



---

Anthropology, Evolution, and "Scientific Creationism"

Author(s): James N. Spuhler

Source: *Annual Review of Anthropology*, Vol. 14 (1985), pp. 103-133

Published by: Annual Reviews

Stable URL: <http://www.jstor.org/stable/2155591>

Accessed: 26/10/2009 12:30

---

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=annrevs>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).



*Annual Reviews* is collaborating with JSTOR to digitize, preserve and extend access to *Annual Review of Anthropology*.

<http://www.jstor.org>

# ANTHROPOLOGY, EVOLUTION, AND “SCIENTIFIC CREATIONISM”

*James N. Spuhler*

Department of Anthropology, University of Michigan, Ann Arbor, Michigan 48109

## INTRODUCTION

According to a Gallup Poll reported 29 August 1982 (150, p. 21), 44% of the population in the United States does not accept an evolutionary origin for the human species, 9% are uncertain, and only 47% appear to be committed to a belief in human evolution, although most of those who believe in human evolution also expressed some theistic beliefs.

G. Evelyn Hutchinson warned in 1983: “. . . [T]he contemporary attacks on evolutionary theory . . . are terrifying, for they question the whole of the unity of knowledge and of the living world . . .” (85).

While a candidate, President Ronald Reagan stated at a meeting of Christian fundamentalists in Dallas on 22 August 1980 (83, p. 1214) that he supported the teaching of the biblical story of creation in the public schools and that he thought there were great flaws in the theory of evolution.

In 1976 President Jimmy Carter wrote (25, p. 2) in support of the separation of church and state and the importance of a well-rounded background in science, including the biological theory of evolution, for the development of young persons.

This review stresses publications during the years 1978-1984, but important works from earlier times are included. It does not present a full review of current facts and theories on evolution as such; rather it considers selected aspects of the ongoing controversy between the science of evolution and religious creationism, with special reference to those facts and theories that lead most scientists, many religious persons who are not fundamentalists insisting on a literal interpretation of the Bible, and the high courts to reject “scientific creationism” as a part of anthropological and other involved sciences.

For those who want a quick overview of the controversy, six works are recommended: Education Committee of the American Society of Zoologists,

*Science as a Way of Knowing—Evolutionary Biology*, 1984 (53a); Committee on Science and Creationism, *Science and Creationism*, 1984 (33); Godfrey, *Scientists Confront Creationism*, 1983 (67); Harris, *Evolution: Genesis and Revelations*, 1981 (76); Wood “*Scientific Creationism*” and the Public Schools, 1982 (210); and Zetterberg, *Evolution versus Creationism*, 1983 (218). J. R. Moore (133) supplies a bibliography of 200 titles concerning creationism, and McKim (122) provides a selected bibliography on the debate.

### *Definitions of Science and Religion*

The legal definition of “religion” is of top importance in the controversy. Justice Black stated in *Everson vs Board of Education* (330 U.S. 1.15–16, 1947):

The “establishment of religion” clause of the First Amendment means at least this: Neither a state nor the Federal Government can set up a church. Neither can pass laws which aid one religion, aid all religions, or prefer one religion over another. Neither can force nor influence a person to go to nor to remain away from church against his will or force him to profess a belief or disbelief in any religion. No person can be punished for entertaining or professing religious beliefs or disbeliefs, for church-attendance or non-attendance. No tax, large or small, can be levied to support religious activities or institutions, whatever they may be called, or whatever form they may adopt to teach or practice religion. Neither a state nor the Federal Government can, openly or secretly, participate in the affairs of any religious organizations or groups and vice versa. In the words of Jefferson, the clause . . . was intended to erect “a wall of separation between church and state.”

### *Definitions of Facts and Theories*

Many evolutionary scientists teach that “evolution is a theory.” Because one dictionary definition of “theory” is “hypothesis, guess,” some conclude that the theory of evolution is mere guesswork. The folk wisdom of America trusts “facts” and distrusts “theories.”

Bertrand Russell (1929) made a useful classification of facts. A fact is not one of the simple things of the world; facts mean that a certain thing has a certain quality, or that certain things have certain relations. Facts are never simple; they have two or more constituents; they assign one or more qualities or relations to things. The fact itself is objective, and independent of our thought or opinion about it; but the assertion is something which involves thought, and may be either true or false (178, pp. 54–56).

Gluckhohn (1939), writing for anthropologists, gave a helpful dictionary-type definition of theory:

“Theory” refers to a statement or statements of somewhat abstract nature covering the relationship between a number of discrete facts. The differentia of “theory” is primarily that the validity of operations of reasoning is at stake as well as the correctness of operations of perceptions. Theory is dependent on the logic of inference. Theories depend upon inferences from observations, but cannot themselves be observed directly (100, p. 344, footnote 32).

Cohen & Nagel (29) distinguish between two kinds of theories. Physical theories appeal to an easily imagined hidden mechanism which will explain the observable phenomena, for example, the atomic theory of chemistry and the theory of the gene in biological inheritance. Mathematical or abstractive theories avoid all reference to hidden mechanisms and make use of relations abstracted from the phenomena actually observable, for example, the theory of gravitation and the Darwinian theory of organic evolution. Neither kind of theory is more useful nor more fundamental than the other; some scientists use a fusion or synthesis of the two points of view as in most of neo-Darwinian evolutionary theory (see Mayr & Provine 120). Some anthropologists, especially archaeologists, prefer to avoid use of the term “facts” in the context of the present controversy and to speak instead of “data” in terms of some theoretical perspective, in reference to, for instance, a pot sherd or fossil bone.

### *Surveys on Belief in Evolution*

Riddle found in 1942 that less than one half of high-school biology teachers in the United States taught evolution in their courses (173). Bliss (16) reported that a 1973 survey by a creationist group of a random sample comprising 2000 residents of Cupertino, California, gave these percentages: believe in creation 44.3, in evolution, 23.3, in both 3.5, in neither 10.6, and undecided 18.3.

## FUNDAMENTALISM AND “SCIENTIFIC CREATIONISM”

### *Fundamentalist and Evangelical Churches*

The Fundamentalist and Evangelical churches are a diverse group of theologically conservative Protestant churches with origins in the millenarianism of the 19th century. Some trace the movement back to the anabaptists of Zurich in 1523, who advocated a return to primitive Christianity. The word “Fundamentalist” was coined by Curtis Lee Laws of the *Baptist Watchman-Examiner* on page 834 of the issue of 1 July 1920 (J. R. Moore 134, p. 70). Sandeen (180) makes an excellent exposition, including an extensive bibliography, of the religious character of the fundamentalist movement back to its millenarian beginnings. Cole (32) gives an accurate description of beliefs, actions, and events in the 1920s, a period when several still existing fundamentalist churches were founded in the United States. Gasper (64) gives a descriptive account of the movement in America from the 1930s to the 1960s. H. L. Mencken (1880–1956), journalist, editor, and philologist, was perhaps the harshest critic of the movement, writing in his *Treatise on the Gods* (126, pp. 257–58): “In Fundamentalism it [Protestantism] reaches the nadir of theology. What is worst in Fundamentalism is common, perhaps, to all forms of Christianity, but it is only in the imprecations of the backwoods Wesleys that

it is stated plainly. No more shocking nonsense has every been put into words by theoretically civilized men."

In the 1920s Mencken introduced the term "Bible Belt" for that region, chiefly in the southern states but now including parts of Oklahoma, west Texas, eastern New Mexico, and southern California, where churchgoing people held that the Bible is literally true. Among novels critical of the fundamentalist movement, probably the best known is *Elmer Gantry* (1927) by Sinclair Lewis (107), an account of certain ignorant, gross, and predatory preachers who operated midwestern fundamentalist churches in the 1920s.

J. R. Moore (134) shows that some of the early fundamentalists, including Augustus Hopkins Strong (1836–1921), author of *Systematic Theology* (193), and the leading Baptist theologian, Benjamin B. Warfield (1851–1921), and George Frederick Wright (1838–1921), glacial geologist, were strongly proevolutionists. " 'Evolution,' in short," said James Orr (1844–1914), Professor of Theology at Glasgow, "is coming to be recognized as but a new name for 'creation' " (156).

In America the religious antievolution crusade was delayed by the Civil War. Moore (134) argues convincingly that the campaign really got underway as an aftermath of World War I. Lewontin (110) outlines a social class explanation of the American fundamentalist movement.

In general, the fundamentalists of the 1920s claimed to defend the standards of orthodox Christianity against the church liberals and modernists who accepted 19th century and early 20th century biblical criticism and wished to make the activities of the church more relevant to contemporary social problems. The fundamentalists stress a complete, often verbal inspiration of the Bible and accept its full and final authority over religious faith and practice. Fundamentalists preach that a happy eternal life in Paradise after death is reached by accepting Jesus Christ as Savior; a view that moves a few rich and many not so rich fundamentalists to contribute money to support antievolutionary action and publications of the creed (134).

A coalition of fundamentalists called the "New Christian Right," and by some the "Moral Majority," took credit for having helped elect President Reagan and several members of the Senate and House. Most of the Christian Right were brought and held together by television evangelists, notably Rev. Jerry Falwell of Virginia, Rev. Jimmy Lee Swaggart of Louisiana, and Rev. James Robison of Texas.

The Christian militants claimed that liberals, humanists, and leftists had conspired to remove God from the public schools and to teach evolution as an alternative *religion*. Jorstad (90) showed that the fundamentalists had previously had some influence in electing rightest candidates in the United States, including Sen. Joseph R. McCarthy in the 1950s and Sen. Barry Goldwater and Gov. George Wallace in the 1960s, but these pioneers lacked the skillful use of television and computerized direct mailing shown by the New Christian Right

during the 1980 and 1984 campaigns. Television fundamentalism is now a multimillion dollar business in Bible Belt America.

According to de Puy, in 1980 the conservatives defeated the liberals in the 13-million-member Southern Baptist Convention in electing as their president Bailey Smith, an avowed believer in an inerrant Bible (46, p. 597).

A reliable census of the number of fundamentalists who are antievolutionists, or special creationists, is not available. In 1984 fundamentalist organizations claimed nearly 40 million members. Probably about one half of these are antievolutionists of some degree. There were at least several hundred active “scientific creationists” in the United States in 1984; the Creation Research Society claims 3000 members (Encyclopedia of Associations, 18th edition, 1984).

TRANSLATIONS OF THE BIBLE A belief in the literal truth of the Bible presupposes designation of a particular version out of the many that have been written in the last 2000 years. By about 1450 A.D., when printing from movable type was introduced in Europe, there were 33 translations, and by about 1800 there were 71. For our purposes, *The Septuagint* (3rd–2nd century B.C.), *The Vulgate* (ca 383–405 B.C.), the *King James Version* (of 1611), and some modern translations are the most important. The three-volume *Cambridge History of the Bible*, 1963–1970, gives an excellent history of the translations.

Of several modern translations, the Anchor Bible is of special interest in the present context because William Foxwell Albright, a distinguished biblical scholar, archaeologist, and anthropologist, was the first general editor of the series: “Its object is to make the Bible accessible to the modern reader; its method is to arrive at the meaning of Biblical literature through exact translation and extended exposition, and to reconstruct the ancient setting of the biblical story, as well as the circumstances of its transcription and the characteristics of its transcribers (190, General Editor’s Note, Vol. 1).

