Are textbook references to Darwin close to extinction?

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ABSTRACT The textbooks used to teach GCE A-level biology 30 years ago tended to concentrate on traditional zoology and botany, with just a passing reference to evolution. As biology established itself as a new discipline, books (and syllabuses) began to take an integrated approach, and evolution became an important theme that helped students to appreciate the interrelationships between plants and animals, cells and molecules, biochemistry and physiology, systematics and genetics, and ecology and behaviour. With the modularisation of modern specifications this theme has all but disappeared from textbooks and a detailed discussion of Darwin and the evidence for evolution has been replaced by perfunctory references to variation and selection and, in some cases, politically correct acknowledgements of creationism.

In 2007, GCE A-level biology examinations (for 16–18 year-olds) were taken by 54 563 candidates in the UK (JCQ, 2007). It is probably safe to say that they had all handled a Bank of England £10 note. But did they know anything about the person whose image is on the reverse of the note? The design depicts Darwin as an old man, his magnifying lens, *HMS Beagle* and a hummingbird feeding on a flower. It includes an ornamental border based on the decoration on Darwin's spill-holder.

We honour Darwin in many other ways. In 2002 the Natural History Museum in London opened the Darwin Centre which houses 22 million specimens, some of which were collected by Darwin himself. The UK Government's 'Darwin Initiative' funds overseas programmes which promote biodiversity conservation.

In 1859, Darwin published *On the origin of species* and, in a single stroke, provided biologists with their theory of everything: a theory that explains how every organism on Earth has come to exist. But now, as the bicentenary of Darwin's birth approaches, we appear to be raising a generation of young people who know little or nothing about him. Why is this? It is because Darwin, and the study of evolution, seem to be slowly disappearing from GCE A-level syllabuses and textbooks.

The treatment of evolution in A-level textbooks

For many years the standard textbook for students studying GCE A-level zoology (and later biology) was *Animal biology* by Grove and Newell (1969). This work was first published in 1942 and took a systematic approach to zoology, with the majority of chapters dealing with individual phyla, illustrated by detailed line drawings. A short chapter dealt with various aspects of the evidence for evolution and was probably a fair representation of the state of knowledge at the time. This text was used by biology students alongside *Lowson's textbook of botany* (Simon, Dormer and Hartshorne, 1973), which mentioned evolution only in passing. An alternative to these texts was the two-volume *Animal and plant biology* (Vines and Rees, 1972), which devoted a similar number of pages to evolution as Grove and Newell, but in a much larger work.

It is perhaps a little unfair to criticise these early books for their poor treatment of evolution as it was not uncommon for the A-level students of the day to use a number of standard texts, including Sheppard's *Natural selection and heredity* (1958), to cover genetics and evolution.

In the early 1970s these works were largely replaced by Roberts's (1972) revolutionary text *Biology: a functional approach*. This book

emphasised the shared interests of zoology and botany rather than their differences, and reflected the trend towards the teaching of biology as a unified discipline at A-level and in universities. Unlike *Animal biology*, it contained photographs (monochrome), stylised diagrams, and information about – and photographs of – biologists, as well as their work. Roberts dealt comprehensively with the evidence for evolution and Darwin's contribution. Interestingly, 30 years later this material was updated and rewritten for incorporation into Roberts's collaborative work, *Advanced biology* (Roberts, Reiss and Monger, 2000).

In the 1970s A-level biology syllabuses focused on a core of topics consisting of the biology of cells, mammals and flowering plants. Simpkins and Williams (1981) published a text to cater for this core in which Darwin's work was described in a few sentences. In fairness, the authors make it clear that they never intended their work to cover evolution, genetics, ecology or the variety of life. This work was later expanded to include other topics including evolution (Simpkins and Williams, 1989).

Other texts published in the last two decades of the last century varied widely in the quality of their treatment of Darwin and evolution (Rees, 2007). *Understanding biology for Advanced level* by Toole and Toole (1987) offered a relatively superficial treatment, while *Advanced biology: principles and applications* by Clegg and Mackean (1994) treated students to an extremely comprehensive account.

