Taking on creationism

Which arguments and evidence counter pseudoscience?

As the noted geneticist and evolutionary biologist Theodosius Dobzhansky (1900–1975) famously commented, "nothing in biology makes sense except in the light of evolution." However, creationism in its many forms insists that everything in nature was created by a deity: from the movement of chloride ions through a channel in response to the binding of a ligand, to the bizarre life-forms that were deposited in the Burgess Shale more than 500 million years ago. To any mainstream biologist, creationism sounds ludicrous and scientists have repeatedly fought attempts to introduce the teaching of creationism generally, and intelligent design particularly, into school curricula. However, like many scientists and commentators, Jerry Coyne, Professor of Ecology and Evolution at the University of Chicago, IL, USA, fears that the social impact of these movements could extend far beyond the purely scientific debate. Therefore, scientists need to counter the claims of the proponents of creationism and determine which arguments best support the case for evolutionary theory and, more generally, support science itself in the public arena.

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From its heartland in America's 'Bible belt', creationism is slowly extending its reach. "It's difficult to quantify, but my strong sense is that creationism is spreading across Europe," said Simon Conway Morris, Professor of Evolutionary Palaeobiology at the University of Cambridge, UK. "Ten years ago the movement was negligible. Today, it is clearly more substantial." Last year, the *Guardian* reported that 59 schools in the UK were using information about intelligent design as "a useful classroom resource" (Randerson, 2006).

Biologists have long-debated whether and how to respond to claims that the theory of evolution must be taught together with more or less biblical interpretations of the origins of life on Earth. However, the fervour of the anti-evolutionary lobby means that it is now a question of how, not whether, biologists must educate the public about evolution and natural selection. Yet, scientists face a dilemma. The danger is that if scientists engage the proponents of creationism and intelligent design in direct debate, they risk giving further credence to anti-evolutionary arguments by inferring that the ideas are worthy of discussion. Conversely, a failure to engage in debate could allow creationists to argue that biologists cannot, rather than will not, counter their arguments.

Creationism itself is not a unified movement; its various incarnations encompass a gamut of philosophical positions (Scott, 2000), including intelligent design. As Michael Coates, in the Department of Organismal Biology and Anatomy at the University of Chicago, IL, USA, noted: "[intelligent design] covers a wide spectrum of beliefs—just as creationists include anything from believers in a god that did no more than light the blue touch-paper of life, the universe and everything, through to a strongly interventionist deity who counts dead sparrows, answers prayers and directs the occasional thunderbolt."

The Catholic Church—one of the most historically ardent opponents of Darwin's grand theory of evolution—has made its peace with the subject. Before he became Pope Benedict XVI, Cardinal Joseph Ratzinger wrote that, "[w]e cannot say: creation or evolution, inasmuch as these two things respond to two different realities. The story of the dust of the earth and the breath of God, which we just heard, does not in fact explain how human persons come to be but rather what they are. It explains their inmost origin and casts light on the project that they are. And, vice versa, the theory of evolution seeks to understand and describe biological developments. But in so doing it cannot explain where the 'project' of human persons comes from, nor their inner origin, nor their particular nature. To that extent we are faced here with two complementary—rather than mutually exclusive—realities" (Ratzinger, 1995).

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Proponents of intelligent design might accept some minor aspects of evolutionary theory. However, intelligent design by definition denies that mutation and natural selection can explain, for example, the evolution of chordates from echinoderms. It draws its intellectual roots from a teleological argument that has been supported by some philosophers since Plato's *Timaeus*. The English theologist William Paley (1743–1805) formulated the most famous example: if one found a watch, the order, complexity and purpose would argue for a watchmaker. Similarly, because the universe shows order, complexity and purpose, there must be a creator.

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According to Conway Morris, such teleological seeds often fall on fertile ground. "Many creationists are genuinely astonished by the diversity of living organisms," he said. "[A]s biologists, we tend to use mechanistic metaphors, which implicitly encourage the idea of a maker. So, one can see why the idea of an intelligent designer appeals to someone not versed in evolutionary theory. [Intelligent design] is not science and I think it's bad theology, but I can see why people hold the view."

This might explain why so many educated people take intelligent design seriously, as Coyne commented: "Intelligent design is attracting some serious attention, it's not just a few quacks who think that the earth is flat." During a debate held in May, three out of the ten Republican candidates for the US presidency said that they did not believe in evolution. "We should worry when the fundamentalists start to run public budgets and gain, or attempt to gain, political influence," Coates said.

Intelligent design and creationism do not just limit themselves to refuting the theory of evolution; the attack on science extends to other fields including geology, astronomy and even scientific materialism. The Center for Science and Culture (Seattle, WA, USA), which describes itself as "the nation's leading think-tank challenging various aspects of evolutionary theory" comments on its website: "We think the materialistic world view that has dominated Western Intellectual life since the late 19th century is false and we want to refute it […] Materialism is a dehumanising philosophy" (Discovery Institute, 2003). Coyne commented, "[c]reationism is an attack on the materialistic basis of science […] This carries forward into [the creationist] view of other evidence. Many creationists believe that global warming is a hoax, for example. They simply don't accept scientific evidence."

Coyne agrees with the British evolutionary biologist Richard Dawkins, one of the staunchest defenders of evolutionary theory, that engaging creationists in direct debate is a waste of time. "The whole history of the debate shows us that such debates of rhetorical fencing are futile," he said. Conway Morris, however, objects to the intellectual arrogance of some biologists. "Some of the more extreme secularists who effectively say that anyone who believes in [intelligent design] is stupid don't help to move the debate forward," he said. "It's insulting and it's not surprising that the debates become acrimonious."

