GOD KNOWLEDGE & MYSTERY

Essays in Philosophical Theology

PETER VAN INWAGEN

CORNELL UNIVERSITY PRESS

ITHACA AND LONDON

First published 1995 by Cornell University Press.

Printed in the United States of America

♾ The paper in this book meets the minimum requirements of the American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials, ANSI Z39.48-1984.

Library of Congress Cataloging-in-Publication Data

Van Inwagen, Peter.
God, knowledge, and mystery : essays in philosophical theology /
Peter van Inwagen.
p. cm.
Includes bibliographical references and index.
ISBN 0-8014-2994-3 (alk. paper). — ISBN 0-8014-8186-4 (pbk. : alk. paper)
1. Philosophical theology. 2. Knowledge, Theory of (Religion)
I. Title.
BT40.V34 1995
230'.01—dc20 95-1426

5

Genesis and Evolution

I am neither a theologian nor a biblical scholar nor a scientist. Indeed, I cannot even claim to know much about Old Testament studies or evolutionary biology. Nevertheless, I am going to discuss the book of Genesis and the evolution of life. I offer three excuses for presuming to pronounce on matters of which I am largely ignorant. First, war is too important to be left to the generals. Other people than those whose professional training most obviously qualifies them to speak on these topics have something invested in the conduct of debates about science and the Bible, and often these other people feel—*I* do at any rate—that it would do the professionals no harm to hear from *them* for a change. Secondly, the blunders of beginners can sometimes help the experts to see that they have failed adequately to communicate some aspect of their subject to the public and can suggest ways in which in this communication might be better done. Quite often there is some technical idea or thesis or argument that could be explained to the lay public in a much more useful way than it has been—and it *would* be, if only the specialists were aware of prevalent misconceptions. If nothing else, perhaps what I say can help the clerks to see what it is that needs to be better explained to the laity. Thirdly, if I can claim little knowledge of what the experts have said about the book of Genesis or the history of terrestrial life, I do claim, as a philosopher, to be something of an expert at tracing the relations between disparate things, and perhaps I can bring some of my expertise to bear in this essay.

I begin with two terminological points about my title. In that title,

and in the remainder of this essay, I mean by *Genesis* the first three chapters of the book of Genesis: that is, the book of Genesis from "In the beginning . . ." to the expulsion of Adam and Eve from the Garden. Secondly, the word 'evolution', at least as it occurs in phrases like 'the theory of evolution', has a strictly biological meaning. It is a vulgar error to suppose that the word 'evolution' designates a sort of "force" which has been in operation from the very beginning of the universe and which has been responsible for the formation and development of the stars and the planets and everything else, and which, as a special case of this general activity, is engaged in pushing living organisms toward ever higher levels of complexity. Despite this fact about the meaning of the word 'evolution', however, and despite the fact that I shall have a lot to say about evolution in this strict sense, I have used the word in my title as a sort of catchall for a very diverse set of scientific considerations—cosmological and geological as well as biological—relating to various questions about how the earth and the cosmos got into their present forms.

Now as to the issue of the relation between these scientific considerations and the book of Genesis, a very wide range of positions is possible. But two positions stand out as extremes and have got the most publicity. The popular or journalistic names for these extreme positions are 'fundamentalism' and 'secular humanism'. But each of these names has been objected to on various grounds, and, rather than become embroiled in terminological disputes, I shall invent my own names for them. More exactly, I shall describe, and invent names for, two positions that I believe correspond to *some* of the things said by people who are popularly called 'fundamentalists' and *some* of the things said by people who are popularly called 'secular humanists'. I shall call the one 'Genesiac literalism' (or literalism for short) and the other 'saganism'—after one of its most illustrious and talkative ornaments.

I begin with a statement of Genesiac literalism. (I say Genesiac rather than *biblical* literalism, because I believe that the early chapters of the book of Genesis are a very special part of the Bible, and I mean to talk about them only. Nothing I say should be regarded as having any implications whatever for questions about how to read, say, Job or the Gospels or Revelation.)

"The planet earth came into existence about six thousand years ago, when God created it in a series of six twenty-four hour days. On the third, fifth, and sixth of these days, God created all the various species of living things, concluding with a single pair of human beings, the first man and the first woman. Any appearance to the contrary in the

geological record is due to a worldwide flood that occurred about forty-five hundred years ago; the geological distortions caused by that vast deluge created phenomena that the clever and perverse have—like someone finding internal evidence of Baconian authorship in *Hamlet*—interpreted as showing that the earth is not thousands but thousands of *millions* of years old, its present geological features supposedly being due to the effects of various natural processes that have been at work over this immense stretch of time.

"We know the facts I have outlined concerning the beginning of the earth and life and man because God revealed them to Moses thousands of years later and Moses wrote them down in the book we call Genesis, a book that God has ensured is historically accurate in every respect because it is a part of His Holy Scripture. It is true that Scripture contains metaphor and hyperbole—as, for example, when it tells us that the soldiers of the kings of Canaan were as numerous as the grains of sand on the shore of the sea—but any reasonably intelligent and well-intentioned reader can tell when metaphor or hyperbole are intended by Scriptural writers, and the main historical statements of Genesis are clearly intended to be taken literally."

So says the literalist.

The saganist tells another story: "The cosmos, the totality of the distribution of matter and radiation in space-time, is 'all that is or was or ever will be.' Ten thousand million years ago or more, it was concentrated in a very tiny volume of space, which was, nevertheless, all the space there was. This tiny volume expanded very rapidly, and certain processes, which we are beginning to understand, led, after a few minutes, to the three-to-one ratio of hydrogen to helium nuclei that we observe today. A few hundred thousand years later, the density of the expanding universe had fallen to a point at which electrons could arrange themselves around the hydrogen and helium nuclei, and the space between the atoms thus formed was suddenly filled with free radiation, radiation that, vastly attenuated, is still detectable. Gravitational effects caused matter to be concentrated in stars and stars to be collected into galaxies. In the stars, new elements like carbon and oxygen were formed and were dispersed when these stars came to the ends of their lives and exploded. The scattered atoms of these elements eventually became parts of new stars and of solid planets circling them.

"On at least one planet, but presumably on many, natural processes led to the formation of a complex molecule capable of replicating itself with variations. Owing entirely to the operation of natural selection, the descendants of this molecule achieved a sufficient level of internal

organization for us to feel comfortable about thinking of them as living organisms. The blind but, in appearance, creative processes of natural selection continued to operate, and produced the cell, the multicellular organism, sexual dimorphism, and, eventually, representatives of all the phyla we see today (and some that we don't). In due course, owing to the interplay of variation and selection over hundreds of millions of years, intelligence appeared. (The broad outlines of the latter part of this narrative, the part dealing with biological evolution, have been accepted by every serious scientist since about 1870. Opposition to it is due entirely to theological obscurantism.) A short time later, perhaps through a social analogue of natural selection, intelligence developed *science,* a powerful, self-correcting mechanism for understanding the cosmos. Various older and much less efficient competitors with science—notably religion—survive, but, having tried and failed to destroy their new and dangerous rival in its infancy, they are steadily losing ground to it and will soon go the way of the saber-toothed tiger. Perhaps the final nail in their coffin will be the discovery of intelligent life elsewhere in the universe, a shock they are too narrow-minded and parochial to survive.

"As to the book of Genesis [here the saganists in the sciences are aided by their colleagues in the other culture], it was not written by Moses or by any single author. It is easy to see that it contains two incompatible accounts of the creation of humanity. One account, which roughly coincides with the second chapter, the detailed story of the creation of the first man and woman, is thought to have been put into its present form in something like the ninth century B.C., hundreds of years after the death of Moses. The first chapter of Genesis (and a bit more), the 'seven days" story, was written by priests about three hundred years later, probably during the Babylonian captivity of Judah. What both sets of authors were doing was editing and rewriting traditional material (ultimately derived from primordial Semitic creation myths) to bring this material into line with their own theologies, and with an eye toward the polemical requirements of the contemporary religious and political situations."

