

THE RELATIONSHIP BETWEEN EVOLUTIONARY BIOLOGY AND RELIGION

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Belief in creationism and intelligent design is widespread and gaining in significance in a number of countries. This article examines the characteristics of science and of religions and the possible relationship between science and religion. I argue that creationism is sometimes best seen not as a misconception but as a worldview. In such instances, the most to which a science educator (whether in school, college or university) can normally aspire is to ensure that students with creationist beliefs understand the scientific position. In the short term, the scientific worldview is unlikely to supplant a creationist one for students who are firm creationists. We can help students to find their evolutionary biology courses interesting and intellectually challenging without their being threatening. Effective teaching in this area can not only help students learn about the theory of evolution but better to appreciate the way science is done, the procedures by which scientific knowledge accumulates, the limitations of science and the ways in which scientific knowledge differs from other forms of knowledge.

KEY WORDS: Evolutionary biology, religion, creationism, intelligent design

“... discussion of religious beliefs between a believer and a non-believer can seem superficial to the former and frustrating to the latter.” (Hinde 1999: 35)

CONTEXT

For many scientists, whether or not they have any religious beliefs themselves, the relationships between science and religion, i.e. the ‘science/religion issue’, may appear outside the scope of a serious science journal. However, a range of factors, including the continuing influence of creationism and the growing influence of intelligent design, suggests that this perspective may be too narrow. Here I begin by examining the nature of science and the nature of religion before looking at the ways in which science and religion relate to one another. I then look specifically at creationism in the light of what we know about evolutionary biology.

THE NATURE OF SCIENCE

Readers of this journal are not likely to need a long treatment of the nature of science. However, my argument relies on some agreement as to the nature of science and any treatment of the science/religion issue surely requires an examination of both the nature of science and the nature of religion (Reiss, in press). I will highlight what I hope are a number of relatively uncontroversial points that are germane to the science/religion issue.

The phrase ‘the nature of science’ is used as a shorthand for something like ‘how science is done and the sorts of things on which scientists work’. It therefore contains two elements: the practice of doing science and the knowledge that results.

It is difficult to come up with a definitive answer to the question ‘What do scientists study?’. Certain things clearly fall under the domain of science – the

nature of electricity, the arrangement of atoms into molecules, and mammalian physiology, to give three examples. However, what about the origin of the universe, the behaviour of people in society, decisions about whether we should build nuclear power plants or go for wind power, the appreciation of music and the nature of love, for example? Do these fall wholly under the domain of science? Although a small proportion of people, including a few prominent scientists, would not only argue 'yes' but maintain that all meaningful questions fall within the domain of science, most people hold that science is but one form of knowledge and that other forms of knowledge complement science.

This way of thinking means that the origin of the universe is also a philosophical or, for some, a religious question – or simply unknowable; the behaviour of people in society requires knowledge of the social sciences (including psychology and sociology) rather than only of the natural sciences; whether we should go for nuclear or wind power is partly a scientific issue but also requires an understanding of economics and risk, and even politics; the appreciation of music and the nature of love, while clearly having something to do with our perceptual apparatuses and our evolutionary history, cannot be entirely reduced to science (Reiss 2005).

While historians of science tell us that what scientists study changes over time, there are reasonable consistencies:

- Science is concerned with the natural world and with certain elements of the manufactured world – so that, for example, the laws of gravity apply as much to artificial satellites as they do to planets and stars.
- Science is concerned with how things are rather than with how they should be. So there is a science of gunpowder and *in vitro* fertilisation without science telling us whether warfare and test-tube births are good or bad.

If it is difficult to come up with a definitive answer to the question 'What do scientists study?' it is perhaps even more difficult to come up with a clear-cut

answer to the question 'How is science done?'. Robert Merton characterised science as open-minded, universalist, disinterested and communal (Merton 1973). For Merton, science is a group activity: even though certain scientists work on their own, all scientists contribute to a single body of knowledge accepted by the community of scientists. There are certain parallels here with art, literature and music. After all, Leonardo da Vinci, Michelangelo and Raphael all contributed to Renaissance art. But while it makes no sense to try to combine their paintings, science is largely about combining the contributions of many different scientists to produce an overall coherent model of one aspect of reality. In this sense, science is disinterested; in this sense it is (or should be) impersonal.