A better strategy might therefore be to let the scientific evidence speak for itself. "It's hard for anyone to claim that evolution hasn't taken place when they're presented with the evidence," Coyne agreed. "And it's worth pointing out that many people who believe in God also regard evolution as fact. The two aren't incompatible." However, countering the rhetoric of the proponents of intelligent design and creationism with scientific evidence is not an easy task; evolutionary theory does not quite stir the belief and passion in most people that the grandeur of an Almighty does. Given the difficulties, what evidence can biologists use to counter creationist dogma?

For example, how can biologists counter the creationist argument that there are still many missing links in the fossil record that make evolutionary theory unworkable? Conway Morris noted that an understanding of what those missing links are is a good start. He pointed out that a marked phenotypic change, facilitating rapid evolution, might arise from a single-nucleotide polymorphism. "Life often seems as if it walks on a knife edge," he said. "But in cases such as this there won't be an intermediate in the fossil record." In any case, the fossil record contains numerous transitional forms that allow the reconstruction of, for example, the development of the modern whale (*Balaena* spp.) from the hippo-like *Diacodexis* spp., which existed some 50 million years ago. Missing links emerge regularly and it is quite likely that palaeontologists have simply not discovered them all yet.

Some biologists find that evolutionary convergence offers a powerful argument against intelligent design and highlights the effectiveness of natural selection. Creationists often cite the eye as a complex organ that could not have evolved without intervention. However, Conway Morris counters that, "[y]ou can track the evolution of the eye on several different occasions […] Despite very different origins, the pathways converge." He cited the examples of the octopus and the trout; both have a similarly altered lens composition that corrects for spherical aberration. "They both produced the ideal parabola as described by physicists," he explained. "But then again, both had to adapt to overcome the same limitation, so is it that surprising that they solved it in the same way?" In other words, the ancestors of the octopus and trout were selected for because these changes to their eye conferred increased fitness to the organism—they were better able to see and escape predators, and find food—and hence the change was propagated. No design was required, only the natural selection of a series of advantageous mutations.

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Other examples of convergent evolution include silk, copper proteins and carbonic anhydrase. "Through examples such as this we can see the footprints of history even without the fossil record," Conway Morris said. "There's almost a sense that these examples have to work in this way because of the environmental circumstance. Rather than being random, common phenotypes developed to adapt to common pressures."

"In instances of convergence, evolutionary evidence is found in the detail," Coates commented. "Molluscan and vertebrate lens composition might be remarkably similar, but vertebrate retinal structure remains 'back to front'. A designer would orient the tips of photoreceptors so that they point

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towards the light source, and the parts of the retina that carry signal towards the brain should be farther removed. This seems fair enough, and this is how the squid retina is built, but vertebrate examples are assembled the other way around—perversely, light has to plunge the full depth of the retina to reach the point of reception."

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Similarly, the HOX gene family that controls limb formation in vertebrates offers another example of evolution in action. "The evolution of paired fins into limbs with digits is a classic example of morphological transformation," Coates said. "Evidence for homology between paired fins and limbs is compelling—from an evolutionary perspective, vertebrate limbs are best viewed as a specialized subset or kind of paired fins." Indeed, the pattern of morphological change—the evolutionary sequence of anatomical transformation—is pretty well established. "This sets an agenda for developmental biology, concerning questions about differences between fin buds and limb buds, cell populations, tissues, signals and patterns," Coates added. "As these questions are answered, the evolutionary transition from fins to limbs is likely to become an exemplar of changing pattern and process underpinning large-scale morphological change."

However, although biologists can present good arguments for evolution, they still need to reach out to the general public and explain those arguments and engage in a dialogue. "Part of the answer is to introduce more evolutionary biology into early school curricula," Coates commented. "Children need to grow up with the fact of evolution, and [the] awareness that it underpins biology. Teachers should be encouraged to be bold enough to talk about this early and often, from infants onwards—whatever the parents' faiths or the school governors' and/or trustees' faiths. There seems to be a widespread fear of treading on toes." Coyne added that, "[t]oo often school science regards evolution as a given and focuses on the mechanisms, mimicry and so on […]. It rarely presents the evidence from, for example, the fossil record."

In any case—like in any scientific field—there are still numerous areas of controversy in evolutionary theory. "Evolutionary theory remains a really fertile field," Coyne agreed. "For example, we don't understand how species form." His main area of research aims to ascertain whether speciation involves many or only a few genes, whether genetic drift plays a significant role, and whether the movement of transposable elements causes hybrid sterility or whether it undermines viability.

Similarly, Conway Morris has built his reputation on another controversy: the interpretation of the Burgess Shale that records an explosion of the numbers and types of life-form during the Cambrian period. His research group has recently submitted two papers that illustrate how body plans as amazingly diverse as those found in the shale might have emerged, and how nature ended up with organisms as different as starfish and fish. However, the basic question of what caused the Cambrian explosion—why life needed to adapt so quickly—remains open. "Before the Cambrian, life evolved fantastically slowly, then there was this sudden sea-change," Conway Morris said. "An increase in oxygen levels is one possibility, but we don't really know."

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The British geneticist and evolutionary biologist J.B.S. Haldane (1892–1964), one of the pioneers of classical population genetics, which reconciled Mendelian and Darwinian theory, once remarked that "fossil rabbits in the precambrian" would invalidate evolution. But his quip makes a serious point and highlights a key difference between evolutionary theory and creationism: as with any scientific theory, Darwinism is constantly challenged and reinforced by new evidence. Creationism, on the other hand, rejects scientific theory and new evidence and favours a more or less narrow world-view based on divine intervention. Therefore, until a Precambrian rabbit comes bounding out of the fossil record, the theories of natural selection and evolution remain the only valid explanations of how life on Earth developed.

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