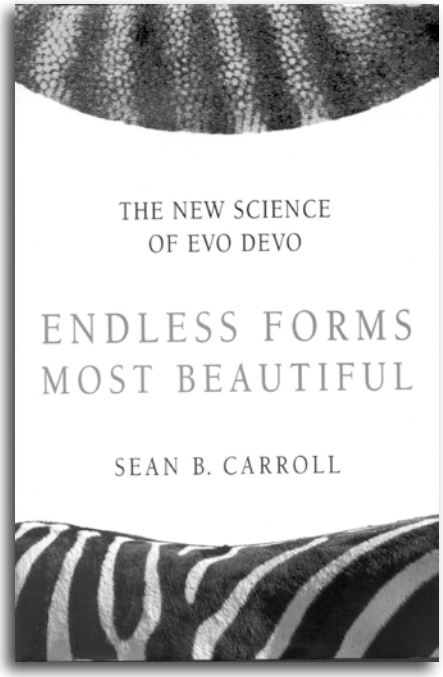
Evo Devo refutes neo-Darwinism, supports creation

A review of
Endless Forms Most Beautiful: The New Science of Evo Devo,
by Sean B. Carroll
W.W. Norton & Co.,
New York, 2005, 350p.



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Summary

Evo Devo (evolutionary developmental biology) is claimed to be the third great advance in evolutionary biology. While the 'Devo' (developmental biology) has indeed made stunning discoveries in recent years, the Evo (evolutionary speculation) part comes a poor second. The most stunning discovery is that the basic tool kit genes that determine all animal forms were already present at the beginning, so mutation has played no discernible role at all. This thoroughly refutes neo-Darwinism, and so Carroll has to rescue 'Evo' by asserting that mutation in gene switches is the key to evolution from one kind to another. But by using his own words, we can demonstrate that gene switches are clearly the product of intelligent design, not random mutations. Carroll shows us that embryonic development is a cascade of 'constellations of switches distributed all over the genome' switching genes on and off in ways that specify three-dimensional coordinates of where and when action is required. He shows us that 'tinkering' and mutation *do* have a role, but only in the *final stages* of the developmental cascade. Everything upstream of these final stages has to be assumed—i.e. created—it cannot be explained by Carroll's 'Evo' ideas.

Introduction

This book blows neo-Darwinism out of the water, and provides stunning evidence of the intelligent design of life. Sean Carroll, an evolutionist, is a developmental biologist in charge of his own Carroll Laboratory at Howard Hughes Medical Institute in Wisconsin. His pioneering work has received national press coverage, including the cover of *Time* magazine. He writes lucidly and passionately about his work and its implications for evolution and society. Ironically, it is textbook material for creationism.

Carroll claims that Evo Devo is the third wave in evolutionary biology. Darwin began the first wave with natural selection. Then the Modern Synthesis tied natural selection to mutation as the engine of variation. Embryologists have now created this third wave by joining forces with molecular biology to discover how a single-celled zygote develops into everything from jellyfish to giants and monsters. Carroll's evolutionary application of this new knowledge takes us right back to Haeckel's discredited dogma that 'ontogeny recapitulates phylogeny'. He claims that embryonic development into adult forms tells us virtually everything we need to know about evolution. Carroll is so certain of this remarkable advance in our understanding that he claims to have solved the mystery of the Cambrian Explosion—the so-called big bang of biology.

New discoveries

The advance in knowledge is indeed remarkable, and Carroll delights in telling us repeatedly that no one ever expected what they found. He reports four new discoveries:

- All animal bodies (i.e. vertebrates and invertebrates) are made up of repeated modules each having front-back, top-bottom, left-right polarity.
- A small number of 'tool kit' gene complexes (e.g. the *Hox* genes that determine body pattern) are responsible for producing all the varied structures that develop along bodies (e.g. eyes, legs, wings). The stunning part of this discovery is that these tool kit genes are virtually the same right across the animal kingdom. That means they were there from the beginning! 'All of the genes for building large complex animal bodies long predated the appearance of those bodies in the Cambrian Explosion' (p. 139).
- Development proceeds on 'geographical' lines as the spherical zygote turns into a three-dimensional adult. Control is exercised via specification of spatial coordinates at which events are to happen. Mutation at any point affects events downstream of that point while development elsewhere proceeds normally.
- Genetic switches (actually cascades of 'constellations of switches distributed all over the genome' (p. 111) that begin in the ovary

of the mother) determine the geographical coordinates at which the tool kit genes act to produce a leg here and an eye there etc.

