

THE LATEST CHALLENGE TO EVOLUTION: INTELLIGENT DESIGN

MAXINE F. SINGER

Albert Einstein's theory of relativity is more than a century old. The Belgian priest George Lemaître helped start the path that led to the idea of the Big Bang and the concept of the age of the universe. Alfred Wegener proposed the concept of continental drift that led to the idea of plate tectonics and our understanding of how the planet has changed since its birth. Charles Darwin's and Alfred Russel Wallace's theory of evolution by natural selection is 50 years older than Einstein's and also remains the topic of work by scientists. But, while Einstein is a revered celebrity, and Wallace, Wegener and Lemaître escape public scorn, Darwin is reviled by many. What is the explanation for these disparities?

Most people don't understand Einstein's theory even at a very superficial level. They are ignorant of the roles of Wallace, Wegener, and Lemaître as they were taught little about science or its history in school. But a lot of people think that they know and understand what Darwin said and they don't like it. Some still don't like what science tells us...that the age of the universe is about 13.7 billion years and that of the Earth about 4.7 billion years. Many reject the idea that we share common ancestors with other primates and that the first member of our species walked this planet as many as 0.5 million years ago. All the evidence we have indicates that they object because the scientific facts challenge any literal interpretation of the creation text in Genesis or the creation stories of other religions. Scientific descriptions of evolution, both physical and biological, are in direct conflict with the religious views of vast numbers of individuals, worldwide.

For example, Protestant fundamentalist Christians recently built a Creation Museum in the state of Kentucky in the U.S. with \$27 million of private money (1). One of the museum's exhibits shows human children playing alongside roaming dinosaurs. The Earth is said to be 6000 years old and the museum's web site says:

'The Bible speaks for itself at the Creation Museum. We've just paved the way to a greater understanding of the tenets of creation and redemption. Our exhibit halls are gilded with truth, our gardens teem with the visible signs of life'.

A poll in 2005 demonstrated that fewer than 40 percent of Americans accept the concept of evolution (2). Note that the word used is 'accept' rather than 'believe' because our view of evolution rests on scientific findings not on faith. This result is consistent with many other polls carried out over decades. Only one country polled had a lower percent of public acceptance of evolution than the U.S., Turkey, the only Muslim nation on the list. Turkey is actually quite a modern country with several excellent universities teaching science as we know it. But it is also the source of that elegant, though problematic 12-pound creationist volume that was sent free of charge to many scientists in Europe and the U.S., *The Atlas of Creation*. Some members of the U.S. Congress, journalists, and a few science museums also received the book. The man who appears to be responsible, Adnan Oktar, is now in prison for unrelated reasons.

This poll also showed that many people in many countries do not accept the idea of evolution. Recent activities confirm this finding. Isolated problems about teaching evolution have emerged in Canada. The Swedish government is discussing how to apply its law on education to private schools run by religious groups that reject evolution. The British Prime Minister's Office was concerned enough about the issue to release a statement in June of 2007 saying that 'creationism (including intelligent design) should not be taught as science'. The issue has arisen in Northern Ireland. In October 2007, the Parliamentary Assembly of the Council of Europe approved a resolution urging its member governments to oppose the teaching of creationism as science; this is a helpful start although it was troubling to read that the vote in favor was far from unanimous. Fortunately, a U.S. organization, the National Center for Science Education, publicizes these stories in its newsletter and web site; the organization is devoted to promoting the teaching of evolution as sound science (3).

The situation in the U.S. seems more acute than that in most other countries and has a rich history. American scientists have known for almost a century that we must be vigilant about what is taught in science classes. The National Academy of Sciences has, since 1984, published 3 versions of a booklet discussing how creationist ideas differ from science and why they should not be part of science lessons in schools (4).

Efforts to curb the teaching of evolution in U.S. public school science classrooms continue to emerge all over the nation. As soon as one challenge

is defeated, another appears. A major difficulty is that public school educational policy including what to teach and what textbooks to use is made by more than 17,000 local school boards with guidance from the states. The national federal government has no authority in this regard. These school boards are usually elected and reflect the tensions of local politics. However, the federal, that is the national, courts do have a say in the matter because the first amendment to the US Constitution, passed in 1789, says that 'Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof...'. Later, in 1868, the 14th amendment to the Constitution extended the first amendment's restriction to the states. Therefore, state and local laws and policies can be challenged in federal court by a citizen or group of citizens on the grounds that they violate the Constitution. These two amendments, one more than two centuries old, have allowed science to prevail in public schools. Private schools including religious schools that do not receive government monies can do what they please including teaching students that the Earth is only a few thousand years old, that the biblical flood story is accurate, and even that the Earth is flat.