Well, here are two extreme positions. Probably every position one could take on the relation between the book of Genesis and the scientific study of the origins of the universe, the earth, and humanity lies on the continuum between them. One possible position, for example, is *deism,* which accepts most of the saganists' story but rejects its contention that there is nothing besides the cosmos. Deism postulates an intelligent Creator who set the universe in motion and then sat back

to watch the show. (Like the typical Hollywood producer, this Creator seems to have rather a taste for shows that involve sex and violence—especially violence. It is, however, doubtful whether he shares Hollywood's taste for happy endings.)

What I mean to do in the rest of this essay is, first, to set forth a position on the relation between Genesis and scientific accounts of the history of the universe that is radically different from literalism and saganism (and from deism). I shall then offer critiques of both literalism and saganism from the point of view afforded by this position. I pick these two positions to criticize because, first, they have been getting the lion's share of the publicity, and, secondly, as a consequence of the fact that they are extremes between which most if not all the other possible positions on this issue lie, what I would say about other positions may perhaps be gleaned from what I say about the extremes.

Now a word as to my own religious beliefs. I am a Christian. More exactly, I am an Episcopalian, and I fully accept the teaching of my denomination that "the Holy Scriptures of the Old and New Testaments are the revealed Word of God"; that they "contain all things necessary to salvation and are the rule and ultimate standard of faith"; that "God inspired their human authors and still speaks to us through the Bible."[1] But I am not constructing a position that I recommend only to Episcopalians. I recommend this position to any Christian—and to any Jew—who regards the book of Genesis as divinely inspired and who, nevertheless, rejects, as I do, Genesiac literalism. I will add that a Christian is not logically committed, by the very fact of being a Christian, to regarding the bible as being divinely inspired throughout. There are only two glancing references to Scripture in the creeds—"on the third day he rose again, in accordance with the Scriptures" and "he [the Holy Spirit] spoke through the prophets." One would suppose, therefore, that, as regards the Bible, a Christian is absolutely obliged to believe only that the Hebrew prophets were divinely inspired, and that the Resurrection is in some sense "in accordance with" *(secundum)* the Hebrew Bible. But such scriptural minimalism has not been the mind of the Church. While one might want to qualify this statement in various ways, in the light of such things as Martin Luther's remarks about the Letter of James, it seems roughly correct to say that all Christians whose witness on the matter has survived have regarded the

1. *The Book of Common Prayer: According to the Use of the Episcopal Church* (New York: Seabury Press, 1979). The first statement (p. 526) is from the Form for the Ordination of a Priest; the second (p. 877) is from Resolution II of the Lambeth Conference of 1888; the third (p. 853) is from the Catechism.

Bible as being divinely inspired throughout, and I have no intention of separating myself from this cloud of witnesses. How, then, shall those who agree with me and the literalists that Genesis is the inspired Word of God and who also agree with me and the saganists that life and the earth and the cosmos have histories that are measured in thousands of millions of years explain themselves? This question is not, in its essentials, a new one. A lot of people seem to think that all Christians were literalists before the geological discoveries of the early nineteenth century. Under the impact of these discoveries and the Darwinian account of evolution that was built upon them (the story goes) some Christians began desperately to scramble about to try to devise some way of reconciling science and the Bible.

This is historically false. Let us consider the greatest of all Christian theologians, St. Augustine (whose death in the year 430 places him at a comfortable remove from the impact of nineteenth-century science). Augustine argued that the "six days" account of creation in Genesis could hardly be literally correct, since (among other reasons he gives) it asserts that day and night existed before the sun was made. (Let me assure you parenthetically that if the author of Genesis 1 did not know much about geology, he certainly did know that daylight was due to the sun.) Now if Genesis is not a literally correct account of the Creation—Augustine reasoned—then it must belong to one of the many nonliteral modes of presentation recognized by the science of rhetoric (which, as we should say today, was Augustine's area of professional competence). But I do not propose to discuss Augustine's hermeneutical theories; I am more interested in the account he gave of what he took to be the literal reality behind the nonliteral presentation.[2] Augustine held that

2. Augustine's views on Genesis are found in his *De genesi ad litteram* ("On Genesis according to the Letter"). The standard English translation by J. H. Taylor (New York: Newman, 1982) is titled *On the Literal Meaning of Genesis*. The "literal meaning" of the English title refers not to what we would today call "the literal meaning of the text" but to what I have called 'the literal reality behind the nonliteral mode of presentation'. To read an inspired text *ad litteram*, for Augustine, is to read it with an eye toward discovering what its human author intended to convey; one could also read an inspired text *allegorically*, with an eye toward discovering types or foreshadowings of persons or events of later sacred history (which, if they are objectively present in the inspired text, were presumably unknown to its human author). In the discussion of Augustine in the text of this essay, I use the word 'literal' in its customary present-day sense. In this discussion, I have drawn heavily on Ernan McMullin's introduction to the collection *Evolution and Creation* (South Bend, Ind.: University of Notre Dame Press, 1985). In this account of Augustine's views, I have glossed over several important matters—such as the relation of the timeless reality of God to the unfolding temporal processes of the created world—that are irrelevant to our purposes.

God had created the universe all at once, and that, at the moment of its creation, the universe was, by present standards, without form, and was empty of things of the kinds it now contains. But there was *latent* form and there were things in which that form was latent. He calls these things *seed-principles,* using a botanical trope, as we use a political trope when we speak of the laws of nature. The newly created universe subsequently, by its own inner necessity, evolved into its present highly differentiated state, this present state having been implicit in its original state much as a field of grain is implicit in a mixture of seed and water and earth. (Or, at any rate, many aspects of the present state of the world were in this strong sense implicit in the initial state. Others may have been due to miraculous actions by God subsequent to the beginning of things. But if miracles did play a part in the development of the world, these miracles were not local acts of creation ex nihilo; they rather consisted in the miraculous activation of potentialities that had existed from the beginning.) This is not to say that Augustine believed in anything like what *we* call "evolution." He did not believe that elephants were remotely descended from fish. The idea of the mutability of species would have been quite foreign to his Platonism. Rather, elephants arose from one seed-principle and mackerel from another. The "days" of Genesis, Augustine says, represent *aspects* of the development of the world; perhaps—he is rather tentative about this—what is represented is six successive stages of the angelic understanding of creation. Augustine's science may strike us as quaint, but it is evident that his account of the origin and development of the universe is no more consistent with Genesiac literalism than is an article covering the same ground in last month's *Scientific American.* Nor is Augustine an isolated example of a nonliteralist in the ancient world: the Alexandrian theologians, Gregory of Nyssa, and St. Jerome (who produced the Latin translation of the Bible that was the Church's standard for fourteen hundred years) were nonliteralists. Jerome once remarked that, in his opinion, the author of Genesis had described the Creation mythically—"after the manner of a popular poet."[3] Genesiac nonliteralism is, therefore, both ancient and fully orthodox: it would be a bold literalist who called the Bishop of Hippo a wishy-washy theological liberal. Nonliteralism was, of course, *rejected* by many important authorities in the Western Church. St. Thomas Aquinas, for example, was a literalist who explicitly stated that the Creation took

3. Attributed, without citation, by C. S. Lewis, *Reflections on the Psalms* (London: Godfrey Bles, 1958), p. 92.

place over a period of six successive twenty-four-hour days. What it is important to note about Aquinas, however, is that, in his discussion of Augustine's "opinion that all the days that are called seven are one day represented in a sevenfold aspect," Augustine is, in the words of Jaroslav Pelikan, "criticized but not hereticized." Pelikan goes on to say, "It took the Reformation to change that."[4]

