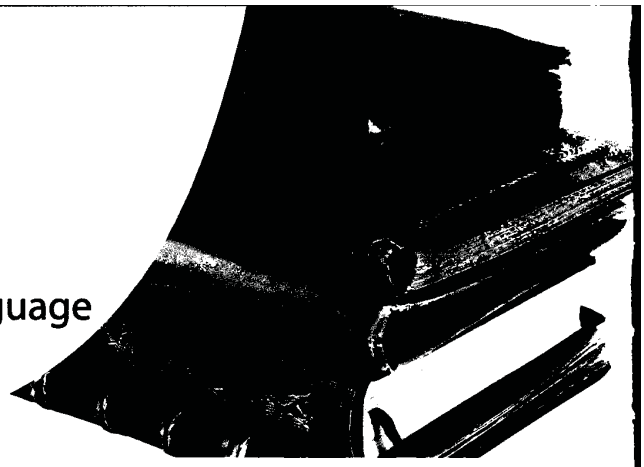

ARTICLE

Putting Darwin in His Place: The Need To Watch Our Language

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In this article, we examine the use of language in debating evolution, and suggest careful choice of the terms by which we describe both ourselves and our opponents. Present-day evolution science is solidly based on fact, and is as far advanced from Darwin's original theory as present-day chemistry is from Dalton's atomic theory. For this reason and others, the common practice of referring to our current understanding of evolution as "Darwin's theory" is ill judged, inaccurate, and a public relations blunder.

Only partly tongue-in-cheek, we also propose language to describe the opponents of evolution science. We suggest *Supernaturalist* as a blanket term for all creationists and intelligent design advocates who deny that biology can ever be explained by the ordinary laws of nature. Within these, we distinguish resurgent *Paleyists* who maintain that biological complexity must be the handiwork of a Designer, *Flintstone creationists* who believe that humans and dinosaurs coexisted on a young Earth, and *Occasional creationists* who believe in repeated separate divine creations on multiple occasions for different kinds of organism.

○ Introduction

We celebrate the 200th anniversary of the birth of Charles Darwin, and the 150th anniversary of the publication of *The Origin of Species*, his most important book and one of the most influential in the entire history of science. There is much to celebrate; but for this very reason, we suggest, we should be careful to distinguish between Darwin's own contributions and the vastly extended scientific framework that incorporates them. To do otherwise diminishes Darwin by ignoring the subtlety of his thought, and distorts the many-stranded scientific logic that leads to our present understanding of evolution. In addition, in the United States at least, describing evolution science as "Darwinism" (let alone "Darwin's theory") plays into the hands of those who distort or deny it for the sake of their own religious or political agenda. The first of these points was discussed in this journal by Paul Farber (2003). This article will mainly concern itself with the second. Finally, since framing (or labeling) is a two-way street, we suggest labels that accurately reveal the divisions and inconsistencies among the opponents of evolution science.

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○ Darwin in Context

Darwin was born in 1809, the year that Madison took over the presidency from Jefferson. He died in 1882, the year Jesse James was shot. His watershed book, *The Origin of Species*, was first published in 1859, shortly before the American Civil War. He did not know about genes, mutations, molecular biology, information theory, DNA, population dynamics and ecology, or the age of the Earth. Not realizing the discrete nature of inherited information, he could know neither how variation arose, nor how variation could be copied without diluting it. His fossil record was full of major gaps, while the use of biochemistry to explore phylogeny lay almost a century in the future.