The 21st century has thus far probably produced the best and the worst treatments of evolution in A-level texts. The account of Darwin's contribution to the study of evolution given by Boyle and Senior (2002) stands out from that of other textbook authors because of its accuracy and attention to historical detail. However, in their textbooks for AQA Specification B, Lea, Lowrie and McGuigan (2000; 2001) avoid discussing evolution almost completely. The process is merely mentioned in passing during a discussion of variation and natural selection. There is no reference to Darwin – or Mendel or Linnaeus – and no evidence for evolution apart from a simplistic description of directional selection in Galapagos finches, disruptive selection in the peppered moth (*Biston betularia*) and differential selection exemplified by sickle cell haemoglobin.

The differences in the coverage of evolution by 16 popular biology textbooks from the last 35 years or so are illustrated in Figure 1. The number of pages devoted to evolution is expressed as a percentage of the book as a whole (or of both volumes of a two-volume work). Although this was not a comprehensive study, nevertheless it is

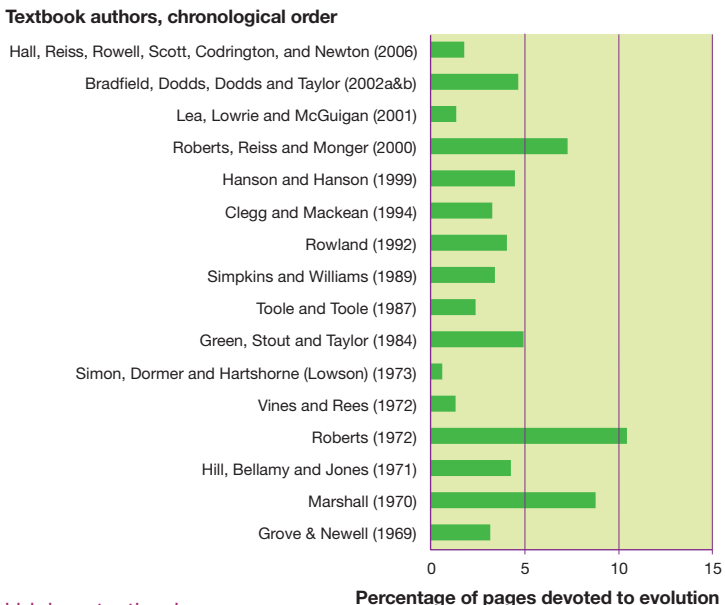

Figure 1 Evolution in A-level biology textbooks

clear that there is a very wide range of coverage, from 10.5% of Roberts (1972) to a mere 1.4% of the two volumes by Lea, Lowrie and McGuigan (2000; 2001).

Creationism disguised as diversity

Political correctness and a misguided desire to encourage students to debate controversial issues in science threaten to undermine biological education. In the United States some schools teach creationism – the theory that the Earth, and everything on it, was created by God – on a par with evolution, as if the two theories had equal status as possible versions of reality. This nonsense is not confined to the United States. In his book *The God delusion*, Richard Dawkins, Professor of the Public Understanding of Science at the University of Oxford, describes a school in Gateshead, England, which teaches creationism as part of the science curriculum (Dawkins, 2007). Its head of science appears to believe in Noah's Ark and thinks '*the entire universe began after the domestication of the dog*'. His advice to science teachers is to:

Note every occasion when an evolutionary/old-earth paradigm (millions or billions of years) is explicitly mentioned or implied by a text-book, examination question or visitor and courteously point out the fallibility of the statement. Wherever possible, we must give the alternative (always better) Biblical explanation of the same data. (Dawkins, 2007)

One textbook for A2 biology claims that the idea that all living things are descended from a common ancestor is a minority view among the people of the world as a whole (Hall *et al*., 2006). This is undoubtedly true. But most people in the world do not understand – in any scientific sense – that genes are made of DNA, and yet biology textbooks do not generally comment on this. It is, of course, neither here nor there what most people know or believe. This textbook is a collaborative effort which involved a number of eminent scientists, making it all the more surprising that such a comment is made as if students should give it some weight and consider it alongside the scientific evidence for evolution. The authors concede that most biologists believe in evolution, but when this assertion is juxtaposed with the statement that most of the people in the world do not, it is possible that at least some students may give more weight to the view of 'most people' than to that of 'most biologists'.

