

Life on earth evolved gradually beginning with one primitive species – perhaps a self-replicating molecule – that lived more than 3.5 billion years ago; it then branched out over time, throwing off many new and diverse species; and the mechanism for most (but not all) of evolutionary change is natural selection. (3.)

This breaks down into six components: the fact of evolution, in the sense of genetic change over time; the idea of gradualism, of changes taking place over many generations (although sometimes they come about relatively quickly, depending on the evolutionary pressures operating); the phenomenon of speciation, whereby new species split off from existing lineages; the common ancestry of different species, since new species, which can be thought of as twigs on the developing branches of life, can be traced back to a common branch, and ultimately to an original ancestor; the mechanism of natural selection, whereby different combinations of genes are reproduced more successfully than others as a result of the different abilities of individual organisms to survive and reproduce in a shared environment; and, finally, the

presence of some processes, in addition to natural selection, that contribute to evolutionary change (the most important being what is known as “genetic drift”).

When Coyne argues that “evolution is true,” he means, first, that the central propositions of evolutionary theory – relating to these six components – are all true. Furthermore, they should be *accepted* as true, as indeed they are in mainstream science, because of the increasingly decisive evidence, from many lines of inquiry, that has become available.

Although the word “theory” is used by evolutionary biologists, this does not mean that the evolutionary account of life's diversity is a mere speculation or conjecture: as used by scientists, the word denotes “a well-thought-out group of propositions to explain facts about the real world” (15). A point can arrive where such a body of propositions has been so thoroughly tested, and so overwhelmingly supported by evidence, that it is not just a theory (in the sense just defined), but should also be acknowledged as a set of facts. In principle, any such group of propositions could be falsified by new data, so the propositions of science are accepted provisionally. But in some cases, as with the heliocentric description of local astronomical bodies and their orbits, it is vanishingly unlikely that the main propositions will ever be falsified. Coyne's central claim is that the main propositions of modern Darwinian theory have graduated to “facthood” in this sense.

Coyne's presentation of the evidence is fascinating and ultimately overwhelming. He produces information from fields as diverse as embryology, biogeography, the fossil record itself, the presence of vestigial structures in modern organisms, and the presence in nature of suboptimal “designs,” in order to demonstrate that organisms have evolved and that natural selection is responsible for the vast diversity of apparent design. Evolutionary theory has made huge numbers of successful predictions, explained data that would not otherwise make sense (“retrodictions”), and never been falsified by anomalous observations (there are no human fossils in Cretaceous rock strata, for example, or anything like J.B.S. Haldane's famous example of fossil rabbits in the Precambrian).

The great strength of *Why Evolutions Is True* lies in Coyne's ability to assemble evidence from all these lines of inquiry, and to demonstrate how the chains of inference converge. He shows convincingly why no serious biologist doubts the main propositions of modern evolutionary theory, such as the claims that organisms evolved over time, that lineages split into different species, and that “natural selection is the main engine of adaptation” (223). Although the field of evolutionary biology is a vibrant one, and its professional journals contain much discussion of the details of the process, the main propositions are

entirely uncontroversial within science, essentially because they are supported so powerfully by huge amounts of converging data.

There is no *scientific* controversy about the status of modern evolutionary theory, but there is obviously a social controversy, in that many individuals reject the theory, and there are concerted efforts by well-resourced organizations, such as America's notorious Discovery Institute, to resist it. In that sense, evolutionary theory is unique: no one engages in a high-profile, aggressive campaign to raise public doubts about, say, plate tectonics or Einsteinian physics, or the claim that many diseases are caused by micro-organisms. One of the few other areas where something approaching this level of resistance may be seen is the science relating to climate change, but even this is seldom denounced with equivalent ferocity – and nor, despite its practical importance, is it basic in the world-image of modern science.

In the final chapter of *Why Evolution Is True*, Coyne examines the motivations that may underlie resistance to the theory of evolution. Why is it that someone of ordinary, or greater, intelligence can be confronted with the convincing evidence of evolution, understand it, but still not accept the main propositions that it supports? Perhaps surprisingly, Coyne does not emphasize that the processes and the timeline of evolution totally contradict fundamentalist Christian positions that include the idea of Young Earth Creationism.

For adherents of such positions, the age of the Earth and the specific creation of each kind of living thing (especially, but not only, of human beings) are not merely add-ons. It is not as if these ideas can be discarded, or seriously modified, to accommodate the discoveries of science, while preserving an essential core of spiritual doctrines. Rather, they are elements of an encyclopedic and closely-integrated theological system that also includes a literal Fall from grace at an identifiable time; the historical introduction of sin and corruption into the world; Jesus Christ's sacrificial atonement for sin; and an ultimate victory of God over Satan. This cosmic victory will culminate in a fiery cleansing of all creation – in effect, a new beginning. Such a belief system cannot lightly accept modifications to its claims about the world, in space and time. As long as this kind of Christian theology retains large numbers of adherents, there will be many people who are strongly motivated to reject evolutionary theory rather than abandon their integrated religious worldview. For such people, even the shift to some kind of "theistic evolution" is likely to be enormously painful, and perhaps no more appealing than abandoning Christianity altogether.

