



Science, evolution, and creationism

Francisco J. Ayala

Department of Ecology and Evolutionary Biology, University of California, 321 Steinhaus Hall, Irvine, CA 92697

On December 20, 2005, John E. Jones III, federal judge for the Middle District of Pennsylvania, issued a 130-page-long decision (*Kitzmiller v. Dover Area School District*) declaring that “The overwhelming evidence at trial established that ID [intelligent design] is a religious view, a mere re-labeling of creationism, and not a scientific theory . . . ID is not supported by any peer-reviewed research, data, or publications.”

In 1984, the National Academy of Sciences (NAS) published *Science and Creationism: A View from the National Academy of Sciences*. A second edition was published in 1999. A third edition, sufficiently modified to deserve a new title, *Science, Evolution, and Creationism*, published on January 4, 2008 (1).

Science and Creationism was prepared by a committee of the NAS in response to statutes passed by the legislatures of, first, the state of Arkansas, and shortly thereafter, the state of Louisiana, that required that “creation science” be taught in public schools together with evolution. The Louisiana “Creation Act” was appealed all the way to the U.S. Supreme Court, which in 1987 (*Edwards v. Aguillard*) concluded that the act’s “primary purpose was to change the public school science curriculum to provide persuasive advantage to a particular religious doctrine that rejects the factual basis of evolution in its entirety. Thus, the Act is designed either to promote the theory of creation science that embodies a particular religious tenet or to prohibit the teaching of a scientific theory disfavored by certain religious sects. In either case, the Act violates the First Amendment” (1, p. 45). *Science and Creationism* was made part of an “amicus brief” submitted to the Supreme Court in *Edwards v. Aguillard* by the NAS, with the endorsement of the American Association for the Advancement of Science and other organizations.

Argument from Design

The “argument from design” for the existence of God, based on the complex organization of living things, was elaborated by English clergyman William Paley in his *Natural Theology*, published in 1802 (2). Paley’s argument from design is two-tined. The first prong asserts that humans, as well as all sorts of organisms, in their wholes, in their parts, and in their relations to one another and to their environment, could not have come

about by chance but rather manifest to have been designed for serving certain functions and for certain ways of life. The second prong of the argument is that only an omnipotent Creator could account for the perfection and functional design of organisms. In the 1990s, several authors in the United States revived the argument from design but modified the second prong of the argument by referring to an unspecified “intelligent designer,” thus avoiding explicit reference to God, so that the argument

“Nothing makes sense in biology except in the light of evolution.”

from design could be taught in the public schools as an alternative to evolution. Judge Jones, like so many other independent observers, saw through this hypocritical subterfuge and determined, moreover, that the argument lacks any scientific cogency whatsoever.

Science, Evolution, and Creationism consists of three main chapters. The first chapter briefly describes the process of evolution and the nature of science in contrast to other forms of knowledge. The second chapter surveys the scientific evidence that supports evolution from diverse disciplines that include astronomy, paleontology, comparative anatomy, biogeography, molecular biology, genetics, and anthropology. The third chapter examines intelligent design and other creationist perspectives so as to point out the scientific and legal reasons against teaching creationism in public school science classes. The text concludes with a selection of frequently asked questions and additional readings.

Evolution and Natural Selection

In 1973, the eminent evolutionist Theodosius Dobzhansky famously asserted that “Nothing makes sense in biology except in the light of evolution” (3). Biological evolution is the central organizing principle of modern biology. Evolution provides a scientific explanation for why there are so many different kinds of organisms on Earth and gives an account of their similarities and differences (morphological, physiological, and genetic). It accounts for

the appearance of humans on Earth and reveals our species’ biological connections with other living things. It provides an understanding of the constantly evolving bacteria and viruses and enables the development of effective new ways to protect ourselves against the diseases they cause. Evolution has made possible improvements in agriculture and medicine and has been applied in many fields outside biology, including forensics and software engineering; it has stimulated chemists, for example, to use the principles of natural selection for developing new molecules with specific functions.

Darwin and other 19th-century biologists found compelling evidence for biological evolution in the comparative study of living organisms, their geographic distribution, and the fossil remains of extinct organisms. Since Darwin’s time, biological disciplines that emerged more recently—genetics, biochemistry, ecology, animal behavior, neurobiology, and especially molecular biology—have supplied powerful additional evidence and detailed confirmation. Accordingly, evolutionists are no longer concerned with obtaining evidence to support the fact of evolution. Rather, evolutionary research nowadays seeks to understand further and in more detail how the process of evolution occurs. Yet, the evidence from paleontology and the older disciplines continues to accumulate, such as the discovery published in 2006 and described in *Science, Evolution, and Creationism* of *Tiktaalik*, a fish that lived in shallow freshwater streams and swamps approximately 380 million years ago (4, 5). *Tiktaalik* is a nearly precise intermediate between typical fish and the first known four-legged animals from which would evolve all animals that live on the land from frogs to reptiles, to birds, and to mammals, including humans. No intermediate fossils between humans and apes were known in Darwin’s time. Now, thousands of remains are known that belong to the human lineage after it separated from the lineage that goes to the apes.