I agree, although perhaps my "agreeing" on a point of church history with one of our greatest church historians has its comic aspect. Literalism before the Reformation was no doubt the majority opinion. The theory that the Bible is literally and in every sentence and in every respect inerrant is, after all, the simplest and most natural theory of the "reliability" of the Bible that must in some sense be a consequence of the doctrinal statement that the Bible is the revealed Word of God—just as geocentrism is the simplest and most natural theory of the causes of observed celestial motions. But *militant* literalism, the literalism that makes the denial of plenary verbal inerrancy a heresy to be destroyed before any other, is a child of the Reformation. (And not of the Counter-Reformation. To say that Galileo was condemned for contradicting the Bible on astronomical matters is, at best, a vast oversimplification of an extremely complex episode.) It is not hard to see why this should be, for one of the most important offspring of the Reformation is biblical individualism, the doctrine that individual Christians are perfectly capable of reading the Bible for themselves with no help from anyone but the Holy Spirit—or at the very most with no human assistance but that of their pastors. Now no one but an extreme theological liberal would be happy with the prospect of widespread radically diverse interpretations of Scripture. This prospect is avoided (in theory) in the Roman church by the concept of a *magisterium,* or teaching authority, that God has granted to His One, Holy, Catholic, and Apostolic Church, an authority that of course extends to matters of biblical interpretation, the Bible being one of many important things the Church has in her care. A denomination that espouses biblical individualism, however, must avoid by some other means the danger of ubiquitous conflicting interpretations of the Bible, and it will find a theory about the Bible that minimizes the opportunities for diverse interpretations of a given text—as biblical literalism of course does—to be very useful. *Militant* biblical literalism, then, is not simply a

4. Jaroslav Pelikan, "Darwin's Legacy: Emanation, Evolution, and Development," in *Darwin's Legacy: Nobel Conference XVIII,* ed. Charles L. Hamrum (San Francisco: Harper & Row, 1983), p. 81. No citation of the words attributed to Aquinas is given.

product of the doctrine that the Bible is the revealed Word of God; its other parent is biblical individualism, a johnny-come-lately in the history of the Christian Church. Having said this, I must add that I do not mean to imply that all the great Reformers were themselves literalists. John Calvin, I understand, questioned the historicity of the book of Job.[5] But this qualification strengthens rather than weakens the credentials of nonliteralism.

To establish the credentials of nonliteralism, however, is not to establish its possibility. How can the Bible be the revealed Word of God if, to take one example among many, it says that birds and fish came into existence on the same day, when the plain truth is that there were fish for hundreds of millions of years before there were birds? Well, I don't *know* the answer to this question, but I will do what St. Augustine did: I will present an answer which I find plausible and which I am willing to recommend. To do this, I must discuss both the content of Genesis and its formation. These two matters are intimately related, but I shall begin by treating them separately.

First, as to content. Suppose that someone who had never heard of the Bible and had never so much as thought about the beginning of the world were one day to read the book of Genesis and were to take everything it contained in a pretty literal sense and were to believe every word of it. This person would thereby come to believe many true things and many false things. Among the false things there would be two that we have already mentioned: the proposition that the alternation of day and night existed before the sun, and the proposition that Aves and Pisces are coevals. We could make quite a list of such false propositions. Here are some of the true ones. That the world is finite in space and time—at least time past. That it has not always been as it is now but has changed from a primal chaos into its present form. That it owes its existence and its features to an immeasurably powerful being who made it to serve His purposes. That it was originally not evil and not neutral as between good and evil and not a mixture of good and evil but simply good. That human beings are part of this world are formed from its elements—that they were not separately created and then placed in it like figurines in a China cabinet. That the stars and the moon are inanimate objects and are without any religious significance—that, at least in relation to human beings, their main purpose is to mark the hours and the seasons. That it is not only kings but all men and women who are images of the divine. That human

5. Lewis, *Reflections on the Psalms*, p. 92. Again, no citation is given.

beings have been granted a special sort of authority over the rest of nature. That these divine images, the stewards of all nature, have, almost from their creation, disobeyed God, and have thereby marred the primal goodness of the world and have separated themselves from God and now wander as exiles in a realm of sin and death.

So our imaginary credulous reader of Genesis comes to believe some true things and some false things. The first (but not the last) point to note about the credulous reader's situation is that the true things are much more important than the false things. In fact, the true things are among the most important there are, and the false things are not very important at all. Someone who believes that the world began six thousand years ago is wrong; so is someone who believes that Columbus was the first European to reach North America. For the life of me, however, I can't see that it is much more important to get the age of the earth right than it is to get the identity of the first European voyager to reach North America right. I can expect a protest at this point from both the literalists and the saganists. Each will tell me that the question of the age of the earth is of very great importance. The literalist will say that it is important because a mistake about the age of the earth could lead one to reject the Word of God, and the saganist will say that it is important because a mistake about the age of the earth could lead one to reject science and reason. But these protests rest on a misunderstanding. I am talking about the *intrinsic* importance of a mistake in this area, not about its *extrinsic* importance. Clearly any false belief whatever, however trivial its subject matter, *could* have disastrous consequences in special circumstances. We could easily imagine circumstances in which a woman's mistaken belief that her husband had stopped to buy a newspaper on his way home from work led her to suspect that he was lying to her about his movements and eventually destroyed their marriage. And, of course, a false belief about the age of the earth could lead to a disastrous repudiation of the reliability of something that *is* reliable and whose reliability is important. It could, in fact, lead one to devote a large portion of one's life to defending the indefensible—as, no doubt, false beliefs about Columbus have done. What I am saying is that the matter of the age of the earth is of little importance in itself. This is far from an empty platitude. The last few hundred years have seen thinkers who overestimate the intrinsic value of scientific knowledge as absurdly as Matthew Arnold and F. R. Leavis overestimated the intrinsic value of a well-honed literary sensibility. Here is a quotation from the Nobel Prize–winning physicist Steven Weinberg that illustrates the evaluation I am deprecating:

> The more the universe seems comprehensible, the more it also seems pointless.
>
> But if there is no solace in the fruits of our research, there is at least some consolation in the research itself. Men and women are not content to comfort themselves with tales of gods and giants, or to confine their thoughts to the daily affairs of life; they also build telescopes and satellites and accelerators, and sit at their desks for endless hours working out the meaning of the data they gather. The effort to understand the universe is one of the very few things that lifts human life a little above the level of farce, and gives it some of the grace of tragedy.[6]

Against this, I would set the following statements of the "great champion of the obvious," Dr. Johnson:

> We are perpetually moralists, but we are geometricians only by chance. . . . Our speculations upon matter are voluntary and at leisure.
>
> [Scientific knowledge] is of such rare emergence that one man may know another half of his life without being able to estimate his skill in hydrostatics or astronomy; but his moral and prudential character immediately appears.
>
> The innovators whom I oppose are turning off attention from life to nature. They seem to think that we are placed here to watch the growth of plants, or the motions of the stars.[7]

Well, I have set before you a choice of values. If you think that the evaluation of scientific knowledge that is implicit in my quotation from Weinberg is the right one and that Johnson's belongs to the rubbish of history and good riddance to it, you will not believe a word of anything I am going to say. But at least don't mistake my position: I am not saying that science is unimportant; I am only denying scientific knowledge the central place in the proper scheme of human values that Weinberg gives it. I also deny this central place to a knowledge and appreciation of history or music or literature, each of which is neither more nor less important than scientific knowledge.

My first step in reconciling the thesis that Genesis is the revealed Word of God with the findings of science is, therefore, to contend that

6. Steven Weinberg, *The First Three Minutes: A Modern View of the Origin of the Universe* (London: André Deutsch, 1977), p. 155.

7. Quoted by Michael D. Aeschliman, *The Restitution of Man* (Grand Rapids, Mich.: Wm. B. Eerdman's, 1983), pp. 25–26. The quotations are from Johnson's essay "Milton," in his *Lives of the English Poets*.

what Genesis is right about is of great intrinsic importance and that what it is wrong about is of little intrinsic importance. This contention, however, raises the question why Genesis, if it is the Word of God, is wrong about *anything*. I said that I should discuss questions both of content and of formation. I have said something about content. To discuss the question I have now raised I introduce some points having to do with the formation of the Genesis narrative—the genesis of Genesis, as it were.

