundations of Evolutionary Biology* (Chicago: University of Chicago Press, 2006), last sentence of book: “The master was (largely) right after all.”] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4613-4621). Discovery Institute Press. Kindle Edition.]

- Darwin was not “right after all.” There is an irresistible consilience of evidence for rejecting Darwinian cumulative selection as the major driving force of evolution. And what makes this consilience of evidence against Darwin so significant is that it is precisely what we should expect to see if—as many biologists before Darwin believed—the Types are real existents in the order of nature. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4627-4629). Discovery Institute Press. Kindle Edition.]
- Evolution is still a theory in very deep crisis. And as the arguments and much of the evidence I have presented here suggest, the only resolution to the ongoing crisis is the adoption of a new, twenty-first-century version of “laws of form” biology in which the basic “Types” would no longer be seen as artifactual assemblages, as they have been since 1859, but as lawful natural forms comparable to the forms of the inorganic realm. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4630-4633). Discovery Institute Press. Kindle Edition.]
- Only by rejecting the “contingent narrative” can biology be restored to its rightful place in the lawful and rational realm of natural science. Only by rejecting the “contingent narrative” can the inorganic and organic realms be united in the same causal framework. [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4633-4635). Discovery Institute Press. Kindle Edition.]
- Although I am convinced that the structuralist view is increasingly supported by many lines of evidence, I am aware that all scientific hypotheses are in the end provisional. It is perfectly possible that the phenomenon of life may ultimately prove to be beyond any explanation in terms of either the structuralist or functionalist frameworks. The causal answer may lie in models of nature as far removed from present-day conceptions as quantum

physics is from Newton's Principia. Given that the sheer complexity of living systems is already beyond ordinary comprehension, in the last analysis nature may be, as J. B. S. Haldane famously proclaimed, "not only queerer than we suppose, but queerer than we can suppose"—and certainly far, far queerer than conventional Darwinism supposes.⁹ [9. John Burdon Sanderson Haldane, *Possible Worlds and Other Papers* (London: Chatto and Windus, 1945), 286.] [Michael Denton: *Evolution, Still a Theory in Crisis* (Kindle Locations 4643-4649). Discovery Institute Press. Kindle Edition.]

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