Biological evolution is part of a compelling historical narrative that scientists have constructed over the last few centuries. The narrative begins with the formation of the universe, the solar system, and the Earth, where conditions occur suitable for life to evolve. There are the-

© 2008 by The National Academy of Sciences of the USA

ories that seek to account for how life originated on Earth, but none of them has gathered enough supporting evidence to be generally accepted by scientists. But natural selection, discovered by Darwin, has been convincingly demonstrated as the process that accounts for the adaptive configuration and function of organisms (for their “design”). Darwin’s greatest contribution to science is not that he accumulated evidence demonstrating the evolution of life, but that he discovered natural selection, the process that accounts for the design of organisms and their wonderful adaptations to survive and reproduce in the environments where they live, including wings for flying, legs for running, eyes to see, and kidneys that regulate the composition of the blood.

Evolution and Religion

Scientists and religious authors have written eloquently about their awe and wonder at the history of the universe and of life on this planet, explaining that they see no conflict between the evidence for evolution and their belief in God (ref. 1, p. 15; ref. 6). Authorities of diverse religious denominations have also issued statements affirming the compatibility between the tenets of their faith and the acceptance of biological evolution (ref. 1, pp. 13 and 14; ref. 6). Science and religion concern different

aspects of the human experience. Scientific explanations are based on evidence drawn from examining the natural world and rely exclusively on natural processes to account for natural phenomena. Scientific explanations are subject to empirical tests by means of observation and experimentation and are subject to the possibility of modification and rejection. Religious faith, in contrast, does not depend on empirical tests and is not subject to the possibility of rejection based on empirical evidence. The significance and purpose of the world and human life, as well as issues concerning moral and religious values, are of great importance to many people, perhaps a majority of humans, but these are matters that transcend science.

Many people have questions about biological evolution. They may have been told that scientific understanding of evolution is incorrect or at least doubtful. They may be skeptical that a natural process could account for the astonishing diversity of the living world and the marvelous adaptations of organisms to their ways of life. People of faith wonder whether accepting evolution is compatible with their religious beliefs. *Science, Evolution, and Creationism* speaks to these questions. It is written to serve as a source of information and as a resource for people who find themselves embroiled in debates about evolu-

tion. It should be helpful to “school board members, science teachers and other education leaders, policy makers, legal scholars, and others in the community who are committed to providing students with quality science education.” Moreover, as stated in the preface, *Science, Evolution, and Creationism* “is also directed to the broader audience of high-school and college students as well as adults who wish to become more familiar with the many strands of evidence supporting evolution and to understand why evolution is both a fact and a process that accounts for the diversity of life on Earth.”

A related document, *You Say You Want an Evolution? A Role for Scientists in Science Education*, recently has been made public (7). This document is sponsored by 17 scientific societies, representing the physical, chemical, biological, and social sciences and science teachers’ communities. It presents the results of a recent extensive survey of the public acceptance of evolution as a function of the level of education and other variables. The document concludes with a determined call “for scientists to become involved in promoting science education. . . . If our nation is to continue to develop the talent necessary to advance scientific and medical research, we must ensure that high standards in science education are maintained and that efforts to introduce non-science into science classes do not succeed.”

1. National Academy of Sciences and Institute of Medicine (2008) *Science, Evolution, and Creationism* (Natl Acad Press, Washington, DC).
2. Paley W (1802) *Natural Theology* (R Fauldner, London).
3. Dobzhansky Th (1973) Nothing makes sense in biology except in the light of evolution. *Amer Biol Teacher* 35: 125–129.

4. Daeschler EB, Shubin NH, Jenkins FA, Jr (2006) A Devonian tetrapod-like fish and the evolution of the tetrapod body plan. *Nature* 440: 757–763.
5. Shubin NH, Daeschler EB, Jenkins FA, Jr (2006) The pectoral fin of *Tiktaalik roseae* and the origin of the tetrapod limb. *Nature* 440:764–771.

6. Ayala FJ (2007) *Darwin’s Gift to Science and Religion* (Joseph Henry, Washington, DC).
7. Coalition of Scientific Societies (2007) *You Say You Want an Evolution? A Role for Scientists in Science Education* (evolution.faseb.org/sciencecoalition). Accessed on December 15, 2007.