What is the purpose of the first chapters of Genesis? What is their purpose in relation to the Hebrew Bible as a whole? The Hebrew Bible is mainly the narrative of God's covenant relationship with His people Israel. The opening chapters of Genesis are intended to set the stage for the story of that covenant. They are intended to describe and explain the relations between God and humanity as they stood when God made a covenant with Abraham. Thus, Genesis begins with an account of the creation of the world and of human beings, an account which displays God as the maker and sovereign of the world and the ordainer of the place of humanity in the world, and which does that in a way that militates against various disastrous theological misconceptions current among Israel's neighbors and conquerors—as that divinity is divided among many beings whose wills are often in conflict; or that the lights in the sky are objects of worship; or that the image of divinity is present in a few human beings—kings—but not in ordinary people. But then why doesn't Genesis get it right? I say that Genesis does get it right—in essence. W. J. Bryan may have been a fool in many respects,[8] but he had a more accurate picture of the cosmos than Carl Sagan (who, if we may trust the Fourteenth Psalm, is also a fool). Bryan believed that the world had been created by God, and that by itself is enough to outweigh all the matters of detail in which Sagan is right and Bryan wrong. But why doesn't Genesis get it right not only in essence but in detail? Why doesn't Genesis get it wholly right? After all, we expect a reliable source to get even relatively unimportant details right, insofar as it is able, and God knows all the details. The beginning, but not the end, of the answer to this question is that if Genesis did get it right in every detail, most people couldn't understand it. Never mind the fact

8. But not nearly so big a fool as the character who bears his name in the almost wholly fictional movie *Inherit the Wind*. The popular account of the Scopes trial is one of the two great legends of the saganist history of Darwinism, the other being the story (as it is usually told) of the confrontation between T. H. Huxley and Bishop Wilberforce in 1860. Of course, each of these legends, like Piltdown Man, was put together from pieces of real things.

that only a person with years of rigorous formal training in mathematics can fully understand the current theories about the first three minutes of the existence of the cosmos. Consider only the *age* of the cosmos: more than ten thousand million years. You and I can in a sense grasp numbers like 10^{10}: we know how to do arithmetic with them. But how could the age of the universe be conveyed to most people at most times? Suppose the Bible began, "Ten thousand million years ago, God created . . . " Suppose you are a missionary trying to explain the Genesis narrative to a tribe of Amazonian Indians. How shall you explain these words to them? Shall you leave off teaching them about important things like the sovereignty of God till you have taught them about unimportant things like the decimal system? (Do not suppose that teaching them the decimal system will be the work of an afternoon, for there is no basis in their culture for using the kinds of numbers it gives access to.) And most cultures have been like our imaginary Amazonian culture in that respect. A scientifically accurate rewriting of Genesis, therefore, would turn it into something all but useless, for the result would be inaccessible to most people at most places and times. Only a few people like you and me—who are simply freaks from the historical and anthropological point of view—could penetrate even its surface. I wonder how many of us believe, at some level, that God—if there is a God—regards scientifically educated people as being somehow the human norm and therefore regards Amazonian Indians or elementary-school dropouts as being less worthy of His attention than we; I wonder whether many of us aren't disposed to think that if the Bible were divinely inspired it would be written with the preoccupations of the scientifically educated in mind? I will not bother to quote the very clear dominical and Pauline repudiations of the values that underlie this judgment. Everyone is of equal value to God and the Bible is addressed to everyone. A Bible that was made easy for kings to understand at the cost of making it hard for peasants to understand would be in violation of this principle—if only because there are a lot more peasants than kings. And, of course, there are a lot more people who could not understand a scientifically accurate rewriting of Genesis than there are people who could.

To this I can expect the skeptic to reply along the following lines: "That's beside the point. Of course the universe is so complex—no doubt any *possible* universe would *have* to be so complex—that only a few highly trained people in a few very special cultures could understand a *detailed* account of its origin and development. But the writer of Genesis could have described the early history of the cosmos very

abstractly. He could have included all of the theses that you regard as 'important truths', and, nevertheless, everything he said about the development of the physical universe could have been true as far as it went. When God inspired the author of Genesis. why didn't He inspire him to write it that way?" The answer to this question is threefold. One of the three parts I am not going to explore. I will simply mention it and leave it. I do this because I think it is very important, but that it could not be adequately discussed within the scope of this essay. It is this: not all the truths that are revealed in Genesis can be said; some (to employ a distinction of the early Wittgenstein) can only be shown. These truths, I believe, truths relating to sin and knowledge, can be shown only by telling a very concrete story. I believe that as a result of knowing the story of the fruit of the knowledge of good and evil, I know something important that I cannot articulate; something which could not have been conveyed in discursive prose and which perhaps did not have to be conveyed by a story about trees and a serpent but which certainly had to be conveyed parabolically—that is, by means of *some* story about the actions of concrete, picturable beings.

I pass with relief to the two more straightforward points I want to make. First, that an abstract version of Genesis would have little pedagogical value for most people at most times. Even if it contained all the correct lessons, the lessons would not be learned—or would be learned only by rote, as "lessons" in the schoolroom sense. Secondly, the idea of God's inspiring Moses (or whomever) to write an "abstract" Genesis purged of all harmless error seems either to presuppose a primitive "dictation" model of inspiration or else to imagine God as purging His revelation of harmless error at a very high cost to the recipients of that revelation. I will illustrate these points with a parable.

Imagine that a doctor visits our Amazonian Indians with the intention of teaching them some useful medicine—say, some elementary principles of first aid and hygiene and antisepsis, and such pharmacological lore and simple surgical procedures as they can be trusted with in the absence of continuing supervision. What would be the best way to teach such things? One might give one's pupils a précis of a medical encyclopedia, deleting whatever material was not applicable to their condition. But this précis, because it was presented in a form that was without model or precedent in their culture, might well be forgotten or ignored or even be sung as a chant to accompany the application of traditional tribal medical procedures. Another, and perhaps more effective technique, would be to revise and purify and extend the existing medical lore of one's pupils, making use of literary and mnemonic

devices indigenous to their culture. In applying this technique, one might simply not bother to correct parts of the existing medical lore that were harmlessly wrong. If one's pupils believed that childbirth fever was caused by demons, why should one not teach them that the demons must make their way into the bodies of new mothers via the hands of midwives, and that this path could be blocked by a scrupulous ritual washing before the delivery? If this teaching would lead to the same behavior on the part of midwives as a much longer lesson that involved an introduction to the germ theory of disease, and if the extra time required by the longer lesson were time that could be devoted to a lesson about making effective splints—well, one would have to ascribe a very high value indeed to truth in the abstract to recommend the longer lesson.

This parable has, I hope, presented an analogical case for the pedagogical ineffectiveness of an "abstract" Genesis. It also shows, by analogy, some of the difficulties God would encounter in getting an abstract Genesis into our hands, even granted that it would be advisable to do so. He might, of course, have dictated it, Hebrew word by Hebrew word, to a shining-faced Moses or to some terrified priest in the time of the Captivity. I do not want to say that revelation never occurs in that mode: perhaps the Name of God and the Ten Commandments were delivered to Moses in that way. But it is certainly clear that little, if any, of the Bible has been simply dictated by God: God's usual procedure has been to use as His instrument of revelation the whole person of an inspired author and not simply the hand that held the pen. If God has simply dictated Genesis, then He might as easily have dictated a "pure" abstract version of Genesis as any other. If, however, He proceeded, as He seems usually to have done, by inspiring modifications of the kind of story that it was natural to the author—who must be the concrete product of a particular culture, even as you and I are—to tell, then it would have been a very difficult business to produce an abstract Genesis. Not that anything is too hard for God, but, if God chooses to work with human tools, He subjects Himself to limitations inherent in the nature of the tools.