The depersonalisation of biology

In some modern textbooks, accounts of evolution are confined to a basic description of the mechanism of natural selection and the importance of genetic variation. Clearly it is possible to teach students about this mechanism without reference to Darwin, just as we may teach students that the blood in the human body flows in one direction through arteries without reference to the experiments performed by William Harvey in the 17th century. Much of biology is taught like this. Teachers do not mention (and, in most cases, probably do not know) who discovered the mechanisms that they describe. This is not so in psychology. Psychology textbooks at A-level have a long history of describing the role of individual psychologists. What has become the standard textbook for GCE A-level psychology was first published in 1987; the fourth edition (Gross, 2001) contains an author index of well over 2000 names (including Darwin) and 72 pages of around 3500 references.

In 2005–06 there were 155 220 students studying higher education courses in biological sciences in the UK. Of these, 71 185 (45.9%) were studying psychology, while only 27 075 (17.4%) were registered on courses described as 'biology' (HESA, 2007). Could it be that the popularity of psychology is in part due to the fact that students are taught that what we know about human behaviour was discovered by real people whose names they have to learn? A-level psychology questions ask about the work of Piaget, Bowlby, Skinner, Freud and many others. According to the marking scheme provided by AQA, one recent AS-level psychology question on research into the nature of long-term memory appeared to require knowledge of the work of Baddeley, Standing *et al*., Bahrick, Bahrick and Wittinger, Craig and Lockhart and Tulving (AQA, 2007). All for just six marks.

Lost opportunities

As developments in molecular biology and genetics demand their place in the biology curriculum it is inevitable that other areas become less important, or at least occupy less class time

and fewer textbook pages. But should we teach students about cloning and genetic weeding at the expense of Darwin and evolution? Lea, Lowrie and McGuigan (2001) do. Learning to deal with antibiotic-resistant bacteria such as MRSA and *Clostridium difficile* is an enormous challenge for the National Health Service. If evolution needs to be 'modernised' to make it fit for purpose in a 21st century syllabus, surely we could teach students about this? Lea *et al*. explain how plasmids can be used as vectors to transfer genes for antibiotic resistance into bacteria. This is all interesting, hi-tech content, but the authors fail to explain how the bacteria became resistant in the first place. They are more concerned with teaching students about genetic engineering than about evolution, and so lose an opportunity to emphasise the unifying nature of Darwin's theory.

Evolution really should be 'the theory of everything' for biologists. But A-level syllabuses have been fragmented and modularised into discrete units, making it difficult to sustain a constant theme throughout a course. Instead of being presented as a unifying theory, evolution has frequently been relegated to the status of a small chapter in a book filled with biochemistry, physiology and genetic engineering.

A-level questions

Key stage 4 of the National Curriculum (the last two years of compulsory schooling in maintained schools in England and Wales) only requires students to understand that:

variation within species can lead to evolutionary changes and similarities and differences between species can be measured and classified.
(QCA, 2007)

Students who elect to give up biology in favour of other subjects when they have completed their AS-level will – at least if they follow the AQA Specification B – never hear a word about Darwin or evolution (or genetics)!

Pre-1970 GCE A-level biology examinations (reprinted in Marshall, 1970) asked detailed questions about evolution:

Write a brief account of the evidence for evolution that can be deduced from the study of both fossilised animals and fossilised plants.
(University of London School Examinations Board)

What does the theory of evolution mean to a biologist? What in your opinion are the two most convincing kinds of evidence for evolution? Describe each as fully and critically as you can.
(University of Cambridge Local Examination Syndicate)

An A-level paper set in 1983 asked students questions on a passage paraphrased from Chapter 1 of *On the origin of species* (Variation under domestication), including '*Who was the author of the passage?*' and '*When was it published?*' The remaining questions sought to test the candidates' understanding of variation and the process of evolution (Oxford Local Examinations, 1983, Paper 1, reprinted in Toole and Toole, 1987).