### *Creationist Literature*

Boadt (1982), a theologian, pointed out that the literalist approach to biblical interpretation is not present in Judaism and Catholicism, but is present only in Protestantism, with its greater stress on the power of the word and lower stress on the power of the social community. He distinguished the descending, “transcendent,” literal interpretation of the biblical text used today mostly by Protestant fundamentalists, from the ascending, “anthropological,” critical interpretation employed by other biblical scholars. Boadt insists: “These are not simply different methods of arriving at the same insight. They are two distinct views. The conflict between creationism and evolutionary theory reflects these viewpoints, and it will not be resolved by a neutral discussion of how best to interpret evidence” (17, p. 17). The fundamentalist, transcendent interpretation of the Bible makes it the infallible, inerrant, and verbally inspired word of God (200, 201).

The nonfundamentalist, anthropological approach to interpretation of the Bible holds that the Old Testament is about but not by Jehovah, and that the New Testament is not written by Jesus Christ, but is about him. Inspiration does not mean dictation [see Benoit (11) for a full treatment of this question and also Megivern (124)].

The Catholic Church has long endorsed the historical, critical, anthropological method (36). Pope Leo XIII in his 1893 letter *Providentissimus Deus*, ordered Catholic scholars to attempt recovery of the ancient forms so as better to understand the intent of the text. Pope John Paul II stated in an address to the Pontifical Academy of Sciences on 3 October 1981:

Cosmogony itself speaks to us of the origins of the universe and its makeup, not in order to provide us with a scientific treatise but in order to state the correct relationship of man with God and with the universe. Sacred Scripture wishes simply to declare that the world was created by God, and in order to teach this truth, it expresses itself in the terms of the cosmology in use at the time of the writer. The sacred book likewise wishes to tell men that the world was not created as the seat of the gods, as was taught by other cosmogonies and cosmologies, but was rather created for the service of man and the glory of God. Any other teaching about the origins and makeup of the universe is alien to the intentions of the Bible, which does not wish to teach how heaven was made but how one goes to heaven (167).

Gardner judges that of the thousands of “dreary and pathetic” books attempting to harmonize evolution and the Bible, published in the 19th century after Darwin’s *Origin of Species*, only one stands out today—the book entitled *Omphalos*, by the English zoologist Philip Gosse (71). His delightful and fantastic theory is logical, in accord with geological theory, but untestable and not negatable. Gosse concluded that God created the earth, living species, and man about 4000 B.C., in six days, with the geological strata and their contained fossils all in the places and order that scientists discover; just as Adam and Eve were created with a navel that was never connected by an umbilical cord to a placenta, so the earth was created with stratified fossils that had no existence except in the mind of God (63).

The greatest of the 20th century Protestant creationists is George McCready Price, born in 1870, educated in Seventh Day Adventist schools, Professor of Geology at the Adventist Walla Walla College in Washington State, Bryan’s chief authority in the Scopes Trial, quoted by nearly every fundamentalist antievolutionist. In 1923 he published *The New Geology* (168), a classic of pseudo-science. The heart of Price’s argument is the literal six-day creation, the deluge, and the notion that the evidence for evolution is circular and thus invalid: the fossils are used to date the geological deposits and the sequence of fossils from “old” to “young” strata is used as evidence and proof of evolution. Price believed that the anthropoid apes are degenerate or hybridized men.

Probably the most influential of the Catholic antievolutionists is George Barry O’Toole, *The Case Against Evolution* (157), a work based mostly on Price. The Neo-Thomist philosopher Mortimer J. Adler has published (2, 3)

several items against the evolutionary, gradualistic origin of species, claiming that species differ not in degree but, radically, in kind. The Catholic church now accepts the scientific theory of evolution with reservations about the original infusion of the soul (36, 167). Father Ernest C. Messenger, in *Evolution and Theology*, gives a full discussion on problems of the soul and evolution (127).

### *Is the Bible Literally True?*

Apparently all “scientific creationists” are prior fundamentalists, who believe in the literal interpretation and absolute inerrancy of the Bible (56, 209), but many fundamentalists are not creationists and antievolutionists (25). Thus the claim that creationism is true and that evolution is false rests on a literal interpretation, free from error or mistake, of sentences in Genesis saying that God created man and all other species within six 24-hour days about 6000 to 10,000 years ago (217).

A classical statement of absolute inerrancy is by the 19th century English biblical scholar John William Burgon (21): “The Bible is none other than the voice of Him that sitteth upon the Throne! Every Book of it, every Chapter of it, every Verse of it, every word of it, every syllable of it (where are we to stop?), every letter of it, is the direct utterance of the Most High!” A modern statement is by Rev. Jerry Falwell, of the TV show “Gospel Hour,” who holds that “the Bible is absolutely infallible, without error in all matters pertaining to faith and practice, as well as in the areas of geography, science, history . . .” (56). But the Bible literally interpreted makes contradictory statements, one or both of which must therefore be in error.

Of course, a wide variety of arguments may reconcile literally interpreted biblical contradictions. See, for example, Heidel’s finding (79, pp. 245–48) that the numerical data in Genesis on the duration of the deluge are in perfect harmony. Many special creationists [see several mentioned in (147, 218)] perceive a unifying design in the final form of the creation and flood account in Genesis, notwithstanding dual origin and internal contradictions. Nevertheless, such rectifications are of no solace to those who believe in a strictly literal interpretation.

The contradictory statements are understandable if the Book of Genesis is a loosely edited compilation from more than one source, as modern biblical scholarship has conclusively demonstrated (61, 204). Often creationists argue on the basis of an English translation of the Hebrew or Greek texts, frequently accepting the King James Version despite its known lack of accuracy in identifying Hebrew roots (17, p. 19; 75). There is no reason to accept the creationist claims about the origin of man or Noah’s flood if there are many factual errors elsewhere in the Bible. Here we will include errors in translation, but not obvious typographical errors [like that of a 17th century Bible which made the 7th commandment state (76): “Thou shalt commit adultery.”] A

partial list of biblical errors relevant to the evolution-creation controversy is given in references 17, 76, 190, and 218.

The view of a biologist regarding the virgin birth phenomenon in Matthew 1:18–25 becomes quite different upon learning that Hebrew *'almah*, “girl,” is translated (uniquely in the New Testament) into Greek *parthenos*, “virgin” (6, p. 8). These authors explain further: “It is possible on some views that Isaiah was using mythological terms current in his own time to demonstrate an expected deliverer’s birth. The LXX [Septuagint] translators would appear to have so understood the passage, and only later did Greek translations of the Hebrew appear with the word one would expect, *neanis*, ‘young maiden,’ instead of *parthenos*.” See also the comments by Fitzmyer (59) on the birth of Jesus narrative in Luke 1:26–38. If the birth was in fact virgin, that is, parthenogenetic without fertilization by a male gamete of the same species, then Jesus should have been a female with X chromosome(s) but no male sex-determining Y chromosome. Whether the conception of Jesus was “immaculate” is of course a religious and not a scientific matter.

A majority of Christians believe that the true Bible is religious, not scientific. As Alfred North Whitehead remarked (208, p. 17): “Collective enthusiasms, revivals, institutions, churches, ritual, bibles, codes of behaviour, are trappings of religion, its passing forms. They may be useful, or harmful; they may be authoritatively ordained, or merely temporary expedients. But the end of religion is beyond all this.” And, to expand a phrase of Whitehead (208, p. 15): “You use arithmetic [or the facts and theories of evolution], but you are religious.”

### *The “Creation Scientists”*

Williams (209, p. 92) found that “An exegesis of the seminal works of Henry M. Morris, Director of the Institute for Creation Research, clearly reveals that scientific creationism is a religious doctrine. It is a necessary dogma of the conservative evangelical’s particular form of Christianity, is premised upon a literal interpretation of the Bible, and has as its purpose the defense of Jesus Christ as Lord and Savior” (see also 137, 138, 142).

Three works by Morris are of special interest in the current controversy: 1. *Scientific Creationism*, issued in a General and a Public School Edition, 1974 (139), 2. *Many Infallible Proofs*, 1974 (140), and 3. *The Beginning of the World*, 1977 (141). The omission of material printed in the General Edition of *Scientific Creationism* from the Public School Edition is of particular importance in understanding the political strategy and the religious basis of scientific creationism. The final chapter of the General Edition (139), entitled “Creation According to Scripture,” lays the theological foundation for a belief in creationism, gives documentation to the Bible, and defends against modern apostasy. This “religious” chapter is omitted entirely, and the references to God and the Bible in the opening chapter were removed from the Public School Edition.

After the Supreme Court invalidated a state antievolution law in *Epperson v. Arkansas* (1968), the creation scientists developed a “Creation Science Model” as a strategem to combat what they termed the “Evolution Model” (130–132). If creationism and evolution are really competing scientific models, then it is only fair, the creationists held, that the two theories should be given equal time in the public schools (130).

An advertisement by the Institute for Creation Research in 1981 (cited by Williams 209, p. 94) described Morris’s *Many Infallible Proofs* (140) as: “A comprehensive and systematic handbook written as a survey of the unique truth and authority of Biblical Christianity. Contains evidence from science, prophesy, history, internal structure, and common sense. Used as a textbook in seminaries and colleges, and for church and home study classes, as well as for personal witnessing.”

Benkov & Rothstein conclude that “Creation-science is a collection of statements that allege scientific support for the Biblical account of creation” (10, p. 1114). All acceptable individual applicants for membership in the Creation Research Society must sign a four-paragraph statement of belief (cited in Pipho 165, p. 224).

## BIBLICAL CREATION AND FLOOD MYTHS

### *The Development of the Pentateuch*

The Hebrew Old Testament consists of three parts: Torah, Nebhiim, and Kethubhim, the Law, Prophets, and Writings. The Torah is called the “Five Books of Moses,” or, by the early Fathers beginning with Tertullian, the Pentateuch. The traditional view is that Moses was the sole author (with the possible exception of the closing verses) of the Pentateuch, including the Book of Genesis (205). Probably Moses was born in the late 14th century B.C. (5).

Jean Astruc (8), in his *Conjectures* (published 1753), accepted the Mosaic authorship but maintained that Moses incorporated in the Pentateuch several older written sources with little alteration (see Figure 1). During the later part of the 18th and the first part of the 19th centuries, biblical scholars continued and modified Astruc’s views, first demonstrating, in the Supplement Theory, that the Elohist portion of the Pentateuch was the older, and that it was later modified by Jehovist additions. The discovery in 1853 by Hupfeld (86) of a second Elohim source led to the Document Theory, the prevailing theory today as modified in the Graf-Wellhausen or Development Theory.

