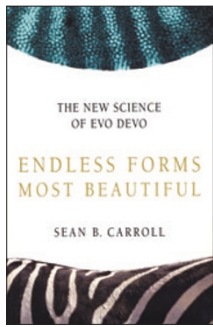


Evo-devo for the general reader

**Endless Forms Most Beautiful:
The New Science of Evo-Devo**

By Sean B Carroll

W.W. Norton, 2005
350 pp. hardcover, \$25.95
ISBN 0-393-06016-0

Reviewed by Adam S Wilkins

In *Endless Forms Most Beautiful*, Sean Carroll sets himself the task of explaining, to the general reader, what the field of evolutionary biology (or evo-devo) is and why it is exciting. This is a big challenge, given the amount of required background material, but the writing is clear and the organization of the present book is sensible. The introduction starts with a brief history of evolutionary biology and then lays out the themes and ideas of the book. The body of the main text is divided into two main sections. The first section is devoted to the basics of animal development and begins with a chapter called 'Animal architecture' that stresses the universality of modular morphological units in animal development. Two key concepts are also elaborated in this section. The first is the idea of a basic genetic 'tool kit', the set of crucial developmental genes, that is essentially the same in all animals, from simple flatworms to humans. This leads to the second idea: that all key differences in development are due to differences in the molecular 'switches', the enhancers, which give spatial and temporal specificity to the expression of particular genes in different animal embryos.

The second half of the book, 'Fossils, genes and the making of animal diversity', presents the evolutionary material, starting with a chapter on the 'Big Bang' of animal evolution (the sudden appearance of remarkably diverse animal forms in the fossil record of the Cambrian period). This material is interpreted in terms of the key genetic ideas introduced earlier, a common genetic tool kit and evolving transcriptional switch elements. Subsequent chapters deal with the evolution of new structures (such as wings and legs), color patterning of butterfly wings, developmental and evolutionary genetics of mammalian coat colors and patterning, and special questions of human evolution. The final chapter sums up the basic arguments and makes an eloquent plea for the incorporation of evo-devo into the teaching of evolution. The author argues that a wider understanding of evo-devo has a potentially important role in a growing public acceptance of, interest in and understanding of evolution in general.

To be a success, however, a trade book requires more than good organization and clarity. The writing itself must engage and keep the reader's

interest from the start; good illustrations accompanying the text (as they do here) help. One way in which *Endless Forms Most Beautiful* keeps the reader's attention is that the author introduces himself into the story, as Andrew Knoll did in *Life on a Young Planet*. Thus, the book is an exposition of the field as experienced by Sean Carroll in his personal voyage through it. A second plus is the vigor of the writing. Although the prose may lack the eloquence of Carl Sagan or the erudition of Stephen Jay Gould, it is lively and engaging throughout. The reader's interest is also maintained with just the right amount of injected history. Besides quotes from and stories about great figures (Darwin, Wallace, Huxley, Bateson), there are unexpected treats such as an anecdote about Teddy Roosevelt's marvelously misguided views on coat color and camouflage, showing that common sense is not always the road to scientific wisdom. Perhaps the most interesting bit of history is the account of Darwin's efforts in crafting the final paragraph of what became the *Origin of Species*, over a 17-year period. It is from that final paragraph of *The Origin* that the title of this book is taken.

Yet, unfortunately, the book has flaws. In particular, using the autobiographical voice as a narrative device carries the risk that by making the author the key protagonist, the story of the field can begin to seem to be that of the protagonist himself. In this case, a naive reader could well come to believe that Sean Carroll is the only key player in evo-devo, an impression only partially corrected by the notes at the back. Even one of the major themes of the book, the crucial importance of enhancer evolution as a direct source of developmental evolution, comes across as the author's own insight rather than as the elaborated collective view of the field. The fact that this idea remains a hypothesis, and one that is open to much debate, is not acknowledged at all.

There are other forms of imbalance as well. Nearly all the examples are taken from either insect or vertebrate evolution (as was also true for Carroll's textbook, *From DNA to Diversity*) while plants are ignored entirely. Furthermore, the detailed description of early embryogenesis focuses heavily on the fruit fly, without a hint to the reader as to how unrepresentative the embryos of holometabolous insects are. Though early embryogenesis in vertebrate embryos is briefly described, one could easily come away thinking that the early embryonic patterning processes of the fruit fly embryo are (essentially) universal.

The book is also relentlessly gene-centric. Though the word 'forms' is prominent in the title and in the preface, there is practically nothing about how development converts gene-expression patterns into characteristic three-dimensional embryos. The word 'morphogenesis' occurs only once and is defined there as "the formation of pattern," a description that few developmental biologists would recognize, let alone use.

Although these criticisms would be serious, perhaps fatal, ones for a monograph or a textbook, I think they are beside the point here. This book is not a treatment of the subject for advanced students or researchers. It is for the general reader, and neither scholastic balance nor thoroughness is necessary for such readers: lucidity and liveliness (plus, of course, basic accuracy) are the requisite qualities. *Endless Forms Most Beautiful* possesses these characteristics in abundance, and I would not hesitate to recommend this book to nonbiologist friends. ■

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