Current papers concentrate on asking relatively simple questions about, for example, variation in the shells of snails or the bills of Galapagos finches:

The Galapagos Islands are an isolated group about 900 km from South America. Thirteen species of small birds called finches live on the islands. All species are thought to have evolved from a single species which reached the islands from South America. This species fed only on seeds, but the finches on the islands include species which specialise in feeding on buds, nectar and insects, as well as on different sizes of seed. Explain how evolutionary change could have resulted in this diversity of finch species on the Galapagos Islands. [6 marks]
(AQA Specification B, A2 Biology, June 2004)

Why is there so little reference to evolution?

M. B. V. Roberts's *Biology: a functional approach* stands out from all the other textbooks examined here, with more than 10% of its pages devoted to evolution. Even after incorporation into its modern manifestation as part of Roberts, Reiss and Monger's *Advanced biology* some 30 years later, this material still represents 7.4% of the new text. But why do so many modern texts contain so little about evolution?

Modern A-level textbooks are often written with specific specifications (syllabuses) in mind. There is no incentive for authors to write about topics that are not on current specifications or for publishers to allow texts to expand unnecessarily. It is tempting to suggest that content relevance

and cost act as selective pressures, which ensure that the only textbooks that survive are those that closely match popular specifications. The economics of textbook publication are undoubtedly more complex than this.

An examination of current A-level biology specifications reveals an interesting trend. The Edexcel Biology Specification B (Salter–Nuffield) requires students to understand the contributions of Darwin, Wallace, Lamarck and Malthus to our understanding of evolution, and the WJEC Biology specification expects students to know about Darwin's theory of evolution by natural selection and the process of speciation as exemplified by Darwin's finches. However, although the current specifications from AQA (Specifications A and B), OCR, Edexcel (Specification A) and CCEA all require some understanding of the process of evolution, they make no reference to Darwin at all.

Darwin is not the only scientist to be 'removed' from A-level specifications. The Scottish Qualifications Authority's *National course specification for biology higher* (2002) does not mention Darwin, Mendel or Linnaeus (SQA, 2002), but it does cover evolution.

Conclusion

Biology syllabuses should be encouraging teachers to explain to their students that scientific knowledge is created by ordinary people. Lord Sainsbury's recent *Review of science and innovation* (HMSO, 2007) emphasised the need for improvements in science education in the UK. But without role models how can we expect students to aspire to become biologists themselves? Teaching students about Darwin, Linnaeus, Mendel and other scientists helps to give biology a scientific, historical and social context. But if examination boards remove scientists from their syllabuses, and textbooks reflect these new syllabuses, how long will it be before we produce a generation of biology teachers who know little or nothing about the people who created the foundations of their science?

It is in the nature of banknotes that their appearance evolves over time. Darwin replaced Charles Dickens on the English £10 note in 2000, and Dickens supplanted Florence Nightingale in 1992. Our currency will continue to evolve and Darwin's image will one day no doubt be replaced by another British hero or heroine. It would be a pity if he were to be as easily removed from the scientific and social education of our children.

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Council for the Curriculum Examinations and Assessment (CCEA) Northern Ireland
Edexcel Specification A
Edexcel Specification B (Salter–Nuffield)
Oxford Cambridge and RSA Examinations (OCR)
Scottish Qualifications Authority (SQA) Biology Higher
Welsh Joint Education Committee (WJEC)

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What *did* you think?

Hints to promote discussion if you are struggling with the questions on page 34.

1 Consider what is happening at the instant of impact to the molecular structure of the screen.

2 Consider which parts of the body move during cycling compared with walking.
Estimate how much additional work a walker has to do.

3 Estimate would include:
- typical volume of air in full lungs;
- typical volume of air in Earth's atmosphere;
- the Avogadro number.

4 Consider electrical energy supplied = thermal energy increase of water.

5 Assume the weight of the rope and frictional forces at the pulley are negligible.
If the man has a mass of m_m and the platform a mass of m_p, consider whether it is possible to have $T > m_m + m_p$.