The human author or authors of Genesis, whatever their historical period may have been, would have had no natural disposition to tell a story like our imaginary abstract Genesis, a story utterly at variance with every model provided by their own culture and every other culture I know of. People are not naturally inclined to divest a story they want to tell of the concrete details that give that story its character, and the ancient Hebrews had very concrete minds indeed—as did all their

contemporaries. No doubt the continued influence of the Holy Spirit could *eventually* have produced an abstract Genesis. I have no idea how long this would have taken, but certainly longer than it took to produce the concrete, suggestive, effective Genesis that we have. And what would have been the value of this costly thing? Only this: that a few saganists in our own time would have had to find some other excuse to reject the Word of God than its disagreement with the fossil record. I do not see why God, who values any six holders of endowed chairs neither more nor less than He values any six agricultural laborers in ancient Palestine, should have thought the price worth paying.

This completes my outline of the position that I oppose both to Genesiac literalism and to saganism. I shall now, as I have promised, offer critiques of literalism and saganism from the point of view afforded by this position.

To the literalists, I have little to say. Anything I said to them would be based on a premise that no literalist could accept: that "creation science" is pretty much nonsense. It's not that it's not science at all, as the rather silly—and certainly politically motivated—Arkansas decision would have it. It's that—in my view, at least—it's very bad science, consisting of contrived, ad hoc arguments and selective appeal to evidence.[9]

As to the saganists, I can happily accept a good deal of the story they tell about how the world got into its present state. The universe of modern cosmology is a cozy, tightly knit affair, entirely unlike the rather frightening infinite and amorphous universe of nineteenth-century popular science, a universe which, in my view, was not based on the actual content of nineteenth-century science but which was rather an ideological construct put together for the express purpose of making theism seem implausible. The nineteenth-century cosmos was made infinite and amorphous so that anything might happen in it given sufficient time. It was made eternal to ensure sufficient time—and, of course, to avoid awkward questions about where it came from. But the lovely universe the late-twentieth-century cosmologists have given us is as tidy and peculiar and homely as the medieval *mundus* of crystalline spheres.

I cannot, of course, accept the saganists' statement that the cosmos is all that is or was or ever will be. (Nor can I accept the fatuous

9. This is well documented in many publications. Howard J. Van Till, Davis A. Young, and Clarence Menninga, *Science Held Hostage: What's Wrong with Creation Science* and *Evolutionism* (Downers's Grove, Ill.: InterVarsity Press, 1988), is as good as any.

attempt of the deists to append a Creator and Voyeur to the saganists' cosmos.) From my point of view, the cosmos depends from moment to moment on the sovereign power of God who is infinitely greater than it, and it would vanish, all in a moment, like a candle flame in a high wind, if He were to stop supplying it with the power to continue to be. And I believe that the Lord and sustainer of the cosmos, the only helmsman of the wide and single stars, the faithful guarantor of the laws of nature, has become locally involved in His creation in a special way, and that, as a result, a man has risen from the dead and many other miracles have occurred.

So I differ from the saganists on two points at least: the cosmos does not exist on its own, and the power that sustains it sometimes manifests its sustaining presence in ways radically different from the norm (that is, there are miracles). Now if I differed from the saganists on only these two points (and on such closely related points as the imminent end of the Church), they and I could accept pretty much the same science. Whether the world depends on a power outside itself, and whether there are miracles are not questions to be decided by science. (I do not of course deny that if science can provide a convincing natural explanation for a hitherto mysterious event, then that is an important piece of evidence that must be taken into account by anyone who is trying to determine whether *that event* is a miracle. But this point has nothing to do with the question whether there are miracles.) Thus it would seem that on one point at least the saganists and I agree against the literalists: we accept the same science, or, at least, they and I are no more likely to disagree about science than are any two saganists.

As a matter of fact, however, this is very far from being true. If the saganists' science were entirely correct, this would not trouble me a bit. Nevertheless, I'm very skeptical about some of it. It's just not clear to me that it all *works*. There are three points about which I am doubtful. The first of them has to do with the beginning of the cosmos. When it began to emerge that the cosmos had a beginning in time, or, at least, that the cosmos did not have an infinite past in which it was pretty much the same as it is now, saganists began to try to come to terms with this awkward fact—producing in the process such philosophically motivated theories as the now discredited steady-state theory, the pretty much discredited "oscillating universe" theory, and the currently rather fashionable theory that the cosmos began as a quantum fluctuation. All these theories are addressed to the same sort of questions as the cosmological argument. I will not discuss them. I want instead to raise some questions in the general vicinity of the argument from design. (But I am not going to discuss those very general features of the cosmos and the laws it obeys that have led some to observe that it appears to have been "fine-tuned" to permit the existence of life—the features that led Fred Hoyle to say, one might almost say to *complain*, that it looked as if a superintellect had been monkeying with the laws of physics.) The two theses which are important components of the saganists' science and about which I am doubtful are their theses concerning macroevolution and human origins. (To these two theses a third might be added: that life arose as the result of a purely natural process. But it would be hard to have a profitable discussion of this question, because, owing to the fact that the origin of life is at present wholly mysterious, wise saganists will probably want to say only that life arose by *some* natural process, and, while I am not as sure of this as they are, I see no particular reason to dispute it. I will remark only that if all life on earth is, as someone facetiously suggested, descended from bacterium-like organisms negligently deposited by extraterrestrial picnickers on the recently cooled surface of the earth, this would account perfectly for the earliest fossil evidences of life.)

Let us turn to the topic of macroevolution, the evolutionary differentiation of very broad taxa, such as phyla. Macroevolution, according to saganism, is microevolution writ large. The same principles of random variation and natural selection that have caused a pair of fruit flies blown by chance to the Hawaiian Islands to have descendants that belong to many different species have brought it about that that first self-replicating molecule has as descendants arthropods and vertebrates and the members of every other phylum.

There is, I think, no reason to believe this, beyond the bare fact that phylogenesis has in fact occurred. This is not to say that there is no reason to believe that all living organisms have a common ancestry. No doubt the fact that penguins and spiders and algae share at least one apparently arbitrary characteristic—the code by which nucleic acid specifies the structures of proteins—is best explained by the same hypothesis that explains the common features of the Hawaiian fruit flies: common ancestry. The common-ancestry thesis cannot be regarded as a fact that is known simply on the basis of induction on many observations since (I believe) no two known species, living or extinct, are such that it is universally agreed by the experts that one is ancestral to the other; even cases in which, of two known species, one is believed by some experts to be ancestral to the other (e.g., *Homo sapiens* and *Homo erectus*) are rare.[10] But the indirect arguments are persuasive. It

10. The logical structure of this thesis could easily be misunderstood. Compare the following similar statement: No living human being is known to be descended from any

is not that there are no difficulties with the common-ancestry hypothesis, but, as Cardinal Newman said in another connection, a thousand difficulties do not add up to a single doubt, and it seems reasonable to believe that these difficulties will someday be resolved. So I am not saying that the common-ancestry thesis is supported by no evidence beyond the bare fact that phylogenesis has occurred. What seems to me to have only that much evidential support is that the interplay of random variation and natural selection—I shall hereafter refer to this interplay as simply 'natural selection'—is the sole mechanism responsible for the genesis of phyla and other broad taxa. Or, since we are not disputing the common-ancestry thesis, we may say: for the *differentiation* of phyla and other broad taxa—that is, for macroevolution.