The four documents are identified by their initials as J, E, D, and P: the Jehovistic Document uses the divine name Jehova in the sections prior to the call of Moses. The Elohist Document uses the divine name Elohim. The Deuteronomic Code provides most of the text of the Book of Deuteronomy. The Priestly Document, combining both history and law, is so named because it

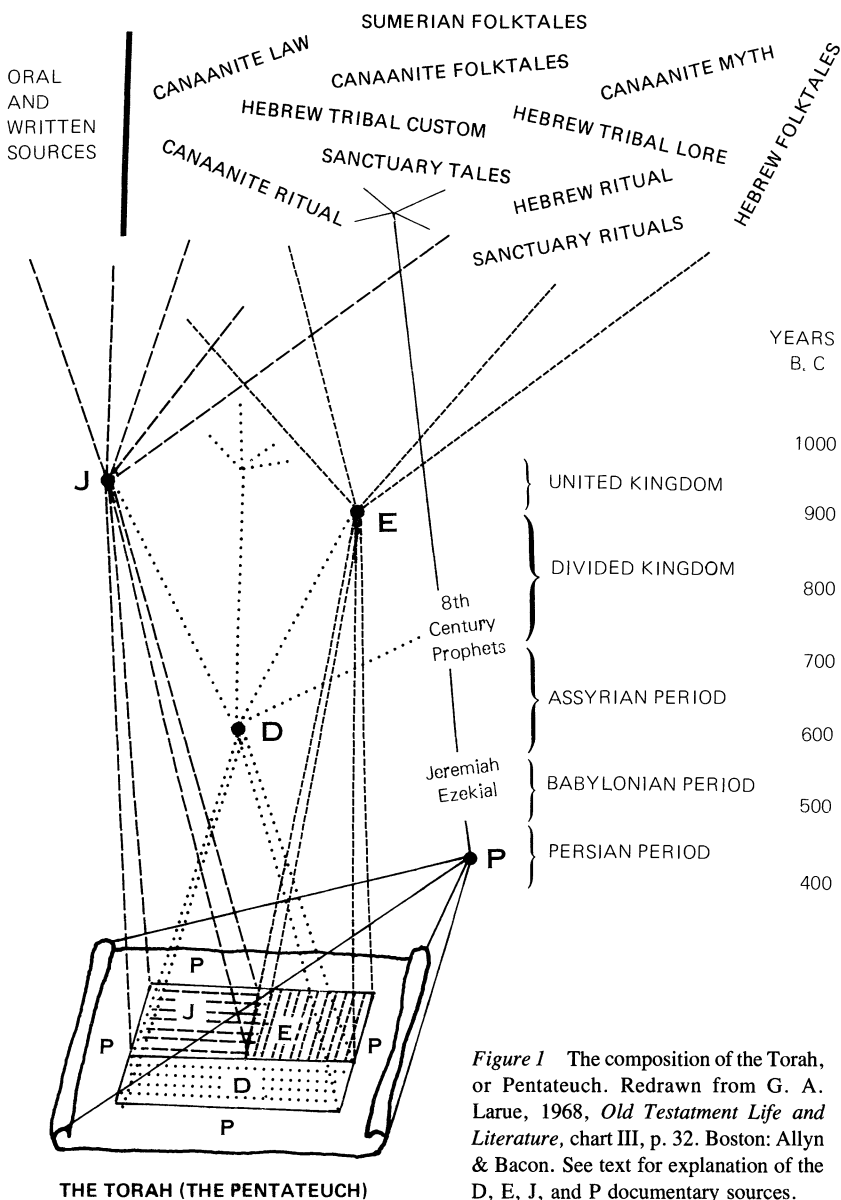


Figure 1 The composition of the Torah, or Pentateuch. Redrawn from G. A. Larue, 1968, *Old Testament Life and Literature*, chart III, p. 32. Boston: Allyn & Bacon. See text for explanation of the D, E, J, and P documentary sources.

was written at a time when priests had a more dominant position in Judah than they had before the exile when prophets were dominant. According to Wellhausen (203, 204), the four documents are thought to have originated in the order J (about 850 B.C.), E (about 750 B.C.), D (about 650 B.C.), and P (about 500–350 B.C.). The language, style, and world view of the J and P documents are very different, and the linguistic peculiarities of the P Document are numerous. The author of J is the best narrator of the Bible (see 58 and various chapters in 54). Noth (152, 153) holds skeptical views on the historical sources of the pentateuch and the traditional role of Moses in the history of Israel. Rowley (176) makes a serious attempt to relate the data of biblical tradition to archaeology, as is done in the works of Albright (5, 6). Some modern biblical scholars prefer to speak of traditions (southern vs northern, royal ideology vs priestly views) rather than, or in addition to, documentary sources (Beyerlin 12, DeVaux 47).

### *The Creation Stories*

The most serious difficulty with a literal interpretation of the creation stories in the Bible is that two strikingly different and contradictory accounts of the creation of humans, male and female, are given in the first and second chapters of Genesis. Comparative mythology demonstrates that similar but somewhat variant creation myths are widespread in the earliest world literatures from the fourth to the first millenium B.C., and comparative linguistic and literary studies of the Bible and other documents in the ancient Near East show that the Genesis story can be traced to older Babylonian and Sumerian stories that are exactly parallel in numerous points but different in ways associated with known cultural differences in the area.

Among anthropologists, probably James George Frazer's *Folklore in the Old Testament* (61) is the best known source. Frazer shows, in the first chapter of Genesis, that on the fifth day God created the fishes and the birds, all the creatures that live in the water or in the air; on the sixth day God created all the terrestrial animals, and last of all man, whom he fashioned in his own image, both male and female. According to Genesis 1, man was the last to be created of all living species, and, incidentally, that bisexuality is shared also by the divinity. "So God created man in his own image, in the image of God created he him; male and female created he them" (Gen. 1:27). But the second chapter gives a totally different, and, indeed, contradictory account of the origin of man. There God created a male human being first, then other species of animals, and a female human being last of all, fashioning her out of a rib which he took from the male in his sleep. In the first story God starts with fishes and creates steadily up the chain of beings to man and women; in the second narrative God begins with man and works downward through the lower animals to woman. The second narrative says nothing about Adam and Eve being made

in the image of God; rather “the Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living soul” (Gen. 2:7).

Speiser (1964) translated Genesis 2:7 as: “God Yahweh formed man from clods in the soil and blew into his nostrils the breath of life. Thus man became a living being.” In the *Notes* Speiser explains (190, pp. 14–16) that here man is Mesoretic Text ‘*adam*’, and “clods in the soil” ‘*dama*’, in assonance with ‘*adam*’, a play on words which the Bible shares with other ancient literatures, but not as mere punning: “Names were regarded not only as labels but also as symbols, magical keys as it were to the nature and essence of the given being or thing” (190, p. 16). Speiser finds the traditional “dust” hard to part with, yet inappropriate in Genesis 2:7, although preferable in Genesis 3:19: “For dust you are/And to dust you shall return.” The theme that the gods created man from earth or clay is widespread in ancient creation myths (61). But as the great physical biologist Alfred Lotka remarked (113, p. 197): “We are indeed earth born, but yet not altogether common clay. Indeed, taken literally the expression ‘common clay,’ as applied to man, is an extreme case of poetic license; for aluminum and silicon—the chief constituents of clay, and taking second and third place in rank of abundance among the components of the earth’s crust, are both present only in traces in the human body.”

According to Graves & Patai, the writers of Genesis represented Eve as formed from Adam’s rib, “an anecdote based apparently on the word *tsela*, meaning both ‘rib’ and ‘a strumbling’ (72a, p. 15).”

Modern biblical scholarship derives Genesis 1 from the P Document and Genesis 2 from the J Document (Speiser 190). As Frazer (61, p. 2) put it: “The flagrant contradiction between the two accounts is explained very simply by the circumstance that they are derived from two different and originally independent documents, which were afterwards combined into a single book by an editor, who pieced the two narratives together without always taking pains to soften or harmonize their discrepancies.”

The striking correspondence in detail and order of events that preclude coincidence and demonstrate derivation of the Genesis creation story from the earlier Enuma elish story is shown in the tabulation given by Heidel (79, p. 129):

| <i>Enuma elish</i>                                         | <i>Genesis</i>                                                      |
|------------------------------------------------------------|---------------------------------------------------------------------|
| Divine spirit and cosmic matter are coexistent and eternal | Divine spirit creates cosmic matter and exists independently of it  |
| Primeval chasos; Ti’amat enveloped in darkness             | The earth a desolate waste, with darkness covering the deep (tehom) |
| Light emanating from the gods                              | Light created                                                       |
| The creation of the firmament                              | The creation of the firmament                                       |
| The creation of dry land                                   | The creation of dry land                                            |
| The creation of luminaries                                 | The creation of luminaries                                          |
| The creation of man                                        | The creation of man                                                 |
| The gods rest and celebrate                                | God rests and sanctifies the seventh day                            |

It is clear that the cuneiform *Enuma elish* story is older than the P Document Genesis story, and is most probably its cultural source. There is no basis in fact for assuming an unknown common source for both the Mesopotamian and the Hebrew stories (79, 190).

All well-qualified Old Testament scholars reject a literal interpretation of the Genesis creation poems, as well as the notion that Genesis 1 is a scientific account in the modern sense (57, 58, 79, 80, 172, 190). Paul Tillich (196, 1:252), a philosophical theologian, concluded regarding Genesis 1: “The doctrine of creation is not the story of an event which took place ‘once upon a time.’ It is the basic description of the relation between God and the world.” And in his extensive study of the biblical creation account, Langdon Gilkey (65, p. 260) wrote: “It is a true, although not literal, affirmation about the relation of the whole system of facts in the world to their Creator God.”

### *The Genesis Flood Stories*

The flood myth of Genesis 6:5 to 9:17, often called Noah’s Flood or the Noachian Deluge, repeats a theme found in many ancient Near Eastern traditions that describe a primordial destruction of the earth because of man’s wickedness, with a faithful few being allowed to survive by intervention of God (or several gods), and the building of a huge boat or ark (61, 162). The biblical flood story clearly goes back to Mesopotamian sources originating with the Sumerians of the 4th millennium B.C. and is a part of the world’s oldest known literature (166, 186). Reliable translations of the flood myth texts may be found in Pritchard (169); see also Jacobsen (87, 88), Kramer (97–99), and Speiser (190). Heidel provides a detailed discussion of Gilgamesh (79). Oppenheim (155) presents a good general account of the cultural background of Mesopotamia. Peake (163) reviews the world literature on flood myths.

Like the creation account, the Genesis flood story is a composite narrative; clearly one of the sources goes back to P, and probably J is the only other author involved (190). As in the Genesis account of the creation of man, there are obvious internal contradictions in the Genesis account of the flood, especially regarding the numbers of the various animals taken into the ark and the time schedule of the flood (190, p. 54).

Contenau (34, 35) speculates that the widespread flood myths of the ancient cultures record memories of the worldwide elevation in sea level at the end of the Pleistocene. Although the rise in sea level from the maxima of the Main Wurm and Wisconsin glaciations some 18,000 years B.P. was about 120 meters, and sufficient to drown the mouths of large streams in many parts of the world, the average rise in sea level was only 7–8 millimeters per year (60), so that it seems unlikely to be classified as a “flood.”