Darwin's account required a novel mechanism of inheritance. We have that, in the science of genetics. It required ways of generating new variations. We have that, in the processes of mutation, gene transposition, and gene doubling. It required ways in which new organs could come into being. We have that at the level of function in the process known as exaptation, where a feature originally developed for one function, such as the feathers that kept dinosaurs warm, acquire a separate function in their descendants. We are also moving closer to it at the molecular level, with the discovery of control genes, which can turn whole blocks of genetic information on and off (see Carroll, 2005). It required vast expanses of time, and now, thanks to radioactive dating, we have that to an extent far beyond 19th-century imagination. (For a thorough treatment of this, with comments specifically directed at students troubled by the six orders of magnitude difference from the literalist interpretation of Genesis, see Wiens, 2002.) It requires the existence of intermediate forms between the fossil species known to Darwin. We now have that in abundance. One prime example, Archaeopteryx, was first described in the years immediately after the initial publication of *The Origin of Species*, in time to be included in later editions. More recently, the last five years alone have yielded up an ever-closer series of fossil fish with limbs (Shubin, 2008; Myers, 2008), mini-dinosaur bird precursors (see Long & Schouten, 2008), two-legged snakes (Houssaye et al., 2008), and common ancestors for the whale and hippopotamus (Thewissen et al., 2007) and for the elephant and the sea-cow (Liu et al., 2008). At the time of Darwin's death, it was still just possible for a well-informed person to believe in a "missing link" between humans and animals. We now have such intermediate forms in abundance, so that the problem becomes one of choosing between them, of distinguishing our ancestors from our second cousins (http://www.talkorigins.org/faqs/homs/species.html; Sawyer et al., 2007). Finally, the methods of molecular biology have given us ways that Darwin could not even have dreamed of, of elucidating the relationships between different species, and the relative time since they last shared a common ancestor (http://www.tolweb.org/tree/; Lecointre & Le Guyader, 2007). Thus present-day evolutionary biology is as far advanced from Darwin's theory

as present-day chemistry is from Dalton's atomic theory, and both Darwin and Dalton would be pleased.

○ The Ongoing Opposition to Evolution

And still the opposition lumbers on. In the years since the guest editorial by the retired nuclear physicist and past Vice President of the New Mexico State Board of Education, Dr. Marshall Berman (2003), the threat from creationism in its various guises has persisted, and spread internationally. It is not going to go away, and victories in the law courts, despite their importance, are no substitute for victories in the court of public opinion.

Given the overwhelming weight of evidence in favor of evolutionary biology (http://evolution.berkeley.edu/evosite/evohome.html; see also National Academy of Sciences, 1999), an academic consensus going back over 70 years, (Sapp, 2003), the confirmation of the relationships between species using the methods of molecular biology (Felsenstein, 2003), the repeated spectacular filling in of gaps in the fossil record (see above), and the all too obvious evolution of resistance to control among pests and pathogens (Palumbi, 2002), we may well ask why this debate was not over long ago. There are, of course, many reasons for this. In this article, we suggest that one of these is the way we present our material, and in particular, the habitual use of language that plays into the hands of our opponents. We will therefore be arguing in favor of choosing words that strengthen our case, and expose the inconsistencies and divisions within the broad tent opposition to evolution science.

Those who succeed in initially framing the terms of debate will gain an enormous advantage, regardless of the actual merits of their position. This phenomenon has been well studied in the context of economic choice, and assigning monetary values (Kahneman & Tversky, 2000), and has also been graphically described (Lakoff, 2004) in a partisan political context. Now, at last, there is a growing awareness among scientists (Nisbet & Scheufele, 2007) of the need to frame debate in scientifically valid terms, since it is of the greatest importance that the broader public be able to recognize the difference between legitimate arguments and pseudoscientific special pleading. It is time to take the advice of Aristophanes (414 BCE), and learn from our enemies. In particular, we should notice what expressions they apply to us, what arguments they use against us, and why.

○ The Current Situation

Over the years (most forcefully in the *Kitzmiller/Dover School Board case**), the courts have found that "creation science" and, more recently, "intelligent design theory" are indelibly tainted with their creationist origins, and, as such, are religion rather than science and have no place in the U.S. public schools. The creationist response has been to promote its agenda under the guise of freedom of speech and discussion of alleged scientific controversy, with the Discovery Institute (a leading Supernaturalist think-tank) generating imitation textbook material designed for this purpose. (One recent success of this strategy is the "Academic Freedom Act," formally the Science Education Act, SB 733, recently passed into law in Louisiana with strong bipartisan support. Note again the importance of framing: Who could possibly oppose academic freedom?) Recent years have also seen a significant deterioration of the political situation in Texas, with Governor Perry's appointment of a Flintstone creationist, Don McLeroy, to the Chairmanship of the Texas State Board of Education. The State of Texas, of course, has enormous influence throughout the U.S. and beyond because of its importance to textbook publishers. Senator John McCain and Governor Palin have both supported the suggestion that "both sides" should be taught, as, famously, did President George W. Bush. So, clearly, do most congressmen of both major parties in Louisiana. Well-funded creationist groups are also active in the UK, Australia, and Turkey.