One of the strongest reasons for being skeptical about the hypothesis that natural selection is the only mechanism driving macroevolution is the absence of intermediate forms. This absence is striking, even at the level of the biological class. Amphibians, for example, are supposed to have evolved from lobe-finned fish in a sequence that involved no radical difference between one generation and the next. A few fish of some species, or so the story goes, got into some environmental situation in which, owing to natural selection, their descendants in due course formed a new species; a population of fish belong to *that* species suffered a similar fate, and, eventually, across a bridge of many, many species, the original population of fish produced descendants with pentadactyl limbs and all the other taxonomic characteristics of amphibians. The trouble with this scenario is that the fossil record reveals none of these intermediate species. Full-blown amphibia simply *appear* at a certain point in the fossil record with no visible not-quite-amphibian antecedents. And this is not an isolated example: there are few, if any, even remotely plausible fossil candidates for intermediates between reptiles and amphibians or between any class and the class out of which, by general agreement, it is supposed to have evolved. And yet the theory of evolution by natural selection seems to predict that, if the members of class *A* are descended from a population belonging to class *B*, then there must once have existed a vast number of "transitional" organisms, organisms intermediate between the two classes. The theory seems to make this prediction because the members of any two classes are radically different in anatomy and physiology

known human being who lived before the fall of Rome. Indeed, it is possible (although unlikely) that no person known to history who lived prior to A.D. 400 has any currently living descendants.

and because the effects of natural selection on a population accumulate very gradually.

Darwin was deeply troubled by the fact that no trace had been discovered of forms intermediate between broad taxa. His solution to the problem was to ascribe the absence of known intermediates to the inherent imperfection of the fossil record and to the fact that "only a small portion of the surface of the earth has been geologically explored and no part with sufficient care."[11] In Darwin's day, fewer than 1 percent of the fossils that have today been discovered and catalogued were known. My impression is that today few if any paleontologists accept his solution. If my amateurish researches have not led me astray, the current judgment of most paleontologists is that if, for example, amphibians had evolved from some population of fish as gradually as Darwin believed they must have, then the fossils of some forms intermediate between fish and amphibians would almost certainly have been discovered. The obvious move to make in the face of this judgment, if one wants to save the hypothesis that natural selection is the sole mechanism behind macroevolution, is to say that the evolutionary differentiation of the amphibia proceeded not gradually but explosively and that the number of generations separating true fish and true amphibian was consequently very small. ('Gradual', 'explosive', and 'small' are, of course, relative terms. Any evolution by natural selection must be "gradual" by some standards, since any generation of the most rapidly evolving population must be practically indistinguishable from its predecessor. The idea is that, contrary to what Darwin thought, the time required for a species to become distinct is small in comparison with the average "lifetime" of a species of that sort.) In that case, the intermediate organisms would not have been numerous or widespread. If they were few and were confined to a small geographical area, then the discovery of even one fossilized intermediate could be highly improbable. And, of course, the same story can be told about all macroevolutionary transitions. It goes like this: *all* taxa at whatever level tend to be stable—particularly as regards the gross anatomical properties evidence of which is preserved in fossils—for long periods and then, under special environmental conditions, to differentiate locally and all but instantaneously. Now by the timetable of the geological record, "instantaneously" could comfortably encompass many thousands of generations of evolving organisms. The trick is to suppose that differen-

11. Charles Darwin, *The Origin of Species*, 6th ed. (1872; New York: Collier Books, 1962), p. 327.

tiation occurs slowly enough to be explained by natural selection and fast enough to account for the absence of intermediate forms from the fossil record.[12] Well, maybe this will work. But the skeptic will wonder whether such a rate exists, even as an abstract possibility. Despite my very real awareness of my ignorance of these matters, I make bold to confess that I find it difficult to believe that some fish was separated from some amphibian by only—to pick a figure that must be right within a factor of two or three—ten thousand generations, each of which differed from is predecessor only to the extent allowed by the operation of natural selection. Most biologists, apparently, find this easy enough to believe. The ignorant skeptic like myself, the village atheist, will wonder whether their ability to believe this is rooted in their nuts-and-bolts anatomical, physiological, and biochemical expertise, or whether it is a product of their belief that things could easily have happened this way because this is how things did in fact happen.

And then there is a statistical problem. Even if there were few enough intermediates between fish and amphibian for it to be highly improbable that we should have found any of their fossils, it could nevertheless be highly probable that we should have found fossils of intermediates between *some* two classes.[13] The statistical principle I am appealing to is illustrated by the following fact: If I am a member of a randomly selected group of twenty-three people, the odds are just short of 17 to 1 against any of the others having the same birthday as I, but the odds are better than even that *some* two people in the group of twenty-three will have the same birthday.

One can also raise the question whether the missing intermediates are even logically possible, given that evolution proceeds by natural selection alone. Let us ask the question this way. If you took the genotype of a given lobe-finned fish, could you change it into the genotype of a given primitive amphibian by a sequence of gradual steps of the kind that evolution—even explosive evolution—by natural section requires? (Here we think of natural selection as operating at the genetic

12. These words are my own attempt to give a brief statement of the "theory of punctuated equilibria" in such a way that this theory is clearly represented as a Darwinian theory. For a description of the theory of punctuated equilibria by its most eloquent exponent, see Stephen Jay Gould, "The Episodic Nature of Evolutionary Change," in his *The Panda's Thumb* (New York: Norton, 1980).

13. But what about *Archaeopterix?* Is it not an intermediate between reptiles and birds? This is possible. There are, nevertheless, powerful arguments for the conclusion that *Archaeopterix* was simply a bird. See chap. 8 of Michael Denton, *Evolution: A Theory in Crisis* (Bethesda, Md.: Adler & Adler, 1986), for a discussion of *Archaeopterix* and the coelacanth and other candidate "intermediates."

level; we think of selection pressure changing the relative frequencies of the genes that make up a population's gene pool.)

It might be argued that it is easy to see that this would be possible. Suppose that the fish and the amphibian genomes each contain one hundred thousand loci and that, in our two selected organisms, the same genes are present at ninety thousand of them and different ones at the other ten thousand. Then to change the genotype of the fish into the genotype of the amphibian in a sequence of one thousand steps, we simply make the necessary gene replacements ten at a time. The problem with this argument is that there is no guarantee that such a procedure would produce at each step a genotype that corresponds to a viable organism. In fact, I find it hard to believe that it would. Let me try to make my difficulties with this notion clear by means of an analogy.

Suppose we own a very sophisticated automated factory. Properly programmed, our factory is capable of turning suitable raw materials into just about any sort of finished product. At present, a stream of steel ingots is flowing into the factory and a stream of meat grinders of identical design is flowing out. Another program, which we have in our files, would cause the factory to produce meat grinders of a more advanced design. (No single part of the "advanced" meat grinder, not even the smallest nut or bolt, would be exactly like any part of the current, "primitive" meat grinder.) Now let us examine printouts of the two programs. Each program consists of one hundred thousand lines, each line being a complex string of characters. Ninety thousand lines are the same in the two programs, and the rest different. Could you change one program into the other by a sequence of one thousand ten-line-at-a-time changes? Obviously you could. But would all the "intermediate" programs produce some sort of meat grinder—or anything at all? It is hard to see how this could be. The new instruction that you insert at line 27 tells a bolt-making machine to produce bolts of a size slightly larger than the bolts it contributed to the original meat grinder. In order to accommodate that change, you have to change the size of 24 holes to be bored in 16 pieces of metal produced by four stamping machines and two milling machines; you have to change the instructions that determine the sizes of the nuts intended to fit those bolts; you have to reprogram the devices that pick up and manipulate the nuts and bolts; it will now take only 960 bolts instead of 1,000 to fill a standard bolt-bin, so the bins will have to be emptied every 88 seconds instead of every 92 seconds or they will overflow, and so the rate at which the bolt-collecting machine moves among the bins will

have to be increased by an appropriate amount—and so on and so on. Unless all of these modifications in the factory's behavior can be embodied in nine other one-line changes in the program—changes that do not themselves necessitate yet further changes—*any* ten-line change in the program that includes the change we have introduced at line 27 will produce not meat grinders but a lot of jammed milling machines and conveyors belts.