This is the science that constitutes the 'Devo' component. The 'Evo' component consists of Carroll asserting that evolution from one form to another occurs via mutational changes in the switches. 'Evolution of form is very much a matter of teaching very old genes new tricks' (p. 135).

Refutation of neo-Darwinism

Neo-Darwinian evolution was said to be a random process of mutation that natural selection would fit to a variety of environments in various ways. Animals that diverged long ago would be so different in their genetic makeup today that neo-Darwinian pioneer Ernst Mayr said in the 1960s that 'the search for homologous genes is quite futile except in very close relatives' (pp. 71–72). Wrong—yet another failed prediction of the evolutionary paradigm! The mammalian tool kit gene for eye development is so similar to that in the fruit fly that you can put the mammalian gene into the embryo of the fly and it will initiate a fruit fly eye in that position (p. 67). Mouse, frog and fruit fly have homeodomains (regulatory proteins that bind to DNA) that vary by only one amino acid. Not only are the genes similar, but the way in which they are clustered and expressed in the invertebrates corresponds almost exactly to the way they are clustered and expressed in the vertebrates. 'No biologist had even the foggiest notion that such similarities could exist between genes of such different animals' (p. 64). 'The discovery that the same sets of genes control [development in all animals] has forced a complete rethink of animal history, the origins of structures and the nature of diversity' (p. 71).

That is, it blows neo-Darwinism out of the water. But this has not shaken Carroll's faith in evolution. On the contrary,

> 'the new facts and insights of embryology and Evo Devo devastate lingering remnants of stale anti-evolution rhetoric … [providing] irrefutable evidence of the descent and modification of animals, including humans, from a simple common ancestor' (p. 10).

Strong words—that are not supported by his evidence.

Evolutionists have never produced a satisfactory explanation of biological origins because they only ever address biological *history*. Natural selection is a theory about history—it can only select among varied organisms that *already exist*. It does not even address the question of origin (i.e. where those organisms and their variations came from). Likewise, mutation is a change in a gene that *already exists*, so it is a theory about history not origin (i.e. where the gene came from). And so it is with Evo Devo. Where does Carroll say the tool kit genes came from? He doesn't. They are in all the organisms that he deals with so he simply says 'these common genetic ingredients must date back deep in time' before the Cambrian Explosion.

Another line of evidence that refutes neo-Darwinism is the locus of control over evolution. Neo-Darwinists say that mutations in (protein-coding) genes control inheritance. But Evo Devo shows that it is the switching cascade that controls inheritance. And where does the switching cascade originate? 'The throwing of every switch is set up by preceding events' so the cascade goes all the way back to 'asymmetrically distributed molecules deposited in the egg during its production in the ovary' (p. 116). That is, control begins with the mother organism and the mother egg cell, not with the genes. This is powerful evidence for creation, not evolution. And it explains why organisms reproduce according to their kind, as the first chapter of Genesis tells us.[1]

Contents

The first half of the book is devoted to 'The Making of Animals' and details research in the genetics of embryological development. The second half is devoted to explaining the history of the evolution of life based on the assumption that 'evolution is as natural as development' (p. 6). Part 1 is excellent and fascinating science. Part II is speculation on a grand scale. It will likely be compelling anti-creationist fodder for years to come among those committed to evolution, but it is not hard to see the holes in it and to predict the future caveats that will no doubt tone down his enthusiasm.