Of course, individual scientists, including evolutionary biologists, are passionate about their work and often slow to accept scientific challenges to accepted ideas. But science itself is not persuaded by such partiality. While there may be controversy about whether the paintings of Jackson Pollock or Francis Bacon are better (and the question is somewhat meaningless anyway), time invariably shows which of two alternative scientific theories is nearer the truth. For this reason, scientists are well advised to retain 'open mindedness', always being prepared to change their views in the light of new evidence or better explanatory theories, and science itself advances over time. As a result, while some scientific knowledge is contentious precisely because it has not yet achieved widespread acceptance within the scientific community, much scientific knowledge can confidently be relied on: it is relatively certain.

Karl Popper emphasised the falsifiability of scientific theories (Popper 1934/1972): unless you can imagine collecting data that would allow you to refute a theory, the theory isn't scientific. The same applies to scientific hypotheses. So, iconically, the hypothesis 'All swans are white' is scientific because we can imagine finding a bird that is manifestly a swan (in terms of its structure and behaviour) but is not white. Indeed, this is precisely what happened when early white explorers returned from Australia with tales of black swans.

Popper's ideas easily give rise to a view of science in which knowledge accumulates over time as new theories are proposed and new data collected to discriminate between conflicting theories. Much school and college experimentation in science is based on a Popperian view of scientific knowledge: we see a rainbow and hypothesise that white light is split up into light of different colours as it is refracted through a transparent medium (water droplets); we test this by attempting to refract white light through a glass prism; we find the same colours of the rainbow are produced and our hypothesis is confirmed. Until some new evidence causes it to be falsified, we accept it.

There is much of value in the work of Thomas Merton and Karl Popper, but most historians and philosophers of science would argue that there is more to the nature of science. Thomas Kuhn made a number of seminal contributions but he is most remembered nowadays by his argument that while the Popperian account of science holds well during periods of *normal science* when a single paradigm holds sway, such as the Ptolemaic model of the structure of the solar system (in which the Earth is at the centre) or the Newtonian understanding of motion and gravity, it breaks down when a scientific *crisis* occurs (Kuhn 1970). At the time of such a crisis, a scientific revolution happens during which a new paradigm, such as the Copernican model of the structure of the solar system or Einstein's theory of relativity, begins to replace (following initial coexistence) the previously accepted paradigm. The central point is that the change of allegiance from scientists working within one paradigm to their working in another cannot, Kuhn argues, be fully explained by the Popperian account of falsifiability.

Kuhn likens the switch from one paradigm to another to a gestalt switch, when we suddenly see something in a new way. As Alan Chalmers puts it:

There will be no purely logical argument that demonstrates the superiority of one paradigm over another and that thereby compels a rational scientist to make the change. One reason why no such

demonstration is possible is the fact that a variety of factors are involved in a scientist's judgment of the merits of a scientific theory. An individual scientist's decision will depend on the priority he or she gives to the various factors. The factors will include such things as simplicity, the connection with some pressing social need, the ability to solve some specified kind of problem, and so on. Thus one scientist might be attracted to the Copernican theory because of the simplicity of certain mathematical features of it. Another might be attracted to it because in it there is the possibility of calendar reform. A third might have been deterred from adopting the Copernican theory because of an involvement with terrestrial mechanics and an awareness of the problems that the Copernican theory posed for it.