In its full form, the Babylonian Flood Story contains nine points, and the same sequence of nine points occurs in the flood account from the Old Testament (58, pp. 42–43):

*Babylonian Cuneiform*

1. The gods decide to make a flood
2. The god Ea warns Artarhasis to build a ship
3. He is to take his family and animals aboard
4. The flood turns mankind into clay
5. The ship grounds on Mount Nisir
6. Artarhasis learns when the waters have subsided by sending out a dove, a swallow, and a raven
7. He offers sacrifice to the gods
8. The gods smell the sweet savor
9. The god Enlil blesses Artarhasis and his wife

*Genesis*

1. The Lord decides to destroy wicked mankind
2. The Lord warns Noah to build an ark
3. Noah is to take his family and animals aboard
4. The flood destroys all flesh
5. The ark comes to rest on the Ararat mountains
6. Noah learns when the waters have subsided by sending out a dove, a swallow, and a raven
7. He offers sacrifice to the Lord
8. The Lord smells the pleasing odor
9. God blesses Noah and his sons

*The Historical and Archaeological Deluges*

In 1929, excavating almost simultaneously, Langdon at Kish (101) and Woolley at Ur (211) announced archaeological evidence of the biblical flood. Mallowan (115) and Raikes (170) reexamine the historical and archaeological evidence on Noah's flood. Mallowan (116, p. 243–44) reached these conclusions: although the flood was not universal, it was exceptional among the long series of various cities in southern Babylonia; there are good reasons for claiming that alluvial mud deposits observed at Ur, Kish, and at Farah (Shurup-pak) correspond with those described in the Gilgamesh epic and transmitted, perhaps through Canaanite myths, to the Old Testament; this flood was during the reign of the Sumerian king named Ziusudra at Shuruppak, precisely where a clean flood stratum has been found; and Ziusudra may be taken to mark the end of Early Dynastic I, for he was succeeded by a new dynasty at Kish which begins E.D. II.

In a review of Mesopotamian carbon-14 dates, Wright (212, p. 96) estimates that Early Dynastic I Period began after 3100 B.C. and ended 2800 B.C.

The Ur "flood" is now dated Late 'Ubeid at about 4500 B.C. The Abu Salabikh (Fara) flood is dated Early Dynastic I (about 2900 B.C.), and the Kish flood E. D. II (about 2700 B.C.), according to Moorey (135, p. 86). Thus the Fara and Kish floods, but not the Ur "flood," could be contemporary within their own range of carbon-14 dating errors. The floods at Fara and Kish, as Mallowan maintains, probably correspond to Noah's deluge.

Seemingly, in the absence of special field techniques not yet widely used in Mesopotamian excavations, "flood" layers are difficult to identify (103, 105). The Ur "flood" layers may be a dust dune (210a). The dune contains burials that are shallow and closely spaced throughout the period of deposition, precluding a long period under water (H. Wright 1984, personal communication). The

“flood” clay at Ur may be from melted mud bricks (103). Kirkby (96) shows that the “flood” layer at Dar-Ul-Kazineh, investigated by Harmer & Thomas (cited in 105, pp. 32–33), is part of a piedmont colluvium.

### *A Post-Pleistocene Cataclysmic Flood*

The Great Spokane Flood in Idaho and Washington at the end of the Pleistocene is probably the largest and most cataclysmic river flood known from geological evidence (7, 151). It occurred about 12,000 B.P. when a melting ice dam let out 3,300 cubic kilometers of water trapped in the Glen Fork tributary valley of the Columbia River in glacial Lake Missoula. According to Alden (7), the water reached a maximum flow of about 64 cubic kilometers per hour, equal to about ten times the normal flow of all rivers in the world. The flood covered nearly 8000 square kilometers of plateau land, extending far beyond the original river valley. Large current “ripples” of boulders and gravel were produced transverse to the direction of the flood torrent, forming a “channeled scabland.” Newell (151) states, “While by no means a common event, the Spokane Flood is an example of a perfectly natural, if cataclysmic, process. If the flood geology of creationists were true, all the lands of the world would resemble the channeled scabland of Washington” (151, p. 40).

### *Biblical Chronology*

The creationists accept 17th century estimates made by biblical scholars of the age of the world and of Noah’s flood. Using several independent lines of evidence, most modern scientists estimate that the planet earth is older by six orders of magnitude (1), and that the origin of man (genus *Homo*) is greater by three orders of magnitude (19).

In order to have a critical understanding of “creation science” doctrine, it is necessary to examine the historical basis of such estimated biblical chronology.

James Ussher (1581–1656), sometimes written Usher, Archbishop of Armagh in Ireland and Vice Chancellor of Trinity College, Dublin, concluded from his extensive Old Testament studies, published 1650–1654 in *Annales Veteris et Novi Testamenti* (197), that earth and man had been created in 4004 B.C. His chronology was inserted in the margin of reference editions of English translations starting with a King James I Version issued in 1703 down to the Berkeley Version of 1959 (58). Carr (24) wrote a biography of Ussher.

Ussher inferred the date of the creation from the genealogies recorded in Genesis that tell the sequence of patriarchs and how old each patriarch was when his oldest son was born. Ussher followed the Hebrew text, adding the successive figures back from the Temple of Solomon (placed by modern scholars at either 968 B.C. or 959 B.C.), to date the Flood in 2349 B.C., 1656 years after the creation of Adam in 4004 B.C. Some difference of dating was possible because of textual ambiguities and differences between the Septuagint (with 2242 years from Adam to the Flood) and the Hebrew or Samaritan texts

(with 2262 years). For example, Dr. John Lightfoot (1828–1889), Vice-Chancellor of Cambridge University and Bishop of Durham, placed the creation at 3928 B.C. Both scholars were more interested in establishing the birthdate of Jesus Christ, which most scholars today place either in the spring of 4 B.C. or in midwinter 5/4 B.C., say in December, 5 B.C. (59, p. 298), rather than the date of creation.

Daub (43) shows the widely quoted statement from A. D. White in *History of the Warfare of Science with Theology in Christendom* that “. . . man was created by the Trinity on October 23, 4004 B.C. at nine o'clock in the morning” (206, 1:9; Daub incorrectly cites 1895, p. 59). This quotation is not from Lightfoot's words (1822) but from the editor of his collected works, John Rogers Pitman, who accepted the year estimate of 4004 among several based on the Hebrew texts, and presented, in an editorial note to Ussher's text, the statement “Creation of the world (Sunday, Oct. 23) . . .” (111, 2:445.) Lightfoot himself supported the day as September 12 (then taken as the day of the autumnal equinox, as England had not yet adopted the Gregorian Calendar). Lightfoot supposed in commenting on Genesis 1:26 that man was created about the third hour of the Hebrew day, or about 9 o'clock in the morning. Opinion differs as to the day of the week, but some assume that the work of creation must have been completed on a Friday, since God rested the next day on the sabbath, Saturday.

Finegan (58) provides a detailed exposition on the principles of time reckoning in the ancient world and the problems of biblical chronology. It is interesting to note that Ussher's date for Noah's flood is 2349 B.C., the date from stratigraphic archaeology is about 3000 B.C., and that the modern estimate from carbon-14 is about 2800 B.C.!

## “SCIENTIFIC” CREATIONISM AND THE COURTS

Of the three divisions of the American government, the courts have been more decisive in the evolution-creationism controversy than the executive or the legislative branches.

The courts have countered the creationist attempt to forbid the teaching of evolution in the public schools, to require that creationism be taught in the schools as science, to demand that it be given equal time with evolution; they have denied that “creation science” is a science. Three major trials require special mention: *Scopes v. Tennessee* in 1925, *Epperson v. Arkansas* in 1968, and *McLean v. Board of Education* in 1982.

The legal literature on the controversy is substantial. Le Clercq (104) considers at length the constitutional implications of the creationist efforts; his paper is an excellent starting place for the layman, with full citations of the cases. Wood (210) provides a nonlegal summary of issues on “scientific creationism” and the public schools. O'Neil (154) has a good introductory

treatment of creationism, curriculum, and the constitution. Other valuable law review papers include Benkov & Rothstein (10), Lines (112), Greenberg (74), Gordon (69) with special attention to legal aspects of treating “creation science” as science, Dean (44) with regard to equal treatment problems, Taylor (195) concerning the McLean case, and Melnick (125), who argues that the influence of secular humanism has altered the very nature of the common law and the legal system away from the theistic concepts of law important in the foundation of western European civilization (125, 175). For philosophical and historical origins of constitutionalism see Friedrich (62) and Peaslee (164); for a general treatment of the United States Constitution see Corwin (38).

The complete text of the First Amendment to the Constitution is: “Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech or of the press; or the right of the people peaceably to assemble and to petition the Government for a redress of grievances.” The 14th Amendment holds that citizenship rights are not to be abridged.

The Establishment and The Free Exercise Clauses have been of first importance in High Court decisions regarding the creation-evolution controversy (Le Clercq 104). A three-part test of the constitutionality of each law or act in question has emerged from establishment clause litigation: 1. a clearly secular legislative purpose, 2. a primary effect that neither advances nor prohibits religion, and 3. an avoidance of excessive governmental entanglement with religion. The Court repeatedly has recognized that tension inevitably exists between the Free Exercise and the Establishment Clauses. In order not to promote one without offending the other, states are required to maintain an attitude of “neutrality,” neither “advancing” nor “inhibiting” religion [413 U.S. 788 (1973)].

### *Scopes v. State of Tennessee*

Some legal scholars consider the Scopes or “Monkey” trial the most famous of all American court cases (106). Scopes was found guilty of teaching evolution as charged, but Tennessee’s antievolutionary law was left intact. The trial received wide public attention because of the bizarre nature of the case, including the court’s permitting Bryan to be a witness severely questioned by Darrow, but not permitting any of the defense scientific witnesses to take the stand. Scopes did much to defuse the political clout of the antievolutionary movement. The trial judge assessed a fine of \$100.00 and Scopes appealed to the Tennessee Supreme Court. Although the court found that the statute itself was upheld, the assessment of the \$100.00 fine against Scopes was found in violation of the Tennessee State Constitution which required any fine over \$50.00 to be assessed only by jury. Since the statute in question provided for a minimum fine of \$100.00, the court had no power to correct the error, and the

lower court judgment was accordingly reversed. In order to put “the bizarre case” to rest, a *nolle prosequi* was suggested to the attorney general. Scopes went free, later to do graduate work in geology at the University of Chicago, and to work as a geologist for the Gulf Oil Company (30).

Kalven (92) concluded: “Along with the Sacco-Vanzetti case, it [Scopes] was one of the law cases of this century that drew the attention of the world to America. The case is at once regarded as a milestone in the history of American freedom and as a case that made America ridiculous in the eyes of the civilized world.”

An exhaustive report of Scopes is in DeCamp (45). Fay-Cooper Cole, Professor of Anthropology at Chicago, was Darrow’s expert on human evolution; Cole wrote an excellent account of the trial (30). Grabiner & Miller (72) hold that Scopes was not a victory for evolutionists, because the chilling effect of the antievolution laws from 1925 on resulted in a downgrading of evolution in nearly all high-school textbooks (see also 31).

When fundamentalist-sponsored legislation failed to eliminate the teaching of evolution in the public schools, the special creationists attempted to impose their minority view by way of school board regulation or state legislation requiring “balanced” teaching of a “theory of creation” alongside the theory of evolution (130, 199). The effort was nearly successful before the California Board in 1972 (129), but the attempt to secure their goals through litigation also failed (112).

### *McLean v. Arkansas Board of Education*

The full text of the opinion by United States District Judge William R. Overton in *McLean v. Arkansas* has been reprinted (158–160); it is essential reading for anyone wishing to understand the current creationism-evolution controversy. Sullivan (194) presents an eyewitness account, and Parker (161) traces the history behind the *McLean* case.

The courts have avoided an inflexible definition of religion (10, p. 1140), using instead ideas and activities associated with traditional religions as a guide. For example, as in *McLean*, the courts have held that the concept of a supreme being is inherently religious and, therefore, because creation science presupposes the existence of supreme being and creator, will be considered religious.

The *McLean* court found that “a central premise [of fundamentalism] was always a literal interpretation of the Bible and a belief in the inerrancy of the Scriptures” (Judge Overton, 529 F Suppl. at 1259, 1981).