It seems to me that the genotypes that underlie the physiology and anatomy of a given fish and a given amphibian are probably in this respect a lot like the programs that underlie our two styles of meat grinder. That is, I doubt whether there is any path in logical space from one to another that proceeds by changing a small number of genes at each step: every path you try will (I suspect) eventually run up against organs and systems that are no longer coordinated—perhaps even against proteins that don't fold properly. You can only look from one to the other and shake your head sadly and say, "You can't get there from here." At least not by the mode of transport envisaged. Not by a sequence of steps the size that selection pressure can effect in a given gene pool in one generation. That is *local* transport. It can take you from light peppered moths to dark ones and—a much longer ride—from one species of fruit fly to another. These are in different parts of the same town. It's no good if you want to go from Europe to Australia—that is, from the fish to the amphibia. I should also point out that even if there *are* possible"small-step" paths from fish to amphibia, these paths might compose only an infinitesimal region within the space of all the possible paths that confront the ancestral population of fish, and thus the evolution by natural selection of amphibia from fish might be so vastly improbable as not to be worth considering.[14] And—to return to our previous theme—it might be that all or most of the possible paths are too long to be consistent with the absence of intermediate forms from the fossil record.

Nevertheless—or so I believe—the amphibia did evolve from some population of fish. If this is right, there are two possibilities. There is

14. We should remember, however, that vastly improbable events are not necessarily surprising events: the conception and birth of a human being with any *particular* genetic makeup is a vastly improbable event. It might be that the number of possible biological classes that could evolve out of *some* population of fish is so huge that it is not surprising that one such class did evolve, despite the fact that the prior probability of *its* evolving was all but infinitesimal. I cannot myself believe that logical space contains a suitably enormous number of possible classes that could evolve from some population of fish, but one's intuitions in this area are probably not of much value.

the possibility that an intelligent being has been guiding evolution by a series of actions that directly affect the genes of the evolving organisms. If we think in terms of our "meat-grinder" analogy, such a being would correspond to a computer programmer who turns one program into the other in a series of steps each of which involves a very large number of carefully coordinated changes. And there is the possibility that there is some yet undiscovered mechanism that does the same thing—perhaps not as efficiently as an intelligent being, but efficiently enough. The second possibility is the one that should be investigated, if only because the first cannot be *investigated.*

Remember the cautionary tale of Lord Kelvin. Assuming that the mechanisms underlying solar radiation must be explainable in terms of the physics he knew, the great physicist calculated—correctly, I understand, given his assumptions—that the sun could not have been shining for more than about twenty million years. When the paleontologists told him that there had been life on earth for much longer than that, he contemptuously replied, "There are two sciences, physics and stamp collecting," meaning that a paleontologist's *estimate* of a period of time must fall before a physicist's *calculation* of a period of time. But if he had had an open mind, he might have looked at the paleontological data and said something like, "It may be only an estimate, but it's a damned good one. It begins to look as if solar radiation may be produced by some mechanism other than heating due to gravitational compression, though I can't imagine what it might be." And, of course, there *was* such a mechanism, one that Lord Kelvin couldn't imagine because it was conceptually inaccessible to a physicist at the turn of the twentieth century.

Many areas of science present us with examples of cases in which long-term effects are produced by different mechanisms from those that produce short-term effects. Michael Denton has pointed out that this is true in the case of meteorology and geology: the mechanisms that underlie changes in climate are not those that underlie changes in the weather; mountain building is explained by mechanisms other than those that account for short-term, superficial geological change.[15] Nevertheless, it may be, for all I have said, that natural selection *can* account for macroevolution. Against the cautionary tale of Lord Kelvin should be set the cautionary tale of Sir Isaac Newton. Newton thought he saw that planetary orbits must be unstable, and he speculated that they were subject to periodic divine correction. Laplace, however, was

15. Denton, *Evolution,* pp. 87–88.

able to show that Newton's own mechanisms—the laws of motion and the law of universal gravitation—entail that planetary orbits are stable enough to account for our observations. The point of this tale would be unaffected if Newton had postulated not supernatural interference with planetary dynamics but an unknown natural mechanism that supplemented the mechanisms he had discovered. The totality of the implications of the theory of evolution by natural selection, like the totality of the implications of Newtonian mechanics, cannot be grasped by the mind in a single flash of insight. But I say this: our understanding of macroevolution is either in the position of our understanding of orbital mechanics before Laplace or else in the position of our understanding of solar radiation before the advent of nuclear physics. If the former—well, the theory of evolution by natural selection has had in Darwin its Newton, but it has not yet had its Laplace. I think that our tentative conclusion should be that the theory of evolution by natural selection alone is doubtful in a way that many scientific theories are not. We may be confident that we understand, at least in very broad outline, where the stars get the energy to shine and what the forces are that cause mountains to rise. It is premature to believe that we have even in broad outline a satisfactory theory of macroevolution. If we temporarily suspend our belief in the theory that macroevolution is microevolution writ large, I cannot see that we shall thereby come to any harm. The theory does not *do* anything for us that I know of, beyond just sitting there and providing an explanation for the diversity of life. In this respect it is like the theory that the diversity of life is the work of an intelligent designer. There are many beautiful and satisfying explanations of microevolutionary phenomena in terms of natural selection. (My favorite is the explanation of the showy plumage of male dabbling ducks.) But I know of no explanation of any macroevolutionary phenomenon—sexual dimorphism, say—in terms of natural selection.

Let us now turn to the evolution of humanity, or, more exactly, to the evolution of those cognitive capacities that make humanity so strikingly different from all other species: I mean the capacities that allow us to do fantastic things like theoretical physics or evolutionary biology or drawing in perspective or, for that matter, making a promise or deciding not to plant wheat if there's a dry winter—things absolutely without analogues in any other species.[16] The evolution of these capacities, unique in the history of life, is a phenomenon of microevolution, and, therefore, even if macroevolution involves other mechanisms than natural selection, it may be that our special cognitive capacities are entirely a product of natural selection. It must be understood that by "cognitive capacities" I mean capacities determined by the physiology of the brain: not capacities that are conferred on one by one's culture and education, but capacities that are written on one's chromosomes. I think that no one doubts that our paleolithic ancestors—our ancestors of, say, thirty thousand years ago—had more or less the same cognitive capacities as we. A paleolithic infant, transported to our era by a time machine and raised in our culture, would be as likely to grow into a normal and useful member of our culture as an infant brought here by airplane from Tibet. Moreover, an immigrant paleolithic baby would be as likely to become a brilliant high-energy physicist or evolutionary biologist as an immigrant Tibetan baby. If this is true, then the cognitive capacities needed to master—and to excel at—any modern scientific discipline were already present, in more or less their present statistical distribution, among our paleolithic ancestors. (A race of mute, inglorious Miltons indeed!) And this means, according to the saganists, that these capacities evolved by the operation of natural selection among the ancestors of our paleolithic ancestors. And this, in its turn, implies that there was some character, or set of characters, such that (a) possession of those characters by some of its members conferred a reproductive advantage upon some population composed of our remote ancestors and (b) the presence of those characters within the present human population constitutes the biological basis of the human capacity for theoretical physics and evolutionary biology.