(Chalmers 1999: 115-116)

A useful development of Kuhn's work was provided by Lakatos (1978) who argued that scientists work within research programmes. A research programme consists of a set of core beliefs surrounded by layers of less central beliefs. Scientists are willing to accept changes to these more peripheral beliefs so long as the core beliefs can be defended. So, in biology, we might see in contemporary genetics a core belief in the notion that development proceeds via a set of interactions between the actions of genes and the influences of the environment. At one point, it was thought that the passage from DNA to RNA was unidirectional. Now we know that this is not always the case. The core belief (that development proceeds via a set of interactions between the actions of genes and the influences of the environment) remains unchanged but the less central belief (that the passage from DNA to RNA is unidirectional) is abandoned.

The above account of the nature of science portrays science as what John Ziman (2000) has termed 'academic science'. Ziman argues that such a portrayal was reasonably valid between about 1850 and 1950 in European and American universities but that since then we have entered a phase largely characterised by 'post-academic science'. Post-academic science is increasingly transdisciplinary and utilitarian, with a requirement to produce

value for money; it is characterised by limits to the growth in the number of scientists; it is more influenced by politics; it is more industrialised; and it is more bureaucratic.

The effect of these changes is to make the boundaries around the city of science a bit fuzzier. It is not to deny that there is a city but to question the absoluteness of the distinction between city and countryside, between monarch and subject, between the judiciary and the executive. Of course, if one accepts the contributions of the social study of science (e.g., Yearley 2005) one finds these boundaries fuzzier still.

THE NATURE OF RELIGION

There are many religions, which complicates answering the question 'What is the nature of religion?'. Nevertheless, the following, derived from Smart (1989) and Hinnells (1991), are generally characteristic of most religions.

First, religions have a *practical and ritual dimension* that encompasses such elements as worship, preaching, prayer, yoga, meditation and other approaches to stilling the self.

Secondly, the *experiential and emotional dimension* of religions has at one pole the rare visions given to some of the crucial figures in a religion's history, such as that of Arjuna in the *Bhagavad Gita* and the revelation to Moses at the burning bush in *Exodus*. At the other pole are the experiences and emotions of many religious adherents, whether a once-in-a-lifetime apprehension of the transcendent or a more frequent feeling of the presence of God either in corporate worship or in the stillness of one's heart.

Thirdly, all religions hand down, whether orally or in writing, vital stories that comprise the *narrative or mythic dimension*, for example the story of the six day creation in the Judaeo-Christian scriptures. For some religious adherents such stories are believed literally, for others they are understood symbolically.

Fourthly, religions have a *doctrinal and philosophical dimension* that arises, in part, from the narrative/mythic dimension as theologians within a religion struggle to integrate these stories into a more general view of the world. Thus the early Christian church came to its understanding of the doctrine of the Trinity by combining the central truth of the Jewish religion – that there is but one God – with its understanding of the life and teaching of Jesus Christ and the working of the Holy Spirit.

If doctrine attempts to define the beliefs of a community of believers, the fifth dimension, the *ethical and legal dimension*, regulates how believers act. So Sunni Islam has its Five Pillars – *Shahada* (testimony of faith), *Salat* (prayer), *Zakat* (alms-giving), *Sawm* (fasting) and *Hajj* (pilgrimage to Mecca) – while Judaism has the Ten Commandments and other regulations in the Torah and Buddhism its Five Precepts.

Sixthly, the *social and institutional dimension* of a religion relates to its corporate manifestation, for example the Sangha (the order of monks and nuns founded by the Buddha to carry on the teaching of the Dharma in Buddhism), the umma' (the whole Muslim community) in Islam, and the Church (the communion of believers comprising the body of Christ) in Christianity.

Finally, there is the *material dimension* to each religion, namely the fruits of religious belief as shown by places of worship (e.g., synagogues, temples and churches), religious artefacts (e.g., Eastern Orthodox icons and Hindu statues) and sites of special meaning (e.g., the river Ganges, Mount Fuji and Eyre's Rock).

