

What to tell Darwin about Darwinism

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With the 150th anniversary of the *Origin of Species* [1] and the bicentenary of Darwin's birth coinciding next year, it is not surprising that some forward-planning broadcasters are considering how best to commemorate this dual anniversary. I spoke to one recently, who asked what I would tell Darwin about Darwinism. This question made me pause for thought. Several fairly obvious ideas skittered through my mind: Mendel's laws of inheritance, the randomness of mutation, random genetic drift, the structure of DNA and peahens that can count. But surely Darwin would also want to know about kin selection and altruism, about how developmental genes mould the traits that selection operates upon, how sexual selection can operate after mating through sperm competition and cryptic female choice and how modern molecular genetics has led to powerful tools that have transformed evolutionary research.

Darwin's hugely enquiring mind and great imagination harboured insecurities, as evidenced by the revisions that he made to his books in later editions. For example, in the first edition of *The Descent of Man*, Darwin put forward an explanation of the generality of the 1:1 sex ratio [2]. However, following criticism, this explanation was removed from subsequent editions with the lines: 'I formerly thought that when a tendency to produce the two sexes in equal numbers was advantageous to the species, it would follow from natural selection, but I now see that the whole problem is so intricate that it is safer to leave its solution to the future' (Ref. [3], p. 399).

So, if one wanted to teach Darwin about Darwinism, one would not only want to discuss the advances in biology over the last century and a half, but also show him how hugely influential his work has been to the development of almost every field of biology, and how he was right about so many things. However, if I could borrow the TARDIS from Doctor Who and sit down for a chat with Darwin, I would face a dilemma because I would much rather that he, not I, did most of the talking. In consequence, I think at our meeting I would simply present him with a book that would tell Darwin most of what he never knew about Darwinism, and then quiz the man about his life and work. For a comprehensive modern view of evolution, I could do no better than *Evolution* by Barton, Briggs, Eisen, Goldstein and Patel.

I suspect that, thereafter, I would have the pleasure of many further meetings with Darwin, for I am sure that his incisively enquiring mind would generate a plethora of questions as he sallied forth into the pages of this comprehensive text. The book aims to integrate molecular and evolutionary biology into a coherent evolutionary perspective of life on Earth, and it achieves this ambitious aim. Divided into four main sections, the book is imaginatively designed. The first section provides an overview of evolution, from early ideas that species might not

be immutable, through the alternative mechanisms of evolution and the difficult melding of Darwinian selection theory and Mendelian genetics, to the development of population genetics and, later, molecular biology. This is followed by a comprehensive examination of what is currently known of the origin and diversification of life. This second section is up to date and well illustrated and, unusually, gives reasonable page space to the three plus billion years of life on Earth before the pre-Cambrian explosion. In many ways I found this the strongest part of the book. It bristles with descriptions of interesting methodologies and examples, while maintaining a tight focus in which evidential threads are woven together to illustrate how life has evolved toward greater diversity and complexity over nearly four billion years. The section closes with a chapter on the evolution of developmental programs, and I have no doubt that Darwin would be fascinated and delighted by insights into how genes passed down the generations affect traits in hugely different taxa, suggesting connections between groups and supporting the interrelated continuity of life that his theory proposed.

The third section, which occupies half the book, is concerned with evolutionary processes. Perhaps unsurprisingly given the range of processes dealt with, this is the most uneven section. One difficulty is that a scattering of four chapters in this section are designed to provide an up-to-date and comprehensive course in quantitative genetics. This aim is achieved, but at the cost of these chapters sitting somewhat uncomfortably among the other more accessible chapters. That said, the material covered in this section as a whole is sensibly chosen and provides good coverage, with the chapters on speciation and the evolution of genetic systems being particularly strong. The final section, two chapters on human evolution, gives a good introductory explanation of where our species fits into the evolutionary scheme of life on planet Earth.

Of course, in a book of this size and breadth, there are factual errors. So, for example, it is a shame that the picture of a melanic peppered moth is of the wrong species. The need for brevity of detail in describing examples also leads to false impressions being given. Thus, the hypothesis that differential predation depending on varying degrees of crypsis was responsible for the rise of the melanic form of the peppered moth is attributed to Haldane in 1924, although the great Victorian lepidopterist, J.W. Tutt, had put forward this explanation almost 30 years earlier [4]. That said, given the huge numbers of illustrative examples used by the authors, such errors are rather sparse.

Through most of the book, the authors maintain a good balance of highly accessible, interesting conceptual and sometimes philosophical material, illustrative examples from the natural world and the Eppendorf tube, explanations of how hypotheses lead to predictions and are tested, and theoretical explorations of evolutionary concepts. Many of the chapters can thus be read from start to finish without any great degree of background knowledge or extrinsic capability. This is not the case for the four chapters that concern quantitative genetics. Here, a relatively high degree of mathematical proficiency is needed to follow the logic of the arguments presented. Moreover, such background is not provided within the book, but is presented on an accompanying website (<http://www.evolution-textbook.org>). This web resource is

advertised in the preface as being especially valuable for instructors and advanced students. This is certainly the case, but it means that readers of the main text, who do not have a strong algebraic acumen, will need to seek explanation of parts of the quantitative genetics chapters elsewhere to find material at their level.

Some 15 years ago I began predicting to first-year students at Cambridge that the best biologists of the future would be neither whole-organism biologists nor molecular geneticists, but those who combined a feel for the organism with recognition of the power of molecular tools in answering whole-organism questions. At last, I have a comprehensive, informative and well-presented text that endorses this view, and illustrates again and again the strength of insights that are being realized as a result of the convergence of evolutionary biology and molecular biology. Perhaps that is what I would want to tell Darwin about Darwinism: that, as this book so comprehensively illustrates, the huge advances in biology over the 150 years since *The Origin* was published have not only added to, but also endorsed and illuminated, Darwin's prescient views on evolution.

References

1 C. Darwin, *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*, John Murray (1859).

2 C. Darwin, *The Descent of Man and Selection in Relation to Sex*, John Murray (1871).

3 C. Darwin, *The Descent of Man and Selection in Relation to Sex* (2nd edn), John Murray (1874).

4 J.W. Tutt, *British Moths*, George Routledge (1896).

Nicholas H. Barton, Derek E.G. Briggs, Jonathan A. Eisen, David B. Goldstein and Nipam H. Patel, *Evolution*, Cold Spring Harbor Laboratory Press (2007) ISBN 9780879696849 US \$100 (833 pages).