Creation science is a collection of statements that allege scientific support for the biblical account of creation of the earth, living organisms, and man. The creationists have attempted to secularize their religious beliefs in a “Scientific Creation Model” (13, 14).

In finding that the Arkansas Balanced Treatment Act had a primary effect of advancing religion, and thus was unconstitutional on the establishment clause, the court in the McLean case identified a legal definition of science based on the testimony of Ruse and other scientific witnesses. Judge Overton ruled that “. . . in a free society, knowledge does not require the imprimatur of legislation in order to become science. More precisely, the essential characteristics of science are: 1. It is guided by natural law; 2. It has to be explanatory by reference to natural law; 3. It is testable against the empirical world; 4. Its conclusions are tentative, i.e. are not necessarily the final word; and 5. It is falsifiable” (159, p. 175). Gordon (69, pp. 394–400) gives an excellent exposition of the scientific and legal aspects of the Overton definition. Background for the testimony of M. Ruse on the nature of science may be found in his *Philosophy of Biology* (177).

The court in the McLean case noted that settled case law rejected the contention that the theory of evolution is as unscientific as is creationism (see 69, notes 4 and 85, for legal details). Gordon (69, pp. 399–400) further shows that the theory of evolution exhibits the characteristics of science according to the legal definition.

“By utilizing the definition of science developed in McLean, courts facing future lawsuits in the creation–evolution controversy will be able to determine whether a state’s activity is a legitimate exercise of its authority to determine the public school science curriculum” (Gordon 69, pp. 401–2).

“Since McLean is a trial court opinion, it can only follow the precedents of higher courts. However, this opinion demonstrates the difficulty ahead for other states which try to enact similar legislation. This case shows that under the present constitutional framework, no creation-science statutes which follow the approach of Act 590 will survive constitutional scrutiny” (Taylor 195, p. 329).

Bible study courses may be offered in public school without violating the constitution if they are “so planned and so taught as to constitute a secular and objective study of the Bible for its historic and literary worth” (Wiley v. Franklin 1979).

The federal courts have traditionally opposed state enactments prohibiting teaching evolution in public schools (10, 44, 74, 104). Also, state laws requiring equal time for teaching divine creation when evolution is taught have also been generally invalidated. Given the strength and organization of fundamentalist, Bible inerrant minority, and the nature of election and appointment to public office, antievolutionary regulations and state laws will continue to appear in the Bible Belt states. As Greenberg concluded (74, p. 486): “The persistence of the groups which back the bills has been unyielding, and the current reappearance of the laws in the form of balanced treatment acts indicate that the controversy is far from resolved.”

### *The Creationist Textbook Watchers*

Some fundamentalists claim that the teaching of evolution from public school textbooks is a root cause of the recent decline in the quality of grade and high school education in America, as documented by the Carnegie Report (23). Nelkin (148, 149) calls these critics the "Textbook Watchers." Her book is a defense of science against creationism with particular reference to the creationism-evolution controversy. She reports the dispute about a proposed curriculum in evolutionary anthropology called *Man: A Course of Study*.

In 1982, 17 states required that a public school textbook must be cleared by state authorities before a local district can buy it. The textbook watchers are particularly effective in Texas and California (129, 181, 188). The Texas textbook adoption system makes that state the largest mass purchaser of textbooks in the nation (53), with a textbook budget of \$64 million in 1983 (81). Weinberg reports that, on Mrs. Gabler's initiative, "the [Texas] Board of Education adopted the requirement that texts which present evolution must treat it only as a theory, not as verifiable fact; must carry a statement to this effect in the front of the book; and must identify evolution as only one of several explanations of origins" (202, p. 543). Most of the watchers are intelligent, devoted, if misguided people. Sometimes their published statements exhibit more zeal than knowledge. Weinberg (202) relates that a lady from Mansfield, Texas, expressed skepticism that American cattle breeders use culling and artificial insemination as reported in a textbook, and asked: "On what facts are these assumptions based?" Hefley (78) gives a highly laudatory report on Norma Gabler of Texas, a leading textbook watcher.

The Textbook Watchers do have some effective, official opposition. The Board of Education of New York City decided in 1982 to reject the use of three biology texts because their treatment of evolution was not sufficiently thorough, and two texts were additionally unacceptable because of an uncritical endorsement of creationism. The texts were published by Prentice-Hall, Laidlaw Brothers, and Burgess Publishing Co. (*New York Times*, June 24, 1982, pp. A1, D23.) On June 25, 1982, a *New York Times* editorial entitled "A Fundamental Confusion" carried the following opening and closing paragraphs: "Censorship is shameful but bowdlerization is ridiculous. Textbook publishers commit both when, in surrender to certain fundamentalists, they put out texts on biology that soft-pedal its unifying explanatory system, the theory of evolution." . . . "The creationists' misplaced desire to protect their children's faith by attacking Darwin is a confusion that should not be extended into the classroom. Yet they have received misplaced encouragement from too many legislatures, school boards and compliant publishers. It was high time someone said no."

In 1984 two developments reversed the recent successes of the Textbook Watchers in Texas and Louisiana. Following a report critical of the quality of

public education in Texas by a commission headed by industrialist Ross Perot, the sitting Board of Education was declared unconstitutional and replaced by a board more receptive to the teaching of evolution. Of the five biology texts approved by the new board, none mention biblical creationism (*Washington Post*, 2 Dec. 1984).

## THE FACTS AND THEORIES OF EVOLUTION

### *The General Theory of Evolution*

There are three great realms of general evolution: 1. cosmic evolution (22, 27, 37, 182), the development of the universe, the solar system, elements and substances, the continents, oceans, and atmosphere of earth; 2. organic evolution (50, 144, 183, 213–216), the development of living things; and 3. cultural evolution (123, 173, 192, 207), the development of human language and cultural behavior. The claims against evolution by “creation science” are contradicted by scientific facts and theories in all three realms of general evolution.

The general idea of “evolution,” like that of “life,” is difficult to define. Dobzhansky (48) suggests that “sustained change” comes as close as possible at present to a general definition. See Lewontin (108) for extensions of the general concept, and Bowler (18) for a convenient history of different meanings of the term “evolution.”

Sorokin (189) held that evolution is “a dominant category of sensate mentality,” and that “The standpoint of ‘origin and development and evolution’ is our main standpoint in studying anything, from religion to the stock market. It has rooted itself in our minds so deeply that many of us cannot even conceive of any other—nonhistorical, or nonevolutionary, or nondevelopmental—approach to the study of any phenomenon.”

The central idea of evolution in its simplest form is that the current state of a system is the result of cumulative change from its original state, and that changes in structure and function of the system follow uniform laws. This may be called the narrow definition of general evolution. The narrow, minimal view becomes an increasingly broad set of views on evolution by adding one or more considerations: order, direction, progress, and perfectability (108). None of the broad evolutionary notions can be made a part of the minimal, narrow definition, because they do not hold for one or more of the important special realms of general evolution (37, 109).

The evolutionary view of things and events opposes a static view of the world, whether the stasis of a universe created only once, as in the Old Testament creation stories, or one created several times, as in the catastrophic view of Cuvier (42). Evolution involves the opposite ideas of persistence and change, but neither ceaseless change nor unchanging persistence is a part of

evolution. Historically the conception of evolution is the development of a variety of entities, whether celestial bodies, chemical elements, geological formations, biological species, languages, items of material culture, economic or other cultural systems, by some dynamic process of cumulative change. New kinds of entities emerge as the outcome of change and then persist for a time after the new kind.

The theory of evolution is a fundamental part of a wide variety of modern sciences including astronomy, geology, botany, zoology, anthropology, linguistics, and economics (82). Today some consider evolution as mainly part of biology and as starting in 1859 with Charles Darwin. In fact, the theory is much older; Kant (93) and Laplace (102) published evolutionary accounts of the formation of suns and planets. The linguist William Jones (89) suggested that the similarities between Celtic, German, Greek, Latin, Persian, and Sanscrit languages could be explained by evolution from a common ancestral language (Greenberg 73). According to Singer (185), the first exact usage of organic evolution in the modern sense was in Lyell's *Principles of Geology* (114).

### *Organic Evolution*

Life is not one of the fundamental categories of nature such as matter, energy, space, and time, which exist everywhere in the universe. Life was manifested only in certain biomolecules, especially nucleic acids and proteins. Life occurs in an environment where a system of macromolecules is capable of undergoing natural selection (41). This kind of environment and those kinds of large molecules could not exist when the earth was molten and will not exist when it becomes cold. Life on earth had a beginning and will have an end.

At an abstract genotypical level elegantly treatable with mathematics, the evolution of life is a history of cumulative change in gene frequencies (Dobzhansky et al 50, Wright 213–216). Evolution is the master concept of biology (49, 183). The ideas of evolution connect with and cut across all the large divisions of biology—genetic, structural, regulatory, developmental, and environmental.

The evolutionary path of life started when molecules capable of undergoing natural selection came into being, perhaps three to four billion years ago (22). Three processes define living organisms: 1. Organisms metabolize; they take raw materials from the outside and remake them inside into substances of the sort characteristic of the species and line. 2. Organisms replicate, then give rise to descendant organisms of the same variety. 3. Organisms mutate; some offspring are varied genetically but are capable of further replication in the mutant form.

Biological evolution proves that animals and plants living today are descended from different species living in the past, some leaving fossils that give historical evidence of phylogenetic relationships. The mechanism of evolution

at the genotype-phenotype level is expressed in three principles: variation, heredity, and natural selection: 1. Members of a species are variable in structure, function, or behavior. 2. Some of the variation is inherited genetically. 3. Different variations have different rates of survival and reproduction in different environments, that is, the variation is subjected to natural selection. Four processes control the frequencies of genes in breeding populations: mutation, gene flow, selection, and genetic drift. Three systems of mating control the distribution of genes in genotypes: random, inbred, and assortative mating. The interaction of genotypes and environments control the expression of phenotypes. Variant phenotypes are subject to natural selection (77, 187, 213–216).

Evolutionary history displays both continuities and discontinuities, both unity and diversity. The unity of organisms is shown by the universality of the genetic code. Except for mitochondrial DNA, the genes of all organisms from virus to man are made of six molecules: two purines, two pyrimidines, a phosphate, and a sugar. All proteins of all organisms are synthesized from members of an identical set containing 20 amino acids, some of which are modified after being incorporated in the primary gene product.

Evidence for the facts of organic evolution, accumulated in the past 120 years, is from many different fields—biogeography, taxonomy, comparative anatomy, embryology, paleontology, biochemistry, genetics, cell physiology, and the study of cultivated plants and domestic animals (39, 183, 184, 215). Each field presents a body of data easily understandable on an evolutionary basis, but incomprehensible or even contradictory on any known theory in opposition. Everyone of open mind who has examined and understands the evidence—which takes some years of study to do—believes in the facts of evolution. There is a good deal of doubt as to some of the mechanisms of evolution, and as to the details of phyletic relations within some lines (55), but the general fact of organic evolution is as firmly established as the general fact of gravitation, or any other scientific theory (50, 109, 183, 187).

### *Molecular Evolution*

There are two levels of organic evolution, the evolution of phenotypes and the evolution of molecules, especially the information molecules in the eukaryotic cell (95). Molecular biology has made spectacular progress in the three decades since Watson and Crick established the molecular structure of DNA, the genetic material (see 4). The concepts and methods of molecular biology furnish new insights into evolutionary processes and new methods in phylogenetics (9, 91). Molecular evolution makes possible identification of nodes in phylogenetic trees (points of origin of new species), and molecular clocks attach absolute dates to those branching points with acceptable accuracy (9).