It is clear that there can be a number of axes on which the science/religion issue can be examined. For example, the effects of the practical and ritual dimension are being investigated by scientific studies that examine such things as the efficacy of prayer and the neurological consequences of meditation (e.g., Lee and Newberg 2005); a number of analyses of religious

faith, informed by contemporary understandings of evolutionary psychology, behavioural ecology and sociobiology, examine the possibility or conclude that religious faith can be explained by science (e.g., Reynolds and Tanner 1983; Hinde 1999; Dennett 2006); the narrative/mythic dimension of religion clearly connects with scientific accounts of such matters as the origins of the cosmos and the evolution of life; the doctrinal and philosophical dimension can lead to understandings that may agree or disagree with standard scientific ones (e.g., about the status of the human embryo); and the ethical and legal dimension can lead to firm views about such matters as land ownership, usury and euthanasia. Perhaps only the social and institutional and the material dimensions of religion are relatively distinct from the world of science (understood, once again, as the natural sciences rather than more broadly).

As will be discussed in the next section, the relationship between science and religion has changed over the years (Brooke 1991; Al-Hayani 2005; Szerszynski 2005); indeed, the use of the singular, 'relationship', risks giving the impression that there is only one way in which the two relate.

Nevertheless, it seems to me that there are two key issues: one is to do with understandings of reality; the other to do with evidence and authority.

Although it is always desperately difficult to generalise, most religions hold that reality consists of more than the objective world and many religions give weight to personal and/or (depending on the religion) institutional authority in a way that science generally strives not to do. For example, there is a very large religious and theological literature on the world to come, i.e. life after death, (e.g., Hick 1976/1985). However, to labour the point, science, strictly speaking, has little or nothing to say about this question, while many religious believers within a particular religion are likely to find the pronouncements on the question of even the most intelligent and spiritual of their present leaders to be of less significance than a few recorded words of their religion's founder(s).

THE RELATIONSHIP BETWEEN SCIENCE AND RELIGION

There is now a very large literature on the relationship between science and religion. Indeed, the journal *Zygon* specialises in this area (see also *Science & Christian Belief*, amongst others). A frequent criticism by those who write in this area (e.g., Roszak 1994) is of what they see as simplistic analyses of the area by those, often renowned scientists, who write occasionally about it. Indeed, it is frequently argued that the clergy both in the past and nowadays are often far more sympathetic to a standard scientific view on such matters as evolution than might be supposed (e.g., Colburn and Henriques 2006).

A particularly thorough historical study of the relationship between science and religion is provided by John Hedley Brooke (1991). Brooke's aim is "to reveal something of the complexity of the relationship between science and religion as they have interacted in the past" (p.321). He concludes:

Popular generalizations about that relationship, whether couched in terms of war or peace, simply do not stand up to serious investigation. There is no such thing as *the* relationship between science and religion. It is what different individuals and communities have made of it in a plethora of different contexts. Not only has the problematic interface between them shifted over time, but there is also a high degree of artificiality in abstracting the science and the religion of earlier centuries to see how they were related.

(Brooke, 1991: 321)

Perhaps the best known categorisation of the ways in which the relationship between science and religion can be understood is provided by Ian Barbour (1990). Barbour, who focuses especially on epistemological assumptions of recent Western authors, identifies four main groupings.

First, there is the relationship of *conflict*; 'first' simply because it is the first in Barbour's list and first, perhaps, also in the minds of many modernists who do not have a religious faith. Barbour does not give a reason for the order of his listing but at least two can be suggested: comprehensibility and familiarity. It is both easy and familiar (given Barbour's declared focus on recent Western

authors) to see the relationship between science and religion as one of conflict. However, Barbour sees limitations in this way of understanding the science/religion issue. As he memorably puts it:

In a fight between a boa constrictor and a wart-hog, the victor, whichever it is, swallows the vanquished. In scientific materialism, science swallows religion. In biblical literalism, religion swallows science. The fight can be avoided if they occupy separate territories or if, as I will suggest, they each pursue more appropriate diets.