Policies attempting to ban or dilute the teaching of evolution in public school science classes have evolved as the federal courts, including the Supreme Court, dismissed as unconstitutional one attempted subversion of the constitution after another. Laws banning the teaching of evolution outright were dismissed in 1968. Next to fall to the courts, in 1982, was the idea that schools could teach a 'balanced treatment' of Biblical creation and science. Five years later, laws requiring the teaching of 'creation science' or 'scientific creationism' were thrown out. In 1992 a federal court affirmed the right of a school district to prohibit a teacher from teaching creation science. The latest court decision, the 2005 Dover case, ruled that so-called 'intelligent design' is also religion masquerading as science and cannot be taught in science classrooms in public schools (5).

In none of these court decisions did the courts say anything about the validity of evolutionary theory or biblical creation. They only ruled that creationism in its various guises is a religious doctrine and therefore, because of the Constitution, is illegal to teach in science classrooms in public schools.

Now, anti-evolutionists are trying new tactics to get around the earlier federal court decisions. One tactic is to call for laws protecting the academic freedom of teachers who teach creationist notions. As recently as June of this year, the Louisiana legislature passed and the governor signed a bill incorporating this new anti-evolution approach. Under the guise of academic freedom it permits teachers to speak of evolution as 'controversial'

and is an invitation to teachers to present alternative, nonscientific explanations. The young governor of Louisiana, Bobby Jindal, signed the bill, making it law although he had been a biology major at Brown University. The 'academic freedom' argument is also a primary thrust of a movie called *Expelled: No Intelligence Allowed* that is popular in some communities in the U.S. (6). It has been a commercial success and is being shown in many fundamentalist Protestant churches.

Even more worrisome, is the strategy attempted by the Kansas State Board of Education that adopted, in 2005, a new definition of science essentially stating that scientific explanations are no longer limited to natural phenomena. Fortunately, a newly elected Board reversed that decision two years later. However, any future elected board could reverse the 2005 decision.

Another troubling tactic is to argue that U.S. school science classes should teach what is called the 'controversy' or the 'debate' between evolution and the creation story. Unfortunately, there are, in the U.S., major political figures, including the current president,¹ who hold this view. (The incoming president espouses a more scientific approach). The argument harbors two profound misconceptions. First, it implies that the biblical creation story is equivalent to a scientific explanation. Second, the argument fails to recognize that in our pluralistic societies, people of faith adhere to many different creation stories and the Bible is not everyone's text. The words 'controversy' and 'debate' are meant to convey the idea that there are real scientific disagreements concerning the fact of evolution. But scientifically, there is no such controversy. Scientists do argue about the details of evolutionary processes but not about whether physical and biological evolution actually occurs. The profound differences between science and faith are muddled by this approach to the advantage of neither.

Intelligent design is one of the more recent subterfuges used to try to get creationist ideas into school science curricula. While the federal court decision in 2005 concluded that intelligent design is essentially creationism dressed up in new terms (5), it continues to be taken seriously by many who seek ways to undermine the teaching of evolution in science classrooms. The Discovery Institute, the primary organization promoting it, defines intelligent design as follows: 'The theory of intelligent design holds that certain features of the universe and of living things are best explained by an intelligent cause, not an undirected process such as natural selection' (7). Intelli-

¹ George W. Bush.

gent design proponents do not generally refer to the Bible. In an effort to circumvent the Constitution, they decline to characterize the 'intelligent cause' but both supporters and critics understand that it is a deity at work.

'Design' is of course an old idea for explaining the extraordinary elegance and complexity of nature. Darwin himself had to deal with it as he did in a letter to the American botanist, Asa Gray. 'I have lately been corresponding with Lyell, who, I think, adopts your idea of the stream of variation having been led or designed. I have asked him...whether he believes that the shape of my nose was designed. If he does, I have nothing more to say' (8).

Contemporary proponents of intelligent design claim to be scientists and indeed several have advanced degrees and university positions. They say their methods are scientific. But they do not describe experiments or systematic observations and do not publish in recognized, peer-reviewed journals. A central argument made by intelligent design proponents is that there are features of living things that are irreducibly complex and could not have developed by evolutionary processes (9). The favorite examples of irreducible complexity are eyes, the immune system, the blood clotting system, and bacterial flagellae. In fact, a great deal is known about how these systems work and evolve and details are published continually. But intelligent design proponents have invented a number of counter arguments to undermine the significance of the data concerning the evolution of these biological elements; with these arguments they continue to maintain the concept of irreducible complexity.

For example, Michael J. Behe, Professor of Biochemistry at Lehigh University and a leader in the intelligent design movement, wrote about the mammalian immune system as follows in 1996 (9). 'As scientists, we yearn to understand how this magnificent mechanism came to be, but the complexity of the system dooms all Darwinian explanations to frustration'. Less than a decade later, a great deal had been learned about the evolution of the immune system including that one essential element derives from transposable elements. When confronted with the recent data during the 2005 trial at Dover, Behe said that the 'evidence of evolution [of the immune system]' was not 'good enough' (5). We can expect similar rejection of the evidence for the evolution of blood clotting and flagellae as well as of eye.