## CREATIONIST ARGUMENTS AGAINST EVOLUTION

### *The Second Law of Thermodynamics*

Creationists repeatedly claim that evolution would violate the Second Law of Thermodynamics (Morris 141) because evolution implies the historical emergence of more highly ordered species that have lower entropy. Entropy is a quantity that measures the amount of energy in a system that is not available for doing work. One part of the Second Law, the Principle of the Increase of Entropy, states that the entropy of an adiabatically isolated system can never decrease (136). But the earth and the species that evolve on earth are not adiabatically isolated; for instance, they take in energy from the sun; thus the claim is false (15, 76, 143). Morris (141) accepts the fact that the earth is not an isolated system, but then repeals the Second Law by fiat: “the Second Law really applies only to open systems, since there is no such thing as a truly isolated system.”

As Lotka (113) pointed out 60 years ago, if we consider that herbivores only appear to be hungry for grass, but that the grass is really hungry for oxygen with the animal performing a catalytic function, then energy is not diverted from its Second Law degradative trend in order to propagate and evolve species; rather the evolution of organisms is secondary to, in service of, and consonant with all natural processes that increase entropy (Black 15).

### *Failure to Observe Intermediate Steps in the Fossil Record*

Creationists argue that gradual evolution is impossible because an eye or a middle ear must be complete and work perfectly in order to be favorably selected. Perhaps the most spectacular, gradual, morphological transition in the phylogeny of the vertebrates is the evolution of the mammalian masticatory apparatus and middle ear bones, a transition that is extremely well documented in comparative anatomy, embryology, and paleontology (40, 171, 174).

### *Failure to Directly Observe Evolution of Species*

Creationists have claimed repeatedly that no living person has observed or will ever observe evolution from one “kind” of organism to another (66). The fact that plant and animal breeders have produced many new varieties of domesticated plants and animals led the creationists to redefine the biblical “kinds” as taxa above the species level or to make up undefined taxa (65, pp. 30–40; 139, p. 29).

Several new species have been created, or recreated, naturally or experimentally, and this trans-specific evolution has been observed directly (Stebbins 191). The grass *Spartina townsendii* is a wild species known to have originated in historic times under human observation. Huskins (84) showed that

it is an allopolyploid derived from a natural cross between *S. alterniflora*  $\times$  *S. stricta*. Several new artificial species were made by hybridizing two related species or even genera of plants; while many such hybrid plants are sterile, some that undergo chromosome doubling (polyploidy) are fertile, true breeding, and reproductively isolated from both parental species. Clausen & Goodspeed (26) synthesized a new species of tobacco, *Nicotiana digluta*, by hybridizing *N. tabacum*  $\times$  *N. glutinosa*. One of the most spectacular of the experimentally created plant species is *Raphanobrassica* made by Karpenchenko (94), who crossed plants belonging to two different genera, a radish and a cabbage. Both the common radish *Raphanus sativus* and the cabbage *Brassica oleracea* have 9 pairs of chromosomes. The first-generation hybrid produced a few tetraploid seeds with 18 pairs of chromosomes, representing the entire genome of both parental species. *Raphanobrassica* is not important as a food plant because it has a cabbage-like root and a radish-like foliage. But the new species produces tall and vigorous plants which breed true and are reproductively isolated from both parental species. Muntzing (146) was the first to recreate experimentally a well-known Linnean species, the hempnettle *Galeopsis tetrahit*. A native of Eurasia, introduced into northeastern United States, this plant has  $2N = 32$  chromosomes, while the related species of this mint family genus, *G. speciosa* and *G. pubescens*, has  $2N = 16$ . Muntzing crossed the latter two species to produce polyploid hybrid offspring with  $2N = 32$ . The newly created tetrahit plants are identical in morphology with the natural ones, cross freely with them, and produce fertile hybrids with normal mitotic and meiotic cell divisions. McFadden & Sears (121) experimentally resynthesized a species of bread wheat that is a naturally existing allopolyploid species. This is a case where a species that became completely extinct could be artificially recreated!

Species formation by allopolyploidy is widespread and important in some plant families; it is uncommon in vertebrates including mammals, mostly because the process upsets the specialized chromosomal, sex-determination mechanism (50). Among vertebrates, speciation often results from the gradual accumulation of genetic differences between geographically isolated (allopatric) populations followed by emergence of reproductive isolation between them (50, 118, 119). By means of laboratory selection through many generations, Dobzhansky & Pavlovsky (51) experimentally created the Llanos incipient species of *Drosophila* which exhibited behavioral (sexual) isolation from its ancestral Orinocan semispecies of *D. paulistorum*.

The H3 hemagglutinin genes of two strains of Hong Kong influenza virus illustrate very rapid evolution. Sequencing shows that each gene contains 1701 nucleotide sites. In the two strains, 63 sites have different nucleotides, 34 of these representing silent substitutions, so that the two strains differ by 28 amino acid substitutions. The degree of protein evolution by gene mutation and amino

acid replacement corresponds to the evolutionary change in mammalian hemoglobin genes over 30 to 50 million years. Yet the time of divergence in the influenza virus strains is only 7 years (198).

Scientific refutations of other major arguments against evolution by "creation scientists" include: (a) the Young Earth claim, that the earth and universe are only about 10,000 years old (1, 20, 22, 28, 145); (b) improbability of the Random Origin of Life (22, 52); (c) the concept of natural selection is tautological and untestable (70, 76, 117, 128); (d) Noah's flood was universal and destroyed all living species not aboard the ark (68, 151).

## CONCLUSION

"In all modern history, interference with science in the supposed interest of religion, no matter how conscientious such interference may have been, has resulted in the direst evils both to religion and to science, and invariably; and, on the other hand, all untrammelled scientific investigation, no matter how dangerous to religion some of its stages may have seemed for the time to be, has invariably resulted in the highest good both of religion and of science" (A. D. White, 206, p. viii).

## Literature Cited

1. Abell, G. O. 1983. The ages of the earth and the universe. See Ref. 67, pp. 33-47
2. Adler, M. J. 1941. Solution of the species problem. *Thomist* 3:279-379
3. Adler, M. J. 1967. *The Difference of Man and the Difference it Makes*. New York: Holt, Rinehart & Winston
4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J. D. 1983. *Molecular Biology of the Cell*. New York: Garland
5. Albright, W. F. 1957. *From the Stone Age to Christianity: Monotheism and the Historical Process*. Baltimore: Johns Hopkins Press
6. Albright, W. F., Mann, C. S. 1971. *Matthew. The Anchor Bible*, Vol. 26. Garden City, NY: Doubleday
7. Alden, W. C. 1953. Physiography and glacial geology of western Montana and adjacent areas. *U.S. Geol. Surv. Prof. Pap.* 231
8. Astruc, J. 1753. Conjectures sur les memoires originaux dont il paroît que Moyse s'est servi pour composer le livre de las Genese. A Bruxelles, chez Friex
9. Ayala, F. J., ed. 1976. *Molecular Evolution*. Sunderland, Mass: Sinauer
10. Benkov, J. L., Rothstein, M. 1982. The lessons of creation-science: Public school curriculum and the religious clauses. *Fordham Law Rev.* 50:1113-56
11. Benoit, P. 1961. *Prophecy and Inspiration*. New York: Cerf
12. Beyerlin, W. 1966. *Origins and History of Old Sinaitic Traditions*, transl. S. Rudman. Oxford: Blackwell
13. Bird, W. R. 1978. Freedom of religion and science instruction in public schools. *Yale Law J.* 87:515-70
14. Bird, W. 1979. Freedom from establishment and unneutrality in public school instruction and religious school regulation. *Harvard J. Law Public Policy* 28:125-205
15. Black, S. 1978. On the thermodynamics of evolution. *Perspect. Biol. Med.* 14:348-56
16. Bliss, R. B. 1978. *A comparison of two approaches to the teaching of origins of living things to high school biology students in Racine, Wisconsin*. PhD thesis. Univ. Sarasota, Fla.
17. Boadt, L. 1982. Countering the creationists: The theologian. *Academe* 68:17-20
18. Bowler, P. J. 1983. The changing meaning of "evolution." *J. Hist. Ideas* 36:95-114
19. Brace, C. L. 1983. Humans in time and space. See Ref. 67, pp. 245-82
20. Brush, S. C. 1983. Ghosts from the nineteenth century: Creationists arguments for a young earth. See Ref. 67, pp. 49-84

21. Burgon, J. W. 1861. *Inspirations and Interpretations*. Oxford: Parker
22. Calvin, M. 1969. *Chemical Evolution*. Oxford: Clarendon
23. Carnegie Foundation for the Advancement of Teaching. 1977. *Missions of the College Curriculum*. San Francisco: Jossey-Bass
24. Carr, J. A. 1895. *The Life of James Ussher, Archbishop of Armagh*. London: Gardner, Darton
25. Carter, J. 1976. Jimmy Carter on evolution. *Humanist* 36(6):2
26. Clausen, R. T., Goodspeed, T. H. 1925. Interspecific hybridization in *Nicotiana*, II. A tetraploid glutinosa-*Tabacum* hybrid, an experimental verification of Winge's hypothesis. *Genetics* 10:279-84
27. Cloud, P. 1972. Scientific creationism—a new inquisition brewing. *Humanist* 37:6-15
28. Cloud, P. 1978. *Cosmos, Earth, and Man: A Short History of the Universe*. New Haven: Yale Univ. Press
29. Cohen, M. R., Nagel, E. 1934. *An Introduction to Logic and Scientific Method*. New York: Harcourt, Brace
30. Cole, F.-C. 1959. A witness at the Scopes trial. *Sci. Am.* 200(1):120-30
31. Cole, J. R. 1983. Scopes and beyond: Antievolutionism and American culture. See Ref. 67, pp. 13-32
32. Cole, S. G. 1931. *The History of Fundamentalism*. New York: Smith
33. Committee on Science and Creationism. 1984. *Science and Creationism: A View of the National Academy of Sciences*. Washington DC: Natl. Acad. Press
34. Contenau, G. 1941. *Le deluge babylonien*. Paris: Payot
35. Contenau, G. 1954. *Everyday Life in Babylon and Assyria*, transl. K. R. & A. R. Maxwell-Hyslop. London: Arnold
36. Cooper, J. M. 1935. The scientific evidence bearing on human evolution. *Primitive Man* 8:1-56
37. Corson, D. W., ed. 1977. *Man's Place in the Universe: Changing Concepts*. Tucson: Coll. Liberal Arts, Univ. Arizona
38. Corwin, E. S. 1958. *The Constitution and What it Means Today*. Princeton: Princeton Univ. Press. 14th ed.
39. Cracraft, J. 1983. Systematics, comparative biology, and the case against creationism. See Ref. 67, pp. 163-91
40. Crompton, A. W., Parker, P. 1978. Evolution of the mammalian masticatory apparatus. *Am. Sci.* 66:192-201
41. Crow, J. F. 1958. Some possibilities for measuring selection intensities in man. In *Natural Selection in Man*, ed. J. N. Spuhler. *Mem. Am. Anthropol. Assoc.* 86:1-13
42. Cuvier, G. 1831. *A discourse on the revolutions of the surface of the globe, and the changes thereby produced in the animal kingdom*. Philadelphia: Carey & Lee
43. Daub, E. R. 1978. Demythologizing White's *Warfare of Science with Theology*. *Am. Biol. Teach.* 40:553-56
44. Dean, S. D. 1983. First amendment concerns regarding balanced science instruction in evolution and creation. *Ohio N. Univ. Law Rev.* 10:145-58
45. DeCamp, L. S. 1969. The end of the monkey war. *Sci. Am.* 220(2):15-21
46. De Puy, N. R. 1981. Baptist churches. 1981 *Britannica Book of the Year*, p. 597. Chicago: Encyclopaedia Britannica
47. DeVaux, R. 1961. *Ancient Israel: Its Life and Institutions*, transl. J. McHugh. New York: McGraw Hill
48. Dobzhansky, T. 1967. *The Biology of Ultimate Concern*. New York: New Am. Library
49. Dobzhansky, T. 1973. Nothing in biology makes sense except in the light of evolution. *Am. Biol. Teach.* 35:125-29
50. Dobzhansky, T., Ayala, F. J., Stebbins, G. L., Valentine, J. W. 1977. *Evolution*. San Francisco: Freeman
51. Dobzhansky, T., Pavlovsky, D. 1971. Experimentally created incipient species of *Drosophila*. *Nature* 230:289-92
52. Doolittle, R. F. 1983. Probability and the origin of life. See Ref. 67, pp. 85-97
53. Edgar, J. W. 1976. *Proclamation/Textbook Adoption*. Austin: Texas Educ. Agency
- 53a. Education Committee of the American Society of Zoologists. 1984. Science as a way of knowing—evolutionary biology. *Am. Zool.* 24(2):421-534
54. Eiselen, F. C., Lewis, E., Downey, D. G., eds. 1929. *The Abingdon Bible Commentary*. New York: Abingdon Press
55. Eldridge, N., Gould, S. J. 1972. Punctuated equilibria: An alternative to phyletic gradualism. In *Models in Paleobiology*, ed. T. J. M. Schopf, pp. 82-115. San Francisco: Freeman, Cooper Publ.
56. Falwell, J. 1981. Quoted on absolute infallibility of the Bible. *Ecumenist* 19(1):26
57. Finegan, J. 1959. *Light from the Ancient Past; The Archaeological Background of Judaism and Christianity*. Princeton: Princeton Univ. Press. 2nd ed.
58. Finegan, J. 1964. *Handbook of Biblical Chronology: Principles of Time Reckoning in the Ancient World and Problems of Chronology in the Bible*. Princeton: Princeton Univ. Press
59. Fitzmyer, J. A. 1981. The Gospel