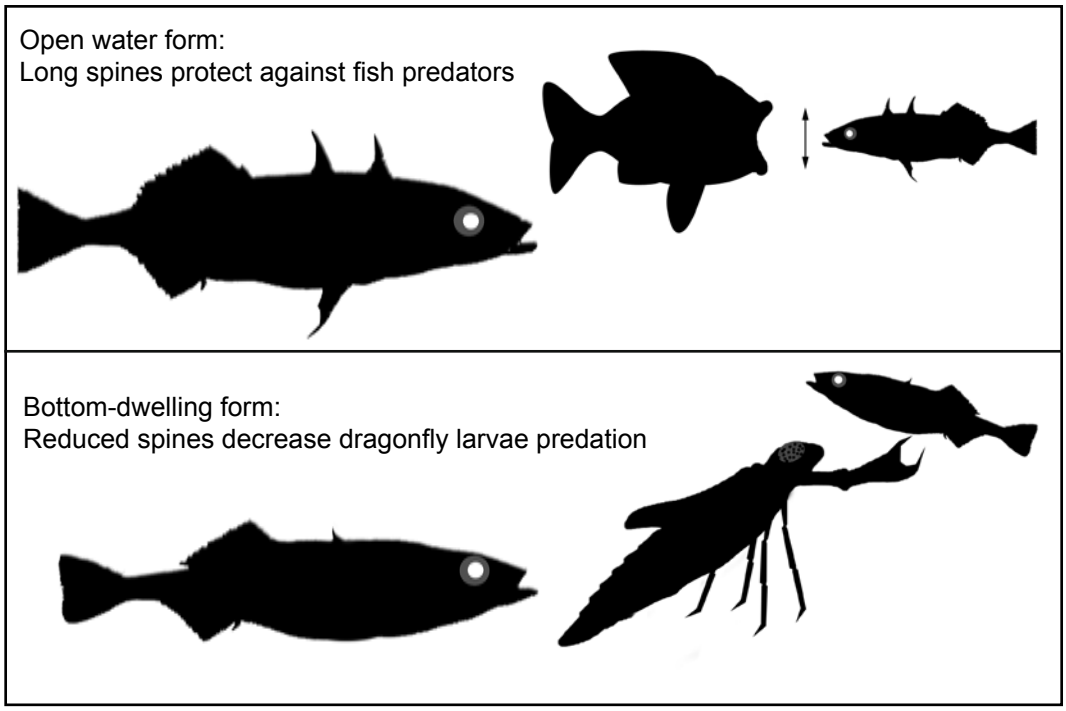
To give credit where it is due, Carroll does put forth a unifying view of how animals are made that no one else has done (at least in the popular literature). We can see this in the contrast between this book and Stephen Jay Gould's *Wonderful Life: The Burgess Shale and the Nature of History* (Norton, New York, 1989). Gould presented the Cambrian Burgess Shale creatures as bizarre animals coming from many disparate origins, but Carroll's Evo Devo model provides a unifying explanation for the varied forms that even creationists could accept as being the likely way the Creator put these creatures together. But as Gould rightly said, the devil is in the detail.

Carroll blithely explains away the Cambrian Explosion as being nothing more than Evo Devo with lots of environmental opportunities (he sounds very much like Darwin). The ancestral animal had a 'full genetic tool kit for body building' and its potential was realized by 'ecology on a grand scale'. But how, actually, did the variations arise? 'The potential of the tool kit was realized largely through evolution of switches and gene networks and the shifting of *Hox* zones' (p. 164). Ah, I see. You take the ancestral animal with its pre-existing genetic tool kit, and you insert a range of new switches and gene networks and rearrange some of the *Hox* zones. Mutation is not even mentioned. Everything else sounds more like the work of a super-intelligent engineer / Creator than of 'ecology on a grand scale.'

We are then told that all the amazing variety among the arthropods (lobsters, spiders, insects etc.) can be explained by

variations in only three genes—*Distal-less*, *Apterous* and *Nubbin* (pp. 179–180). Really? On closer inspection we find that theses three genes are indeed present in all these creatures, but it is the switching patterns, not the genes themselves, that determine the outcome; and they are quite different.

The grandiose claims continue on the vertebrate arm of the animal kingdom. Everything from fish fingers to bat wings can be explained by Evo Devo—except that 'the precise differences responsible for the distinct features of bird and bat wings are not yet known in detail' (p. 190). A small detail.



But at last we do come to 'one of the most compelling case studies of evolution' (p. 193)—the stickleback.

> 'In many lakes throughout the northern ranges of North America, pairs of stickleback forms occur that have evolved from a common ancestral marine form in very recent history. As the glaciers of the last Ice Age receded beginning some 15,000 years ago, populations of sticklebacks were isolated in glacial lakes. Then, in a geologically brief interval, these populations have evolved into forms that occupy different niches: a shallow-water, bottom-dwelling, short-spined form and an open-water, long-spined form' (p. 192–193).

The change was accomplished by an 'evolutionary change' in the switch controlling a gene called *Pitx1*. This gene is 'involved in making hindlimbs in tetrapods and the pelvic fin in fish'. And the 'evolutionary change' was that *Pitx* was turned off to produce the change from the long spine condition to the reduced spine condition.