Walter Gehring, a leading investigator of the development and evolution of the eye has written: 'Recent developmental genetic experiments and molecular phylogenetic analyses...argue strongly for a monophyletic origin of the eyes from a Darwinian prototype and subsequent divergent, parallel and convergent evolution leading to the various eye-types' (10).

The judge in the Dover case raised a major point about the concept of irreducible complexity. 'Even if irreducible complexity had not been rejected [as it has been] by the scientific community at large, it still does not support intelligent design as it is merely a test for evolution, not design'. That is, failure of a test for one theory tells us nothing about the validity of a competing notion. But intelligent design proponents can always say that the evidence is just not good enough. That will be enough to raise doubts in a public that is largely scientifically naïve.

Speciation is another topic that those who object to evolution on religious grounds dismiss in the face of scientific evidence. Until recently, explaining biological evolution to the public was confounded by the scientific difficulty in describing how new species with markedly different phenotypes can arise from existing species.

This difficulty was underscored when, in 1975, Mary Claire King and Allan Wilson demonstrated that chimp and human genomes are 99 percent identical (11). More recent genome sequencing confirms that coding regions vary by only 1.2 percent, although there are larger differences in noncoding segments (12). This fact, by itself does not explain the difference between the two species. However, the clue to the explanation was stated in the summary to the King and Wilson paper: 'A relatively small number of genetic changes in systems controlling the expression of genes may account for the major organismal differences between humans and chimpanzees'. It is increasingly clear that this prediction is true. Variation in gene expression levels can yield marked differences in phenotypes some of them sufficient to lead to speciation.

An interesting example of the importance of gene regulation to evolution by natural selection comes from recent experiments on the very finches that Darwin studied on the Galapagos Islands (13).

Darwin observed that the various finch species on different islands have notably different beaks. Some are wide, some narrow, some deeper and some longer than others. Darwin wrote in his account of the voyage: 'one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends' (14).

Peter and Rosemary Grant of Princeton have spent more than 30 years studying the Galapagos finches. They learned that the beak shape correlates with the food the finches eat. The three dimensions of the beaks can be accurately measured and the Grants and their colleagues measured hundreds of them (15). Thus, the phenotypes are well defined. They also identified the kinds of food eaten by each species and discovered that the shape

of the beak correlates with the type of food consumed by the several species. For example, those finches that probe cactus flowers for food have relatively elongated beaks of low depth while those that crush large seeds have deep, short beaks. Now, the relative levels of expression of two genes, *BMP4* and *CaM*, have been measured in the developing beaks in the various finch species (13). Together, the expression of these two genes account for much of the difference between the beaks; the higher the level of *CaM* expression the longer the beaks: the higher the level of *BMP4* expression the wider and deeper the beaks. Thus, differential regulation of gene expression accounts for the shape of the beaks rather than any kind of change in the coding region and protein structure.

These data are not likely to change the minds of those espousing intelligent design or other forms of creationism. They can argue that the story of the finch beaks is only 'microevolution', which some of them acknowledge to occur. They can still argue that 'macroevolution', the generation of striking new species like chimps and humans from a common ancestor, does not happen. Indeed, their primary concerns relate to the origins of animals, especially humans. The day is not far off when we will have convincing data describing the phenotypic differences between chimps and humans in terms of differential gene regulation. Some relevant papers have already appeared (for example, 16). But those whose beliefs are threatened by such data will resist.

Another approach to resistance is illustrated by the reaction to a 2008 paper in *Nature* magazine that reported on the evolution of cichlid fishes (17). The journal's cover shows a picture illustrating the distinctive coloration of two species in Lake Victoria and carries the headline 'a textbook example of evolution in action'. The difference in color between the males of the two species and associated frequencies of different opsin alleles in the species leads to reproductive isolation without geographic isolation. It took less than a week for the Discovery Institute's web site to display a link to an objecting story that said: 'But the researchers did not observe the origin of a new species. They did what biologists have been doing for a long time: They analyzed differences in existing species to find evidence to support a particular hypothesis of speciation... all they really did was compare existing species and find a correlation between differences in their DNA and differences in their vision'.

These stories are illustrative of the difficulty scientists face in fostering majority public support for the concept of evolution. As scientists, we understand science to be as described by the U.S. National Academy of Sciences:

'Science is a particular way of knowing about the world. In science, explanations are restricted to those that can be obtained through observations and experiments that can be substantiated by other scientists...Explanations that cannot be based on empirical evidence are not part of science'. Yet, rigorous scientific findings obtained according to this definition appear to be powerless in the face of faith in the literal words in ancient religious texts.