- according to Luke, I-IX. *The Anchor Bible*, Vol. 28. Garden City, NY: Doubleday
60. Flint, R. F. 1957. *Glacial and Pleistocene Geology*. New York: Wiley
  61. Frazer, J. G. 1923. *Folk-lore in the Old Testament: Studies in Comparative Religion, Legend and Law*, 3 vols. London: Macmillan
  62. Friedrich, C. J. 1968. *Constitutional Government and Democracy: Theory and Practice in Europe and America*. Waltham, Mass: Blaisdell. 4th ed.
  63. Gardner, M. 1957. *Fads and Fallacies in the Name of Science*. New York: Dover
  64. Gasper, L. 1963. *The Fundamentalist Movement*. New York: Humanities Press
  65. Gilkey, L. 1959. *Maker of Heaven and Earth: A Study of the Christian Doctrine of Creation*. Berkeley: Univ. Calif. Press
  66. Gish, D. T. 1979. *Evolution? The Fossils say No!* San Diego: Creation-Life Publishers
  67. Godfrey, L. R., ed. 1983. *Scientists Confront Creationism*. New York: Norton
  68. Godfrey, L. R. 1983. Creationism and gaps in the fossil record. See Ref. 67, pp. 193-218
  69. Gordon, R. M. 1982. Finding the science in "creation science." Case note, McLean vs. Arkansas Board of Education. *Northwestern Univ. Law Rev.* 77:374-402
  70. Gould, S. J. 1983. Darwin's untimely burial—again! See Ref. 67, pp. 139-46
  71. Gosse, P. 1857. *Omphalos*. London: Van Voorst
  72. Grabiner, J. V., Miller, P. D. 1974. Effects of the Scopes trial. *Science* 185:832-37
  - 72a. Graves, R., Patai, R. 1983. *Hebrew Myths: The Book of Genesis*. New York: Greenwich House
  73. Greenberg, J. H. 1959. Language and evolution. In *Evolution and Anthropology: A Centennial Appraisal*, ed. B. Meggers, pp. 61-72. Washington DC: Anthropol. Soc. Washington
  74. Greenberg, M. M. 1983. The constitutional issues surrounding the science-religion conflict in public schools: The anti-evolution controversy. *Pepperdine Law Rev.* 10:461-87
  75. Hailman, J. P. 1982. Creation stories. *BioScience* 32:129-30
  76. Harris, C. L. 1981. *Evolution: Genesis and Revelations*. Albany: State Univ. New York Press
  77. Hartl, D. L. 1980. *Principles of Population Genetics*. Sunderland, Mass: Sinauer
  78. Hefley, J. C. 1976. *Textbooks on Trial*. Wheaton, Ill: Victor Books
  79. Heidel, A. 1949. *The Gilgamesh Epic and the Old Testament Parallels*. Chicago: Univ. Chicago Press. 2nd ed.
  80. Heidel, A. 1951. *The Babylonian Genesis*. Chicago: Univ. Chicago Press. 2nd ed.
  81. Hentoff, N. 1984. The dumbing of America. *Progressive* 48(2):29-31
  82. Hirshleifer, J. 1982. Evolutionary models in economics and law. *Res. Law Econ.* 4:1-60
  83. Holden, C. 1980. Republican candidate picks a fight with Darwin. *Science* 209:1214
  84. Huskins, C. L. 1934. The origin of *Spartina townsendii*. *Genetics* 12:531-38
  85. Hutchinson, G. E. 1983. What is science for? *Am. Sci.* 71:639-44
  86. Hupfeld, H. 1853. *Qvaestionvm in lobeidos locos vexatos specimen*. Italix Saxonvm: Prostat apud E. Anton
  87. Jacobsen, T. 1970. *Toward the Image of Tamuz and Other Essays on Mesopotamian History and Culture*. Cambridge, Mass: Harvard Univ. Press
  88. Jacobsen, T. 1976. *The Treasures of Darkness: A History of Mesopotamian Religion*. New Haven: Yale Univ. Press
  89. Jones, W. 1788-1790. *Asiatick Researches*, Vols. 1-3. Calcutta: Asiatic Soc. of Bengal
  90. Jorstad, E. T. 1970. *The Politics of Doomsday: Fundamentalism of the Far Right*. Nashville: Abingdon
  91. Jukes, T. H. 1983. Molecular evidence for evolution. See Ref. 67, pp. 117-38
  92. Kalven, H. Jr. 1960. A commemorative case note: *Scopes v. State*. *Univ. Chicago Law Rev.* 27:505-21
  93. Kant, I. 1969. *Universal Natural History and Theory of the Heavens*, transl. W. Hastie. Ann Arbor: Univ. Mich. Press
  94. Karpenchenko, G. D. 1928. Polyploid hybrids of *Raphanus sativus* L. × *Brassica oleracea* L. Z. *Indukt. Abstamm. Vererbungs.* 39:1-7
  95. Kimura, M. 1983. *The Neutral Theory of Molecular Evolution*. Cambridge: Cambridge Univ. Press
  96. Kirkby, M. 1976. Land and water resources of the Deh Luran and Khuzistan Plain. *Mem. Univ. Mich. Mus. Anthropol.* 9:251-88
  97. Kramer, S. N. 1961. *Sumerian Mythology*. New York: Harper & Row. Rev. ed.
  98. Kramer, S. N. 1963. *The Sumerians: Their History, Culture, and Character*. Chicago: Univ. Chicago Press
  99. Kramer, S. N. 1981. *History Begins at Sumer: Thirty-nine Firsts in Man's Recorded History*. Philadelphia: Univ. Penn. Press. 3rd ed.
  100. Kluckhohn, C. 1939. The place of theory

- in anthropological studies. *Philos. Sci.* 6:328-44
101. Langdon, S. 1929. *Excavations at Kish*. London: Luzak
102. Laplace, P. S. 1809. *The System of the World*, transl. J. Pond, 2 vols. London: Phillips
103. Larsen, C. E. 1975. The Mesopotamian delta region: A reconsideration of Lees and Falcon. *J. Am. Orient. Soc.* 95:43-57
104. Le Clercq, F. W. 1974. The monkey laws and the public schools: A second consumption. *Vanderbilt Law Rev.* 27:209-42
105. Lees, J. M., Falcon, N. L. 1952. The geological history of the Mesopotamian Plains. *Geogr. J.* 118:24-39
106. Levy, L. E., ed. 1971. The world's most famous court trial. *State of Tennessee v. John Thomas Scopes*. New York: Da Capo
107. Lewis, S. 1927. *Elmer Gantry*. New York: Knopf
108. Lewontin, R. C. 1968. The concept of evolution. *Int. Encycl. Soc. Sci.* 5:202-10
109. Lewontin, R. C. 1974. *The Genetic Basis of Evolutionary Change*. New York: Columbia Univ. Press
110. Lewontin, R. C. 1983. Introduction. See Ref. 67, pp. xxiii-vi
111. Lightfoot, J. 1823-25. *The Whole Works of the Rev. John Lightfoot, D.D.*, ed. Rev. John Rogers Pitman, 13 vols. London: Dove
112. Lines, P. M. 1982. Scientific creationism in the classroom: A constitutional dilemma. *Loyola Law Rev.* 28:35-59
113. Lotka, A. J. 1925. *Elements of Physical Biology*. Baltimore: Williams & Wilkins
114. Lyell, C. 1833. *Principles of Geology*. London: Mumford
115. Mallowan, M. E. L. 1964. Noah's flood reconsidered. *Iraq* 26:62-82
116. Mallowan, M. E. L. 1971. The Early Dynastic Period in Mesopotamia. In *Cambridge Ancient History*, ed. I. E. S. Edwards, C. J. Gadd, N. G. L. Hammond, 1(2):238-314. Cambridge: Cambridge Univ. Press. 3rd ed.
117. Mayer, W. V. 1982. Evolutionary theory vs. creationist doctrine. *J. Col. Sci. Teach.* 11:270-76
118. Mayr, E. 1970. *Populations, Species and Evolution*. Cambridge: Harvard Univ. Press
119. Mayr, E. 1976. *Evolution and the Diversity of Life*. Cambridge: Harvard Univ. Press
120. Mayr, E., Provine, W. B., eds. 1980. *Perspectives on the Unification of Biology*. Cambridge: Harvard Univ. Press
121. McFadden, E. S., Sears, E. R. 1946. The origin of *Triticum spelta* and its free-threshing hexaploid relatives. *J. Hered.* 37:81-89, 107-16
122. McKim, P. 1983. Evolution vs creation: A selected bibliography. *Anthropol. Newsl.* 24(7):5, 9
123. Mead, M. 1964. *Continuities in Cultural Evolution*. New Haven: Yale Univ. Press
124. Megivern, J., ed. 1978. *Bible Interpretation: Official Catholic Teachings*. Wilmington, NC: Consortium Books
125. Melnick, R. R. 1981. Secularism in the law: The religion of secular humanism. *Ohio N. Univ. Law Rev.* 8:329-57
126. Mencken, H. L. 1930. *Treatise on the Gods*. New York: Knopf
127. Messenger, E. C. 1932. *Evolution and Theology*. New York: Macmillan
128. Mills, S. K., Beatty, J. H. 1979. The propensity interpretation of fitness. *Philos. Sci.* 46:263-86
129. Moore, J. A. 1974. Creationism in California. *Daedalus* 103:173-89
130. Moore, J. A. 1975. On giving equal time to the teaching of evolution and creation. *Perspect. Biol. Med.* 18:405-17
131. Moore, J. A. 1982. Countering the creationists: The scientist. *Academe* 68(2):14-16
132. Moore, J. A. 1982. Evolution and public education. *BioScience* 32:606-12
133. Moore, J. R. 1975. Evolutionary theory and Christian faith: A bibliographic guide to the post-Darwinian controversies. *Christian Sci. Rev.* 4:211-30
134. Moore, J. R. 1979. *The post-Darwinian Controversies*. Cambridge: Cambridge Univ. Press
135. Moorey, P. R. S. 1979. *Kish Excavations, 1923-1933*. Oxford: Clarendon
136. Morowitz, H. J. 1970. *Entropy for Biologists: Fundamental Concepts of Thermodynamics*. New York: Academic
137. Morris, H. M. 1965. *Science, Scripture and Salvation*. Denver: Accent Books
138. Morris, H. M. 1973. Geology and the flood. *ICR Impact Ser. No. 6*
139. Morris, H. M. 1974. *Scientific Creationism*, General edition and Public School edition. San Diego: Creation-Life Publishers
140. Morris, H. M. 1974. *Many Infallible Proofs*. San Diego: Creation-Life Publishers
141. Morris, H. M. 1976. *Entropy and Open Systems*. San Diego: Inst. Creation Research
142. Morris, H. M. 1977. *In the Beginning of the World*. Denver: Accent Books
143. Morse, P. 1974. *Thermal Physics*. New York: Benjamin