If this is one of the most compelling case studies of evolution then creationists are laughing. Evolution occurred by switching *off* a function that already existed. Now that is compelling—evidence for creation!

Viability of intermediate forms

Carroll argues strongly (e.g. p. 10) that 'evolution via gene switches' obviates the anti-evolution argument that animals with incipient structures—half a leg or half a wing—would be selected against. His case seems to be (he does not spell it out) that because only the switch is changed during evolution, the gene that does the job is not damaged in any way. For example,

> 'The evolutionary change in this switch has allowed *Pitx1* function to change in the pelvic fin, without altering the gene's essential functions elsewhere in the developing fish' (p. 193).

But once again, this plays directly into creationist hands. He does not explain where the capacity to build a whole pelvic fin comes from—he simply assumes its existence. And by emphasizing the non-damage to the tool kit gene, he tacitly acknowledges the importance of its integral presence from the beginning. He also simply assumes the incredible amount of multi-dimensional fine tuning that would be required to use the same tool kit gene to do multiple jobs in different organ systems and then to change its switching patterns in such a way as to make a fully integrated and functional different kind of organism. Carroll has eliminated the half-leg problem by assuming the pre-existence of genes for a whole leg!

Tinkerer or engineer?

Carroll also argues strongly that the evidence points towards 'evolution by tinkering' rather than creation by engineered design (pp. 194–195). However, the evidence he presents for this conclusion is an astounding 'four secrets of evolutionary innovation'. These are: (a) work with what is already present; (b) use materials and procedures that have the potential for multifunctionality; (c) start with more than you need and work backwards (redundancy); (d) use modular components and modular switching logic—'switches are the secret to modularity and modularity the secret to arthropod and vertebrate success'.

But secret (a) is a direct appeal to creation, for it assumes the pre-existence of functional life forms already containing their tool kit genes. Secret (b) implies foresight, which only intelligence has. Secret (c) again appeals to creation by starting with more and progressing to less. Secret (d) again appeals directly to creation for 'module' in this context means 'a multifunctional logic driven unit'.

An excellent example that Carroll gives is the development of both fly and butterfly hindwings (p. 183). In both animal kinds, the forewings are fully formed and fully functional for flight, but the hindwings are modified. The modifications come about because a *Hox* gene called *Ultrabithorax* intervenes and shuts down some of the genes that operate to produce the fully functional forewing. Thus the supposed 'evolution' actually occurs because of the pre-existing designed features, and it results from having multiple copies of a modular multifunctional unit into which no new information or material is added, and the 'progress' occurs by shutting down the existing genes!

Butterfly spots

Carroll then comes to his own field—unraveling the genetics of butterfly wing spots. Immediately we are struck with an almost perfect definition of variation within created kinds. After lyrically describing the enormous variation in butterfly wing patterns, we are told it can all be understood in terms of a basic ground-plan containing repeated modules.

> 'Butterfly wing patterns are generally composed of some subset of the maximum ground-plan pattern, ranging from species … which display most of the ground-plan elements to those with just a few … diversity is largely a matter of loss of particular elements, or the modification and repositioning of these elements' (p. 203).

That is, butterflies don't start off simple and become complex, they have it all to begin with and then create variations by taking subsets and variations on the original theme!

And there is more. Butterflies differ from other flying insects by having wing scales, coloration and geometrical patterning systems. Carroll chose to investigate eyespots in more detail and found that they involved a well-known tool kit gene—*Distal-less*. In flies, *Distal-less* plays a role in three areas—embryo development, leg development and wing development. It also does these same three things in butterflies, but now has an added task. A fourth switch has been added to *Distal-less* in butterflies and it turns on the development of eyespots in the wings. Where did the new switch come from? Carroll just says 'the gene acquired it' (p. 209).

He then goes on to tell us—for the first time in the book—the role that mutations play in determining diversity in wing spots. This is highly significant, because up to this point mutations have only been mentioned as corrupters of the toolkit and switching systems—having fatal consequences for development. But now we find that there is flexibility in wing patterns because

> 'genetic regulation of wing patterning is organized so that mutations can occur that affect only wing patterns but do not affect other body parts' (p. 215).
>
> 'Once *Distal-less*-expressing eyespots evolved, tinkering with *Distal-less* expression produced butterflies with fewer or more eyespots, different sized spots or … seasonal changes in eyespots. These changes in *Distal-less* regulation were most likely accomplished by changing the signature sequences of the *Distal-less* gene eyespot switch' (p. 217).