(Barbour 1990: 4)

Barbour's second grouping is *independence* (e.g., Gould 1999). Science and religion may be seen as independent for two main reasons: because they use distinctive methods or because they function as different languages. In any event, the result is that each is seen as distinct from the other and as enjoying its own autonomy:

Each has its own distinctive domain and its characteristic methods that can be justified on its own terms. Proponents of this view say there are two jurisdictions and each party must keep off the other's turf. Each must tend to its own business and not meddle in the affairs of the others. Each mode of inquiry is selective and has its limitations.

(Barbour 1990: 10)

Barbour's third grouping moves beyond conflict and independence to *dialogue* (cf. Berry 1988; Watts 1998; Williams 2001; Polkinghorne 2005). As an example of dialogue, Barbour points out how our understanding of astronomy has forced us to ask why the initial conditions were present that allowed the universe to evolve. The point is not that the findings of science require a religious faith – that would be for the wart-hog of religion to swallow the boa constrictor of science. Rather the point is that scientific advances can give rise (no claim is made that they do for all people) to religious questions, so that a dialogue ensues.

Barbour's final grouping is one in which the relationship between science and religion is seen to be one of *integration* (cf. Polkinghorne 1994; Peacocke 2001). For example, in natural theology it is held that the existence of God can be deduced from aspects of nature rather than from revelation or religious experience (e.g., Ray 1691/2005). Natural theology has rather fallen out of favour (but see Polkinghorne 2006). A more modern version is process theology which rejects a view of the world in which purely natural events (characterised by an absence of divine activity) are interspersed with occasional gaps where God acts. Rather, for process theologians, every event is understood "to be jointly the product of the entity's past, its own action, and the action of God" (Barbour 1990: 29). Furthermore, God is not the Unmoved Mover of Thomas Aquinas but instead acts reciprocally with the world.

EVOLUTION, CREATIONISM AND INTELLIGENT DESIGN

As the above indicates, a considerable range of relationships between evolutionary biology and religion can be envisaged (e.g. Attfield 2006; Grigg 2008; Southgate 2008). However, for reasons that delight some, appall others and bemuse many, belief in creationism persists while acceptance of intelligent design is growing in extent and influence in a number of countries (Jones and Reiss 2007; Williams 2008). Definitions of creationism vary but about 10% to 40% of adults in those countries where reliable data have been obtained, including many of the countries with the highest levels of religious non-belief, believe that the Earth is only some 10,000 years old, that it came into existence as described in the early parts of the Bible or the Qur'an and that the most that evolution has done is to change species into closely related species (see Miller et al. (2006) and enter "creationism evolution poll" into a Search Engine).

This understanding of creationism is best described as young-Earth creationism as other versions (including old-Earth creationism and progressive creationism) exist (Numbers, 2006). However, although hard data

are in short supply, it is clear that the creationism movement is clearly currently dominated by young-Earth creationists. Creationism, of whatever sort, is not the same as the belief that there is a creator. Many people hold that the world has such a creator without being creationists. For a creationist it is possible that the various species of zebra had a common ancestor but this is not the case for zebras, bears and antelopes – still less for monkeys and humans, for birds and reptiles or for fish and fir trees.

Those who advocate intelligent design, a theory that has only really been around since the 1990s but has grown hugely in political influence since then, generally make no reference to the scriptures or a deity in their current arguments (though such references do occur in earlier writings – e.g. Dembski (1999)) but maintain that the intricacy of the order we see in the natural world, including at a sub-cellular level, provides strong evidence for the existence of an intelligence behind this. An undirected process, such as natural selection, is held to be inadequate (e.g., Behe 1996, 2003; Dembski, 2003; Johnson 1999).

To an evolutionist, such as myself, albeit someone who is also a priest in the Church of England, the Earth is some 4600 million years old and all organisms share a common ancestor. Indeed, if you go back far enough, life had its ancestry in inorganic molecules. Furthermore, an evolutionary understanding of the world is fundamental to biology and many other aspects of science. For an evolutionist, understanding of ourselves, the other organisms and the world about us requires an evolutionary perspective (Ayala 2006).