144. Motulsky, A. G. 1974. "Brave New World?" *Science* 185:653-63
145. Moyer, W. A. 1983. Young earth creationism and biology textbooks. *BioScience* 33:113-14
146. Muntzing, A. 1930. Über Chromosomenvermehrung in Galeopsis-Kreuzungen und ihre phylogenetische Bedeutung. *Hereditas* 17:131-54
147. Nebelsick, H. 1983. *Theology and Science in Mutual Modification*. New York: Oxford Univ. Press
148. Nelkin, D. 1977. *Science Textbook Controversies and the Politics of Equal Time*. Cambridge, Mass: MIT Press
149. Nelkin, D. 1981. *The Creation Controversy: Science and Scripture in the Schools*. New York: Norton
150. New York Times. 1982. Report of Gallup poll on belief in evolution in the United States. Aug. 29, p. 21
151. Newell, N. 1982. *Creation and Evolution: Myth or Reality?* Irvington, NY: Columbia Univ. Press
152. Noth, M. 1960. *The History of Israel*, transl. P. R. Ackroyd. London: Black. 2nd ed.
153. Noth, M. 1972. *A History of Pentateuchal Traditions*, transl. B. W. Anderson. Englewood Cliffs, NJ: Prentice-Hall
154. O'Neil, R. M. 1982. *Creationism, Curriculum and the Constitution*. *Academe* 68(2):17-200
155. Oppenheim, A. L. 1977. *Ancient Mesopotamia. Portrait of a Dead Civilization*. Chicago: Univ. Chicago Press. 2nd ed.
156. Orr, J. 1906. *The Problem of the Old Testament Considered with Respect to Current Criticism*. New York: Scribner
157. O'Toole, G. B. 1925. *The Case Against Evolution*. New York: Macmillan
158. Overton, W. R. 1982. Creationism in schools. The decision in McLean versus the Arkansas Board of Education. *Science* 215:934-43
159. Overton, W. R. 1982. Creationism in schools. The Arkansas decision. *Am. Biol. Teach.* 44:172-79
160. Overton, W. R. 1982. Rev. Bill McLean vs. Arkansas Board of Education. *Academe* 68:27-36
161. Parker, F. 1982. Behind the evolution-creation science controversy. *Coll. Board Rev.* 123:18-21, 37
162. Parrot, A. 1953. *The Flood and Noah's Ark*. New York: Philosophical Library
163. Peake, H. 1930. *The Flood. New Light on an Old Story*. London: K. Paul, Trench, Trubner
164. Peaslee, A. J. 1974. *Constitutions of Nations*. The Hague: Martinus Nijhoff. 4th ed.
165. Phipo, C. 1981. Scientific creationism: A case study. *Educ. Urban Soc.* 13:219-33
166. Poebel, A. 1947. *Miscellaneous Studies*. Chicago: Univ. Chicago Press
167. Pope John Paul II. 1981. Address to the members of the Pontifical Academy of Sciences. *Origins* 11:279
168. Price, G. M. 1923. *The New Geology*. Mountain View, Calif: Pacific Press
169. Pritchard, J. B., ed. 1969. *Ancient Near Eastern Texts Relating to the Old Testament*. Princeton: Princeton Univ. Press. 3rd ed.
170. Raikes, R. L. 1966. The physical evidence for Noah's flood. *Iraq* 28:52-63
171. Raup, D. M. 1983. The geological and paleontological arguments of creationism. See Ref. 67, pp. 147-62
172. Renckens, H. 1964. *Israel's Concept of the Beginning. The Theory of Genesis 1-3*, transl. C. Napier. New York: Herder & Herder
173. Riddle, O. 1942. *The Teaching of Biology in the Secondary Schools of the United States*. Washington DC: Union of Am. Biol. Sci.
174. Romer, A. S. 1966. *Vertebrate Paleontology*. Chicago: Univ. Chicago Press. 3rd ed.
175. Rosenfeld, M. 1982. Darwin and the Bible in federal court. *New York Law J.* 187(2):2
176. Rowley, H. H. 1950. *From Joseph to Joshua: Biblical Traditions in the Light of Archaeology*. London: Oxford Univ. Press
177. Ruse, M. 1973. *The Philosophy of Biology*. London: Hutchinson
178. Russell, B. 1929. *Our Knowledge of the External World*. New York: Norton. 2nd ed.
179. Sahllins, M. D., Service, E. R., eds. 1960. *Evolution and Culture*. Ann Arbor: Univ. Mich. Press
180. Sandeen, E. R. 1970. *The Roots of Fundamentalism*. Grand Rapids, Mich: Baker Books
181. Scheid, D. E. 1983. Evolution and creationism in the public schools. *J. Contemp. Law* 9:81-126
182. Shapley, H. 1960. *Of Stars and Men*. New York: Washington Square Press
183. Simpson, G. G. 1967. *The Meaning of Evolution: A Study in the History of Life and its Significance for Man*. New Haven: Yale Univ. Press. 2nd ed.
184. Simpson, G. G. 1977. A new heaven and a new earth and a new man. See Ref. 33, pp. 53-75
185. Singer, C. 1959. *A History of Biology*. London: Abelard-Schuman. 3rd ed.
186. Smith, G. 1880. *The Chaldean Account of Genesis*. London: Sampson Low

187. Smith, J. M. 1975. *The Theory of Evolution*. London: Penguin Books
188. Snow, T. 1976. *Bill of Particulars*. Austin: Texas Educ. Agency
189. Sorokin, P. A. 1937. *Social and Cultural Dynamics*, 4 vols. New York: Bedminster Press
190. Speiser, E. A. 1964. *Genesis. The Anchor Bible*, Vol. 1. Garden City, NY: Doubleday
191. Stebbins, G. L. 1950. *Variation and Evolution in Plants*. New York: Columbia Univ. Press
192. Steward, J. H. 1977. *Evolution and Ecology*. Urbana: Univ. Ill. Press
193. Strong, A. H. 1889. *Systematic Theology*. New York: Armstrong. 2nd ed.
194. Sullivan, L. L. 1982. The Arkansas landmark court challenge of creation science. *Coll. Board Rev.* 123:12-17, 32-35
195. Taylor, M. F. 1983. Creation science's first confrontation with the Establishment Clause. Case note. *McLean vs. Board of Education. Arkansas Law Rev.* 36:326-37
196. Tillich, P. 1951. *Systematic Theology*, 3 vols. Chicago: Univ. Chicago Press
197. Ussher, J. 1847-64. *The Whole Works of the Most Rev. James Ussher*, 17 vols. Dublin: Hodges & Smith
198. Verhoeven, M., Fang, R., Jou, W. M., Devos, R., Huylebroeck, D., et al. 1980. Antigenic drift between the haemoagglutinin of Hong Kong influenza strains A/Aichi/2/68 and A/Victoria/3/75. *Nature* 286:771-76
199. Wade, N. 1972. Creationists and evolutionists: Confrontation in California. *Science* 178:724-29
200. Watch Tower Bible & Tract Society. 1950. *Evolution Versus the New World*. Brooklyn: Int. Bible Students Assoc.
201. Watch Tower Bible & Tract Society. 1967. *Did Man Get Here by Evolution or by Creation?* Brooklyn: Int. Bible Students Assoc.
202. Weinberg, S. L. 1978. Two views on the Textbook Watchers. *Am. Biol. Teach.* 40:541-45, 56
203. Wellhausen, J. 1885. *Prolegomena to the History of Israel*, transl. J. S. Black. Edinburgh: Black
204. Wellhausen, J. 1963. *Die Composition des Hexateuchs und der historischen Bucher des Alten Testaments*, 4. Auf. Berlin: W. DeGruyter
205. West, J. K. 1981. *Introduction to the Old Testament*. New York: Macmillan. 2nd ed.
206. White, A. D. 1895. *A History of the Warfare of Science with Theology in Christendom*. London: Macmillan
207. White, L. A. 1959. *The Evolution of Culture*. New York: McGraw-Hill
208. Whitehead, A. N. 1926. *Religion in the Making*. New York: Macmillan
209. Williams, R. C. 1983. Scientific creationism: An exegesis for a religious doctrine. *Am. Anthropol.* 85:91-102
210. Wood, J. E. Jr. 1982. "Scientific creationism" and the public schools. *J. Church State* 24:231-43
- 210a. Woolley, C. L. 1956. *Ur: The Early Period (Ur Excavations IV)*. Philadelphia: British Museum and Univ. Penn. Museum
211. Woolley, C. L. 1929. *Ur of the Chaldees*. London: Benn
212. Wright, H. 1980. Problems of absolute chronology in protohistoric Mesopotamia. *Paléorient* 6:93-96
213. Wright, S. 1968. *Evolution and the Genetics of Populations*. Vol. 1, *Genetic and biometric foundations*. Chicago: Univ. Chicago Press
214. Wright, S. 1969. See Ref. 213, Vol. 2, *The theory of gene frequencies*
215. Wright, S. 1977. See Ref. 213, Vol. 3, *Experimental results and theoretical deductions*
216. Wright, S. 1978. See Ref. 213, Vol. 4, *Variability within and among populations*
217. Wysong, R. L. 1976. *The Creation-Evolution Controversy*. Midland, Mich: Inquiry Press
218. Zetterberg, P. 1983. *Evolution versus Creationism: The Public Education Controversy*. Phoenix: Oryx