So 'tinkering' does have a role, and mutation does have a role, but only in the very last stages of the developmental cascade!

Let's highlight this astounding result by looking at what constitutes a genetic switch.

> 'To carry out all of its normal functions, a gene depends upon information coming from all of its switches. So a gene with three switches has four separable parts, one coding part and three regulatory parts. … the genetic switches act like global positioning systems (GPS) devices. Just as a GPS locator in a [vehicle] gets a positional fix by integrating multiple inputs [from satellites], switches integrate positional information in the embryo … and then dictate the places where gene (sic) are turned on and off. … the important thing is to understand the logic and specificity built into these switches (p. 114). … The physical integrity of switches is very important to normal development. If a switch is disrupted or broken by mutation, then proper inputs are not integrated' (p. 117).[2]

No wonder Carroll chose not to try to explain where the butterfly's new *Distal-less* switch came from. GPS devices are intelligently designed, so logic should compel us to conclude that genetic switches are also intelligently designed. Carroll has, in his own words, ruled out a mutational origin.

Downhill to the end

Once past Carroll's own research subject (Ch. 8), the remainder of the book consists of large amounts of speculation running after rather few facts. Animal colour patterns of the most common kinds result from mutations (or indeed, natural variations) in the MC1R receptor protein that spans the membrane of melanocytes—the places in cells that produce pigment. These mutations either disable the repression of pigment production, resulting in an oversupply, or disable the pigment production itself, resulting in such things as the white Kermode bear. Either way, no new capacities have evolved, just variations on what already exists through loss of original functionality.

Human evolution is the necessary end point of the book.

> 'Differences in gene number and organization have not played

much, if any, role in the origin of humans or primates. … Everything in our bodies is a variation on the mammalian or primate template' (p. 270).

'The deep history of the tool kit reveals the invention of these [tool kit] genes was not the trigger of evolution. The bilaterian tool kit predated the Cambrian, the mammalian tool kit predated the rapid diversification of mammals in the Tertiary period, and the human tool kit long predated apes and other primates' (p. 286).

Switch evolution is the key, and 'the astronomical number of possible combinations of regulatory inputs and switches' (p. 287).

'Insects, pterosaurs, birds or bats did not invent "wing" genes, butterflies a "spot" gene, or humans a "bipedalism" or "speech" gene. Rather, innovation in all of these groups has been a matter of modifying existing structures and of teaching old genes new tricks' (p. 288).

Amongst this plethora of speculation we find this gem 'The insect wing led to the evolution of the dragonfly …' (p. 289). I just love the way that 'science' allows us to do magic tricks like that!

Carroll mounts a vehement attack on creationists at the end, claiming that they are 'crippling the teaching of evolution in public schools' (p. 297). I find that such a telling comment. Evolution is so weak that any attempt to put forward the evidence against it will cripple it! His very last section is a lament over extinction. But I thought mass extinctions were *good* for evolution. Don't they precipitate adaptive radiations by opening up lots of vacant ecological niches? Oh, I see. That was just neo-Darwinian thinking, not Evo Devo thinking.

Conclusion

I highly recommend this excellent book, for many reasons:

- It is an easy to read introduction to crucial new discoveries in molecular biology.
- It announces a paradigm shift away from the banality of neo-Darwinism.
- It purports to cover the major evolutionary developments of animal life including the Cambrian Explosion—something no one else has ever done.
- The author knows what he is talking about, being an important contributor to the field.
- It is an excellent primer for creationists to practice 'spot the fallacy'.
- It clearly shows how bias can blind us to what is staring us in the face.

References

1. Williams, A.R., Inheritance of biological information, Part III: Control of information transfer and change, *TJ* **19**(3):21–28, 2005.
2. 'The makeup of every switch is different. An average-sized switch is usually several hundred base pairs of DNA long. Within this span there may be anywhere from a half dozen to twenty or more signature sequences for several different proteins. … the signature sequences recognized by tool kit proteins are short, usually about 6–9 base pairs long' (p. 118). 'The general rule [is] that the whole expression pattern of any tool kit gene is actually the sum of many parts, with individual parts controlled by individual switches. … A gene may not only have multiple switches for different sub-patterns of expression at a given time, but will frequently have different switches that control entirely different patterns in different tissues and at different stages in development. … Ten switches or more is not uncommon, and we don't know what the upper limit, if any, may be' (p. 123).