Thus both nationally and internationally, biological science is engaged in an ongoing power struggle with creationists and other advocates of supernatural explanations who find its conclusions unpalatable, generally for religious (although occasionally for political) reasons (see e.g. Scott, 2004; Forrest & Gross, 2004). While close analysis (see e.g. Isaak, 2005) exposes this creationist opposition as foolishness, it would be folly to imagine that those who put it forward are fools. They do, after all, include Phillip Johnson, Emeritus Berkeley Professor of Law and sometime Clerk to Chief Justice Warren, as well as other experts in advocacy (in every sense of the word) and public relations.

Nor should we underestimate the seriousness of what is at stake (see Berman, 2003). Johnson, both in his published books (1997, 2002) and in the Discovery Institute's leaked "wedge strategy" memo (Discovery Institute, 1999), spells out explicitly his aim of undermining the entire program of observational science by introducing non-natural explanations (such as intelligent design) for natural phenomena (note that the "Truth" of Johnson's 2002 title is not mere correspondence with common reality, but, explicitly, the Way, the Truth, and the Life).

○ Naming, Framing, "Darwin" & "Theory"

The most striking feature of the creationist literature is its excessive, almost pathological, obsession with Charles Darwin. Thus in the "alternative textbook," *Of Pandas and People* (Davis et al., 1993), which was at the heart of the Dover case, there are 262 occurrences of Darwin's name or some variant of it within the 144 pages of main text. Behe names his books "Darwin's Black Box" (1996) and "...The Limits of Darwinism" (2007); Johnson calls his "Darwin on Trial" (1993) and "Defeating Darwinism by Opening Minds" (1997); while Antony Latham (2005) offers us "The Naked Emperor: Darwinism Exposed."

Attaching a proper name to a viewpoint suggests that it is individual, rather than part of a consensus, and marks it as incomplete, if not indeed superseded. Thus we speak of a Marxist or Freudian interpretation of history and human behavior, and of Newtonian physics in contrast to relativistic or quantum physics. From this it is but a short step to the use of a proper name to discredit a point of view, rather like the use of proper names by the early Church to label damnable heresies, or by the Communist Party of the Soviet Union to label equally damnable ideological deviations. When, for example, Stalin (and later Khruschev) denounced the science of genetics in favor of the nonsensical ideas of Lysenko, they referred to this science as "Morgan-Mendelism, after the monk whose work

* *Kitzmiller et al. v. Dover Area School District*, July 27, 2005, 400 F. Supp. 2d 707 (M.D. Pa. 2005). This judgment is only legally binding within the Pennsylvania Middle District, but seems likely to be regarded as persuasive opinion elsewhere. For the earlier legal background, see Scott, 2004. For a more detailed history of the legal treatment of the issue, see: http://www.talkorigins.org/origins/faqs-debates.html (scroll down to "Court Decisions"). In the U.S., the courts have become involved when state legislatures, or state or local school boards, attempt to influence the teaching of biology in the public schools. Such attempts have led to repeated conflict with the nonestablishment clause of the First Amendment. In advanced countries outside the U.S., creationism has so far had little political impact, and details of the curriculum are simply left to the educators.

laid the foundations of genetics, and the Cal Tech Professor T.H. Morgan, whose work on *Drosophila* established the relationship between genes and chromosomes.

All of these factors are at work in creationist strategy. The most obvious effect of focusing on Darwin is to take our minds back to the 19th century, revive talk of long-found "missing links" (as Johnson does explicitly), and distract attention from everything that has been learned since Darwin's day.

Moreover, the promiscuous use of Darwin's name can be used to blame "Darwinism" (i.e. evolution science) for shortcomings of human knowledge beyond its own domain, or even with moral corruption. Such absurdities really do happen. Thus Latham (2005) "exposes" Darwin's inability to account for the origins of life or of the universe. This is like "exposing" the claims of philologists exploring the relationships between groups of languages on the grounds that they cannot tell us how human speech itself originated. The 2008 film *Expelled – No Intelligence Allowed* quotes selected sentences from Darwin's work to depict him as an intellectual forerunner of murderous racism, and says that, in contrast to religious faith, "Science leads you to killing people."

