



The Fact of Evolution: Implications for Science Education

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Abstract. Creationists who object to evolution in the science curriculum of public schools often cite Jonathan Wells' book *Icons of Evolution* in their support (Wells 2000). In the third chapter of his book Wells claims that neither paleontological nor molecular evidence supports the thesis that the history of life is an evolutionary process of descent from preexisting ancestors. We argue that Wells inappropriately relies upon ambiguities inherent in the term 'Darwinian' and the phrase 'Darwin's theory'. Furthermore, he does not accurately distinguish between the overwhelming evidence that supports the thesis of common descent and controversies that pertain to causal mechanisms such as natural selection. We also argue that Wells' attempts to undermine the evidence in support of common descent are flawed and his characterization of the relevant data is misleading. In particular, his assessment of the 'Cambrian explosion' does not do justice to the fossil record. Nor do his selective references to debate about molecular and paleontological phylogenies constitute a case against common descent. We conclude that the fossil and molecular evidence is more than sufficient to warrant science educators to present common descent as a well-established scientific fact. We also argue that diagrams depicting the 'tree of life' can be pedagogically useful as simplified representations of the history of life.

1. Introduction

Scientists have reached overwhelming consensus that all forms of life are related by common descent. To give students a rough idea of what this means, one common pedagogical strategy is to call their attention to the relationships they see within their own extended family. For example, each student has ancestors in common with any cousin that student might have, namely, two of their grandparents. Similarly, a first approximation to the idea of common descent is to say that any two species of life have an ancestral species in common, albeit many more generations in the past than the two generations that separate two cousins from their grandparent. As we will see, like all analogies, this one has limitations and does not apply very well to the early stages of the history of life. Nevertheless, students' knowledge of their own family trees can serve as a useful starting point for understanding common descent, an idea scientists often refer to as 'the tree of life'.

In marked contrast to the scientific community, opinion polls consistently show that the idea of common descent is still controversial for a significant percentage of the general United States population (Alters & Nelson 2002, p. 1892). Consequently, it is not surprising that decisions about American public school science curricula often are contentious. While opinion polls show that many religious people accept common descent, those creationists who harbor religious objections sometimes try to influence school board decisions by citing publications that have not been subjected to the usual process of scientific peer review. In this essay we address one such publication, Jonathan Wells' *Icons of Evolution* (Wells 2000), a book that has received uniformly negative reviews by scientists from a wide variety of disciplines (Padian & Gishlick 2002; Scott 2001; Pigliucci 2001; Coyne 2001; Ussery 2001; Raff 2001; Rudge 2002).

We focus our critique on the third chapter of *Icons*, 'Darwin's Tree of Life', the chapter Wells devotes to the notion of common descent. Based on this chapter, Wells uses an appendix to "grade" science textbooks according to their discussion of 'universal common ancestry'. Wells gives progressively poor grades depending upon how straightforwardly a textbook presents the scientific consensus that common descent is a 'fact'. Indeed, of the ten books Wells grades, he gives a grade of 'F' to eight and 'D' to the remaining two. We argue that this assessment is misguided and that Wells has not advanced any refutation of common descent in the chapter he devotes to the subject. Based upon a multitude of many forms of evidence, the thesis of common descent is not controversial within the scientific community; science educators should be assured that Wells' attempt to influence science curricula by sidestepping the usual scientific peer review process should not be given any credence. Although scientists marshal many types of evidence in support of common descent, we concentrate on the two that Wells claims are lacking: the fossil record and the molecular evidence. As a prelude, we clarify the distinction between the idea of common descent and theoretical efforts to explain how this process has come about.

2. Fact and Theory

Before looking at specific arguments, we need to clarify some conceptual and philosophical issues pertaining to the relationship of facts to theories and various usages of the terms 'evolution' and 'Darwinism'.

2.1. DEDUCTION AND INDUCTION

Unfortunately, there is a widespread misconception among students that when scientists refer to 'facts' they mean assertions that have been 'proved' in the deductive sense. Strictly speaking, this is never the case. Deductive 'proof' is indeed accomplished in the disciplines of mathematics and logic, but only by employing axiomatic idealizations irrespective of any relationship to physical reality. In these