Still, many other areas of science – geology and astrophysics for a start – also contradict Young Earth Creationism and its associated system of doctrine. Yet these cause nothing like the same anxiety as

modern evolutionary biology. So perhaps Coyne is right to emphasise more general concerns, rather than those specific to Christian fundamentalism. He suggests that many people require more than *evidence* for the evolution of life because they fear its *consequences*: for these people, who are not all Young Earth Creationists or anything of the sort, “evolution raises such profound questions of purpose, morality, and meaning that they just can’t accept it, no matter how much evidence they see” (224). These well-intentioned people are concerned about what follows, logically and psychologically, if evolution is true.

To be honest, I am tempted to give short shrift to such concerns. Evidence is evidence. If the central propositions of modern evolutionary theory are overwhelmingly supported by the evidence, that is that. Or so I am inclined to say. We then need to work out the implications, rather than imagining that the implications can control whether or not the theory is true. If some of the implications appear to be unpalatable, it is irrational or intellectually dishonest to allow that to decide what to believe. We should, rather, bite the bullet and accept the genuine implications of the theory, whatever they might turn out to be.

Perhaps fortunately, Coyne takes a more gentle approach. He expresses sympathy with the widespread fear that recognition of the truth of evolutionary theory could dissolve whatever constraints stop us from acting in selfish and unscrupulous ways. If we are essentially beasts, so the thought goes, why not give full rein to the beast within? What logical basis might there be to control our most destructive impulses?

Obviously, these questions could provide the theme for an entire book, or for many books. Coyne’s answer is that we are not “marionettes dancing on the strings of evolution” (230). Some of our behaviors may be genetically encoded, but our genes can be expressed in many ways under many different circumstances. Though there is much human selfishness and cruelty, there is also much kindness and altruism – the choices are ours to make, and it is clear that our genetic heritage does not take a form that traps us into so-called “beastly” behaviors. Indeed, as Coyne also points out, we have been able to make a degree of moral progress during recorded history, increasingly ruling out barbaric activities such as human sacrifice and gladiatorial combat, while expanding our circles of sympathy and consideration. This kind of progress is not caused by our genes, at least not in any simple way, but they clearly do not prevent it. Thus it is simply a misconception to think that accepting the truth of evolution will “somehow sunder our society, wreck our morality, impel us to act like beasts, and spawn a new generation of Hitlers and Stalins” (238).

I agree entirely with this analysis as far as it goes, but there is another point to be made, and it's one that individuals who are wary of evolutionary theory might well find less palatable. While it is consistent with Coyne's approach, it really belongs to another book and Coyne can surely be excused for not mentioning it. Still, it is worth a brief discussion in a journal such as this. The point is that a morality grounded in modern, scientific understandings of the world and our place in it will *not* be entirely the same as the old, familiar moral teachings, handed down through religious and cultural traditions. Thus, if some opponents of evolutionary theory – and, beyond it, of a naturalistic and materialist understanding of the world – lament that *their* morality cannot be preserved, in its entirety, they are probably right. From the perspective of philosophical naturalism and materialism, much of the old morality really can't be supported. What has to be added, however, is that this is not a bad thing.

The old morality, closely associated with Christianity, with its long tradition of shame about sex and the body, its hard-line advocacy of human exceptionalism (including a specifically human “dignity”), and its glorification of piety, self-abnegation, and asceticism, simply lacks rational support. Admittedly, much thinking remains to be done about what the social institution of morality is *for*, and hence what form it should take: which deontic constraints should we accept, or which virtues should we aspire to, and why? However, it is unlikely that any rational approach will enable the old morality to be reconstructed, unchanged. Indeed, it is already under challenge, and has been for several decades.

As a first approximation, morality serves such purposes as enhancing individual flourishing, contributing to social survival, and ameliorating the suffering in the world. Nothing about evolutionary theory requires us to cease valuing those kinds of goals. However, a moral system aimed at goals such as these may have little room for supposed virtues such as chastity or piety, or for traditional proscriptions of various more-or-less harmless pleasures. A rationally-revised morality is likely to have little to say against (for example) abortion, stem-cell research, same-sex marriage, or technologies of assisted reproduction and human enhancement. To be blunt about it, much of the old morality's content is miserable and irrational, when viewed against various purposes that can plausibly be assigned to morality itself. If acceptance of evolutionary theory and a naturalistic worldview helps us to understand this, we ought to welcome it, not stick our heads in the sands of tradition.

This, however, takes me far from Jerry Coyne's wonderful book, since its author does not adopt anything like such a radical line, whether or not he might sympathize with it. His achievement is a comprehensive and truly compelling synthesis of the evidence in support of sound, established science. If you care

passionately about science and its advancement, and you're looking for a book that explains the case for evolution with vigor, verve, elegance, and clarity, *Why Evolution Is True* belongs on your bookshelf.

DR.RUPNATHJI(DR.RUPAK NATH)