Most of the literature on creationism (and/or intelligent design) and evolutionary theory puts them in stark opposition. Of course, even before the advent of intelligent design, there were non-creationist accounts that attempted to disprove Darwinism (e.g., Macbeth 1974; Hitching 1982). From the creationist camp, there are a huge number of books and a number of journals devoted to extolling creationism and execrating evolution. It is easy for scientists, perhaps especially those with no religious faith, to ignore or

dismiss such views as worthless but it is important to recognise the vigour with which they are held. After all, imagine you genuinely believed that the theory of evolution was not only factually incorrect but led to increased immorality and the loss of eternal salvation for anyone who believed it, wouldn't you fight passionately against it? For an analysis by an academic psychologist of why creationism is here to stay see Evans (2000).

Evolution is consistently presented in creationist books and articles as illogical (natural selection cannot, on account of the second law of thermodynamics, create order out of disorder; mutations cannot lead to improvements), contradicted by the scientific evidence (e.g., the fossil record shows human footprints alongside animals supposed by evolutionists to be long extinct), the product of special pleading (the early history of life would require life to arise from inorganic matter – a form of spontaneous generation; radioactive dating makes huge assumptions about the constancy of natural processes over aeons of time), the product of those who ridicule the word of God and a cause of a number of social evils (eugenics, Marxism, Nazism, racism) – e.g., Heinze (1973), Hall and Hall (1975), Watson (1975), White (1978), Hayward (1985), Baker (2003) and articles too many to mention in the journals and other publications of the Biblical Creation Society, the Creation Science Movement and other like-minded organisations.

By and large, of course, creationism has received similarly short shrift from those who accept the theory of evolution. In a fairly early study the philosopher of science Philip Kitcher argued that “in attacking the methods of evolutionary biology, Creationists are actually criticizing methods that are used throughout science” (Kitcher 1982: 4-5). He concluded that the flat-earth theory, the chemistry of the four elements, and mediaeval astrology “have just as much claim to rival current scientific views as Creationism does to challenge evolutionary biology” (Kitcher 1982: 5).

A more trenchant attack on creationism was provided by geologist Ian Plimmer whose book title *Telling Lies for God: Reason vs Creationism* (Plimmer 1994) accurately sums up the line he takes. An historical and

philosophical analysis is provided by Michael Ruse (and see Numbers and Stenhouse 2000) who, while passionately critiquing creationism and defending evolution, is acerbic about those evolutionists who deride all religious belief and those theologians who are attracted to non-Darwinian understandings of life:

And given the threat that creationists pose to evolutionists of all kinds, it behooves evolutionists especially to start thinking about working together with Christian evolutionists, rather than apart. For a start, atheists like Dawkins and Coyne might consider taking a serious look at contemporary Christian theology (or the theology of other faiths, for that matter), rather than simply parroting the simplistic, schoolboy travesties of religion on which their critiques are founded. Conversely, Christians like Ward and Rolston might be encouraged to dig more deeply into modern, professional evolutionary biology and to start to get some understanding of its strengths and triumphs before they cast around for alternatives like self-organization.

(Ruse 2005: 274)

Many scientists and others have defended evolutionary biology from creationism – see, for example, Pennock (1999), Dawkins (2006), the various contributions in Manson (2003) and Jones and Reiss (2007) and an increasing number of agreed statements by scientists on the teaching of evolution (e.g., Interacademy Panel on International Issues 2006). The main points that are frequently made are that evolutionary biology is good science in that not all science consists of controlled experiments where the results can be collected within a short period of time; that creationism (including ‘scientific creationism’) isn’t really a science in that its ultimate authority is scriptural and theological rather than the evidence obtained from the natural world; and that an acceptance of evolution is fully compatible with a religious faith, an assertion most often made in relation to Christianity (e.g., Southgate et al. 2005) since it is more obviously true of many other religions – including Hinduism, Buddhism and Judaism – and rather less true of Islam (Mabud 1991; Negus 2005). For USA data about scientists’ religious beliefs at

different times see Larson and Witham (1999).