Despite all this, biologists and others expounding evolution science repeatedly invoke Darwin's name. Thus a 2007 scientifically unobjectionable major work on the perceived tensions between evolution science and religion is titled *Living with Darwin* (and has a picture of a bearded Darwin on its cover) (Kitcher, 2007), when a better title would have been *Living with Evolution*. In this journal, a perceptive analysis (Jensen et al., 2007) of student answers to questions on evolution speaks of "Darwinian components," including among these such later developments as the concept of mutation. No less august a body than the Royal Society (2006), in its statement on the teaching of evolution, refers to "Darwin's theory of evolution" when what is meant is the decidedly post-Darwinian science of the Modern Synthesis.

When Darwin's name is invoked in the context of history of ideas (Gould, 1992), or as a deliberately provocative rhetorical device (Dennett, 1995), this is obviously appropriate. When "Darwin" is used as shorthand for evolutionary biology, it is not; and every time we do this, we play into the hands of our opponents.

○ Choosing Our Words With Care

We should stop describing 21st-century biology as "Darwinism," since this helps our opponents set up a straw man, and in addition is historically inaccurate, rather like calling modern chemistry "Daltonism." We should not say that we are "defending" evolution science, since it is not under valid attack. We should also be sparing in our use of the word "theory," for both rhetorical and scientific reasons.

"Theory of evolution," as a synonym for evolutionary science, is a cliché that we would be much better off without. Despite this, editors, even in distinguished journals, continue to use the term (see e.g. *Nature*, 2008). We are all familiar with the thoroughly dishonest argument that evolution is a theory, theories are uncertain, and therefore evolution is uncertain. This argument appears, thinly disguised, in the wording of the Louisiana "Academic Freedom Act" (Louisiana State Senate, 2008), which refers to "open and objective discussion of scientific theories being studied including, but not limited to, evolution, the origins of life, global warming, and human cloning." We all know the refutation: that "theory" is used to mean two complete different things, but this logical rebuttal does not stop the argument from being used to great rhetorical effect. More fundamentally, the emphasis on theory does biology (and Darwin himself) far less than justice. The reason that Darwin is a major figure, while Wallace is not, despite independent discovery of the same central concept, is the depth of observational detail with which Darwin was able to support his ideas.

There are also deeper reasons, as an article in this journal argued some years ago (Farber, 2003), for avoiding the emphasis on "theory." Strategically, it evokes a fortress mentality, as if the central tenets of evolutionary biology were under valid attack, and the experimental evidence was being invoked after the event to defend them. Rhetorically, this is a losing posture. Pedagogically, it is equally mistaken. The development of evolutionary thought from Buffon to the present day is a beautiful example of the continuous interplay between theory and observation which the biologist Peter Medawar (1979) places at the heart of his discussion of scientific practice. To place theory first, as if observation came second (or even the other way round), is to miss the entire point.

Because setting the terms of the discussion is so rhetorically important, we also need our own language to describe the opponents of evolution science; and these words should be precise, appropriate, and memorable. Here we propose the blanket term *Supernaturalist* for all creationists and intelligent design advocates who claim that biology can never be explained by the ordinary laws of nature, since the intervention of a creator or designer not constrained by the normal laws of nature is by definition supernatural. Among these, those who argue (usually on the basis of a blinkered reading of Genesis) for a young Earth, on which humans and dinosaurs coexisted, are *Flintstone creationists*: This is the position of the Institute for Creation Research. Those who believe in repeated separate creations for different kinds of organism, as Phillip Johnson suggests, are *Occasional creationists* – the appearance of a new species being merely the occasion (Malebranche, 1674) for an act of divine creation. That leaves those who accept the reality of common descent, but maintain that the actual complexity of life necessitates a supernatural designer. These we would call adherents of the Paley-Behe thesis, or *Paleyists* for short, after the 18th century theologian (Paley, 1802) and the contemporary biochemist (Behe, 1996, 2007), both of whom use versions of this argument. All creationists are supernaturalists (as are all Paleyists), but not all supernaturalists are creationists. This choice of words has the added advantage of drawing attention to the serious split in our opponents' ranks between those who reject evolution altogether, and those who accept that evolution occurs, but believe it to be guided by supernatural intervention.