Reviewing this history, leads me to two related general conclusions

My first general conclusion is that we are unlikely to convince those who view their religious faith as in fundamental conflict with scientific evolution. Yet, many people of faith do not find evolution incompatible with their beliefs. This includes many scientists of deep religious faith who accept evolution and are defenders of the nature of science. We heard this week from Francis Collins about his faith. Father George Coyne, S.J., a former member of this Academy, has written eloquently about his faith and acceptance of evolution. Pope John Paul II, revered by Catholics and non-Catholics, was clear in stating that the weight of science supports evolution. (See reference 4 for quotations from these three people). But these approaches do not succeed with many people whose minds are closed and see Darwin as the source of evil in the world.

My second conclusion derives from the first. The most important task for scientists and the only one that has a chance to succeed is assuring that science and evolution are taught properly in school science classes. There are several reasons for this. School science education, certainly in the U.S. if not in other countries, has failed to instruct people in the nature of science, its absolute dependence on honest experimentation and observation, and its inherent quality of being correctable. Science itself is neutral on the subject of religion and this Academy, whose members represent many religious communities, speaks loudly for that fact.

Classroom teachers who are required to teach about evolution face continual challenges. They may be people who reject evolution because of their own faith. Or, they may be people who accept evolution but are challenged by students or parents who do not. For these teachers, the only practical approach is to say that students are not required to accept evolution, but they are required to understand it. And such situations are opportunities to teach what science actually is and is not and how it works. It is my understanding that this was the view of Michael Reiss who was Director of Education at the Royal Society in London until forced recently to resign because of the uproar this position elicited from some scientists. Those sci-

entists have probably not been in a school classroom since they were students themselves. Their lack of understanding of the real challenges to teaching evolution troubles me.

I also find troubling those scientists whose support of evolution and lack of personal faith is accompanied by an apparent lack of respect for religions and religious views. There may indeed be an unbridgeable chasm between science and religion as some have written but there is no need for a chasm between scientists and people of faith.

REFERENCES

1. For the Creation Museum see, www.creationmuseum.org and www.answersingenesis.org.
2. J.D. Miller, E.C. Scott, and S. Okamoto. 2006. Public Acceptance of Evolution. *Science* 313:765-766.
3. For the National Center for Science Education see, <http://ncse.org>.
4. National Academy of Sciences. 2008. *Science, Evolution, and Creationism*. The National Academies Press, Washington, D.C.
5. John E. Jones, III. 2005. Decision in T. Kitzmiller vs. Dover Area School District, www.pamd.uscourts.gov/kitzmiller/kitzmiller_342.pdf, p. 79
6. For the movie, *Expelled: No Intelligence Allowed*, see, www.expelledthemovie.com
7. For the Discovery Institute, see www.discovery.org.
8. C. Darwin. 1861. Letter to Asa Gray, September 17. The Darwin Project letter 3256. <http://www.darwinproject.ac.uk>.
9. M.J. Behe. 1996. *Darwin's Black Box*. Simon and Schuster, New York. p. 139.
10. W.J. Gehring. 2004. Historical perspective on the development and evolution of eyes and photoreceptors. *International J. Devel. Biol.* 48:707-717.
11. M-C. King and A. Wilson. 1975. Evolution at two levels I humans and chimpanzees. *Science* 188:107-116.
12. The Chimpanzee Sequencing and Analysis Consortium. 2005. Initial sequence of the chimpanzee genome and comparison with the human genome. *Nature* 437:69-87.
13. A. Abzhanov, W. Kuo, C. Hartmann, B.R. Grant, P.R. Grant, and C.J. Tabin. 2006. The calmodulin pathway and evolution of elongated beak morphology in Darwin's finches. *Nature* 442:563-567.

14. C. Darwin. 1860. *The Voyage of the Beagle*. The Natural History Library, Doubleday, New York, 1962. p. 381.
15. J. Weiner. 1994. *The Beak of the Finch*. Alfred A. Knopf, New York.
16. S. Prabhakar, A. Visel, J.A. Akiyama, M. Shoukry, K.D. Lewis, A. Holt, I. Plajzer-Frick, H. Morrison, D.R. Fitzpatrick, V. Afzal, L.A. Pennacchio, E.M. Rubin, and J.P. Noonan. 2008. Human-specific gain of function in a developmental enhancer. *Science* 321:1346-1350.
17. O. Seehausen, Y. Terai, I.S. Magalhaes, K.L. Carleton, H.D.J. Mrosso, R. Miyagi, I. Van der Sluijs, M.V. Schneider, M.R. Maan, H. Tachida, H. Imai, and N. Okada. 2008. Speciation through sensory drive in cichlid fish. *Nature* 455:620-626.
18. Creationism row forces out UK educator. 2008. *Nature* 455:441.