DEALING WITH CREATIONISM AND INTELLIGENT DESIGN IN THE BIOLOGY CLASSROOM, LECTURE THEATER OR LAB

How should a biology educator deal with students who reject the scientific theory of evolution, believing instead in one of the forms of creationism or intelligent design? We know that such students are typically strongly resistant to attempts to persuade them that their views are mistaken and that the scientific perspective is the valid one. For example, in their assessment of a first-year evolution course taken by undergraduates at the University of Cape Town, South Africa, Chinsamy and Plagányi (2007) found no statistically significant changes in the views of students as a result of the course for questions that challenged religious views about creation, biodiversity, and intelligent design and concluded “Our study confirms the results of previous studies that adults’ views on evolution are remarkably impervious to instruction” (p. 252).

In a number of writings, David Jackson and Lee Meadows jointly (Jackson *et al.*, 1995) and separately (Jackson 2007; Meadows 2007) have described what it is like for students from conservative religious backgrounds to be faced with teaching about evolution in biology classrooms. Such students not only resist the teaching they receive but may feel threatened by it. This state of mind is usefully encapsulated by the term ‘worldview’. As Gauch (in press), in the lead paper in a special issue on ‘Science, worldviews, and education’ in the journal *Science & Education*, puts it, drawing on early definitions, “A worldview constitutes an overall perspective on life that sums up what we know about the world, how we evaluate it emotionally, and how we respond to it volitionally”. A value of the worldview perspective is that it indicates the extent to which a belief in creationism or intelligent design for many students is not just a simple misconception to be remedied by some straightforward science teaching, as a belief that most of the mass of a plant comes from material extracted from soil might be, but rather a whole way of understanding

the world – a ‘world view’.

Accepting the worldview perspective does not mean that the biology teacher should shrink from presenting the evidence for evolution. However, it does help us appreciate why such teaching may not be as successful as we would hope. As the official English government advice on teaching about science, given the existence of creationism and intelligent design, puts it:

Some students do hold creationist beliefs or believe in the arguments of the intelligent design movement and/or have parents/carers who accept such views. If either is brought up in a science lesson it should be handled in a way that is respectful of students’ views, religious and otherwise, whilst clearly giving the message that the theory of evolution and the notion of an old Earth / universe are supported by a mass of evidence and fully accepted by the scientific community.

(DCSF 2007)

I do believe in taking seriously and respectfully the concerns of students who do not accept the theory of evolution while still introducing them to it. While it is unlikely that this will help students who have a conflict between science and their religious beliefs to resolve the conflict, good science teaching can help students to manage it – and to learn more science. Creationism can profitably be seen not as a simple misconception that careful science teaching can correct. Rather, a student who believes in creationism can be seen as inhabiting a non-scientific worldview, which is a very different way of seeing the world. One rarely changes one’s worldview as a result of formal teaching, however well one is taught.

My hope, rather, is simply to enable students to understand the scientific worldview with respect to origins, not necessarily to accept it. We can help students to find their science lessons interesting and intellectually challenging without their being threatening. Effective teaching in this area can not only help students learn about the theory of evolution but better appreciate the way science is done, the procedures by which scientific knowledge accumulates,

the limitations of science and the ways in which scientific knowledge differs from other forms of knowledge.

CONCLUSION

My experience of having taught evolutionary biology for many years to biology undergraduates, those training to be teachers and others is that there are more creationist students in universities than is sometimes realised. I do not think that teaching about evolutionary biology is likely to cause many creationists to abandon their views. Instead, creationism can perhaps most profitably be seen as a 'worldview' that isn't straightforwardly susceptible to scientific refutation. What, though, good teaching in this area can do can do is to enable creationists to get a better understanding of evolutionary biology and to appreciate how biological knowledge, including knowledge of evolutionary biology, builds up. Nothing is to be gained by ignoring or ridiculing those who have creationist beliefs.

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