○ Conclusions & Recommendations

We should welcome discussion of all these issues, as long as things are called by their correct names. Thus "intelligent design" is a supernatural concept that has no place being taught as science, but can with profit be discussed, along with biological vitalism, pre-atomic chemical theories, and the theory that the sun goes round the earth, among case studies of discredited ideas. In such an environment, the weaknesses of any kind of creationism or design theory (Why such bad design? Why create or design all those intermediate forms?) are immediately evident. As for biblical literalism, we should not be afraid to directly challenge its spurious claim to represent the whole of Christianity; how spurious, even within the limited context of the U.S., is shown by the Clergy Letter Project and the emergence of an "Evolution Sunday" in the calendar (http://www.butler.edu/clergyproject/rel_evol_sun.htm).

When teaching evolution, we should be aware that the vast bulk of what we are doing is presenting the observational evidence. We invoke the morphological similarities between organisms,

which led Linnaeus to classify them according to a scheme still in use today, and his contemporary Buffon to propose common descent with variation (Sapp, 2003, Ch.1). Such common descent is confirmed by a fossil record increasingly rich in the "intermediate forms" whose existence, with carefully cultivated ignorance, the anti-evolutionists continue to deny. Strikingly similar patterns are revealed by comparative molecular biology, and, indeed, a recent *Nature* article (Moore, 2008) goes so far as to suggest that molecular biology be presented as primary, with other evidence relegated to a supporting role. Finally, we have evolution in action: the observation of species formation going on under our very eyes, as in the London Underground mosquito (!) (Byrne & Nichols, 1999; see also Coyne & Orr, 2004); and, most urgently, the evolution (Palumbi, 2002) in pests and pathogens of variants that outwit our attempts to destroy them.

While giving Darwin all due honor, we should make it clear that what we are teaching is a much more complex and complete system than he could ever have imagined. We should stop using the duplicitous word "theory" as shorthand for this entire system, since its inherent ambiguity invites rhetorically persuasive pseudo-controversy. There are the **facts of evolution** (the plural is important), and there are suggested theoretical explanations for these facts; together, these make up the present-day **science of evolution**. That is how it is and how we should describe it.

○ Additional Background Material

The Age of Rocks & the Fossil Record

Younger sediments generally lie on top of older ones, and sediments from the same period carry similar fossils. This gives relative dates only. Absolute dates come from radioactive dating of volcanic intrusions and interlayers, and give the time since crystallization of mineral grains. The most widely used methods are uranium-lead ($^{238}U/^{206}Pb$) and potassium-argon ($^{40}K/^{40}Ar$).

Before radioactive dating became available, geologists estimated the age of the Earth at around 100 million years from the thickness of sediments. Yet we now have rocks more than 4 billion years old. The 19th-century estimate had totally underestimated the amount of sediment lost through erosion, a discovery that Darwin had anticipated in his explanation of the then very incomplete fossil record.

A particularly beautiful example of the use of geological dating to find fossils is provided by the Devonian fish to tetrapod transition. The intermediate forms were predicted to lie in rocks younger than the oldest devoid of land life, but older than the youngest that contained fully-evolved land vertebrates, and the relevant sequence was found as expected (Shubin, 2008) in rocks some 375 million years old in the far north of Canada.

Molecular Phylogeny

No copying system is free of errors, and this guarantees that the much-copied information in DNA will change over time. So differences in related DNA sequences indicate the time since different organisms shared a common ancestor. Things are a little more complicated than this. Sequences with important functions tend to be better conserved, since changes would more often lead to nonviable offspring, while errors that would have no effect because of the redundancy of the genetic code are relatively common. Despite these complexities, we can build up a tree of life (http://www.tolweb.org/tree/; Lecointre & Le Guyader, 2007) on timescales ranging from human migrations in historic times, to the branching between archaea, eubacteria, and eukaryotes in early evolutionary history. Not surprisingly, this tree of life closely matches the one inferred from anatomical similarity and the fossil record, and

apparent differences give valuable information about parallel evolution and even horizontal gene transfer between organisms.

Web Resources

Wikipedia has entries, some very good, on most individuals and topics mentioned. See also resources mentioned in the text, especially http://www.evolution.berkeley.edu/ and http://www.natcenscied.org/evolution for wide-ranging presentations of evolution science, http://www.talkorigins.org/ for scientific evaluation of the evolution-creation-ID "controversy," and links in all of these.

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