Have we any reason to think that there exists any set of characters having both these features? (Let us arbitrarily call a set of characters having both features *special;* I choose an arbitrary designation because an arbitrary designation is at least not tendentious.) If we have indeed evolved by natural selection from ancestors lacking the biological capacity to do physics and biology, then the answer to this question must be Yes; after all, we're here, and we are as we are. But if we set aside any conviction we may have that our cognitive capacities were produced by

16. When I wrote the pages that follow in the text, I was aware that they were inspired by a wonderful lecture of Hilary Putnam's, "The Place of Facts in a World of Values"—in *The Nature of the Physical Universe: The 1976 Nobel Conference,* ed. Douglas Huff and Omer Prewett (New York: John Wiley & Sons, 1979)—that I had read several years before. When I recently reread that lecture, in connection with preparing the present essay for publication, I discovered that I had remembered it better than I knew, and that in some places I had come close to reproducing Putnam's exact words. I have let these passages stand, on the principle that imitation is the sincerest form of flattery. (But Professor Putnam should not be held responsible for the ways in which I have used the materials he has provided.)

natural selection, can we discover any reason to believe that there exists—even as an abstract possibility—a "special" set of characters? It might be said that we know that a special set exists because we can point to it: our collective name for it is "intelligence." Now "intelligence" is a pretty vague concept, but not so vague that we can't see that this suggestion is wrong. I expect that no one would care to maintain that if (say) Albert Einstein and Thomas Mann had been switched in their cradles,[17] Mann would have made fundamental contributions to physics—or even that he would have become a physicist. It is very doubtful whether Mann possessed (in however latent a form) the quality that Einstein's biographers call "physical intuition," a quality which Einsein possessed in an extraordinary degree and which even a run-of-the-mill physicist must possess in some degree. And yet it would be simply silly to say that Einstein was more *intelligent* than his fellow Nobel Prize winner. Einstein did not discover the general theory of relativity because he was so very bright—though doubtless high intelligence was a necessary condition for his achievement—but, insofar as a "cause" can be named at all, because of his superb faculty of physical intuition. Couldn't we easily imagine a population whose members were as *intelligent* as we—if they were dispersed among us, we should hear them commended for their "intelligence" with about the same frequency as we should hear the members of any randomly chosen group of our fellows commended—but who were as lacking in "physical intuition" as the average accountant or philosopher or pure mathematician? (I mean, of course, to imagine a population that is *biologically* incapable of displaying any appreciable degree of physical intuition. No doubt certain genes must be present in an individual who possesses that enviable quality; what I want to imagine is a population of human beings within which some of these genes are so rare that the chance of the requisite combination of genes occurring in any of its members is negligible.) Couldn't such a population develop quite an impressive civilization—as impressive, say, as classical Chinese civilization or the civilization of ancient Egypt? The point raised by this question would seem to apply a fortiori to the reproductive success of such a population in a "state of nature." Why should a population with the gene frequencies I have imagined fare any worse in the forests or on the savannas than a population in which the genes that, in the right combination, yield the capacity for physical intuition are relatively numerous?

17. Actually, Mann was born in 1875 and Einstein in 1879.

The saganists' answer to this question will, I think, go more or less as follows. "You are making mysteries where none exist. You might as well make a mystery of my contention—and I do contend it—that the ability to play the cello is a product of natural selection. Isn't that mysterious, the mystery-monger asks, when there were no cellos, not even primitive cellos, on the primeval savannas? But the capacity to play the cello—that is, the biological capacity to be taught to play the cello in the right cultural circumstances, a biological capacity that was presumably about as frequent among our paleolithic ancestors as it is among us—is an aggregate of a lot of generally useful capacities. Two obvious ones are manual dexterity and the ability to discriminate pitches. Each was advantageous to our primitive ancestors, since they needed to chip flints and to interpret subtle changes in the chorus of insect noises in the forest night. We should also not neglect the fact that most, if not all, genes have many different effects on the constitution of the whole organism. It may therefore be that some of the genes whose co-presence in Einstein was responsible for his remarkable physical intuition were selected for in the remote past because of advantageous effects functionally unrelated to physical intuition. In sum, while we perhaps don't understand physical intuition all that well, there is no reason to doubt that its presence in a given present-day individual is due to a combination of genes that were, individually if not collectively, advantageous to our primitive ancestors."

Well, if there is no reason to doubt this, is there any reason to believe it? If I wanted to pick someone to learn to chip flints or to interpret insect noises, I should certainly pick a cello player over someone who was all thumbs or someone who was tone-deaf. But if you know nothing about a certain person except that he or she is a first-rate theoretical physicist, what can you predict that that person will be good at—other than theoretical physics? You know that the physicist will be of high general intelligence, but you don't need to look for a physicist if you want intelligence. You know that the physicist will have a certain flair for thinking in terms of differential equations, though not necessarily a degree of mathematical ability that would excite the admiration of a mathematician. And that's about it. I don't suppose that you can predict that the physicist will have much in the way of spatial intuition (in the sense in which spatial intuition is required by an architectural draftsman). Nor is the physicist particularly likely to be a good mechanic or an accomplished inventor of mechanical devices or especially good at balancing a checkbook or counting cattle.

Quite possibly the first person to have the idea of the bow and arrow

or to conceive the idea of making fire from the heat produced by friction would have to have had the qualities that would make a good physicist. Nevertheless, the intellectual conception of the great prehistoric inventions must have been a pretty rare occurrence; I can't see the great, but very rarely operative, advantages to a population of having in its gene pool the capacities for making such inventions as exerting much selection pressure on the population's gene pool. But let us concede that a population of modern human beings transported to some vastly ancient time (and divested of modern knowledge) would have had a distinct reproductive edge on otherwise similar populations that lacked the biological basis of physical intuition, owing to its capacity to invent the bow and arrow and fire-by-friction. This concession simply raises a further question: How did the gene frequencies that ground this capacity get established before—it must have been *before*—there was a relatively advanced technology to confer on them the opportunity to be advantageous? I find this question puzzling, but it may well have a plausible answer, and I don't want to let my case rest very heavily on the assumption that it has no plausible answer. I rest my case primarily on two further points.

First, *is* it all that clear that the idea of making fire by friction and the idea of understanding gravitation as a function of the curvature of space-time were arrived at by the exercise of the same cognitive capacity? "This causes heat; greater heat than this causes fire; therefore doing this longer and harder may produce enough heat to cause fire" is a splendid piece of abstract reasoning. But is there any reason to believe that a population a few of whose members are capable of such reasoning must also contain a few people who are, genetically speaking, Newtons and Einsteins? I can see no reason to be confident about the answer to this question, one way or the other.

Secondly, the "cello" analogy is deeply flawed. Cellos are human artifacts and are constructed to be playable by organisms that have such abilities as human beings happen to have. The structure of the science of physics is certainly not arbitrary in the way that the structure of a cello is. A race of intelligent beings descended from pigs rather than from primates might have invented stringed instruments radically different in structure from cellos and quite unplayable by human beings. And music itself is rather an arbitrary thing compared with science. If there are intelligent extraterrestrials who, like us, derive pleasure from listening to rhythmic sequences of sounds among which there are certain definite relations of pitch, it does not seem to be very reasonable to expect that we could make much of their sounds. To

adapt an aphorism of Wittgenstein's, if a lion could sing, we shouldn't want to listen. But if extraterrestrials have invented physics, their physics will have to be a lot like ours. Extraterrestrial physics must resemble terrestrial physics because physical theories are about the real world, and the same real world confronts pig, primate, and extraterrestrial. And yet (to take one example of the sort of thing physicists look into) the structures of the various families of elementary particles, and the forces by which they interact, can hardly have had any sort of effect on the evolution of the cognitive capacities of our remote ancestors. There is no reason for the paleoanthropologist to learn about the decay modes of the Z^0 boson in order to learn about how the brains of our ancestors evolved toward the possession of a capacity that is (among other things) a capacity to theorize about the decay modes of the Z^0 boson. Our ability to do elementary-particle physics seems to me, therefore, to be as puzzling as our ability to play the cello would be if cellos were not artifacts but naturally occurring objects, objects whose occurrence in nature was wholly independent of the economy of *Homo habilis*. Suppose, for example, that cellos grew on trees and only in a part of the world never inhabited by our evolving ancestors. Wouldn't it be a striking coincidence that some of us could learn to play them so well? Isn't it a striking coincidence that we can theorize about elementary particles so well?

I once heard Noam Chomsky say that our ability to do physical science depends on a very specific set of cognitive capacities, and that, quite possibly, the reason that there are no real social sciences may be that we just happen to lack a certain equally specific set of cognitive capacities. He went on to speculate that we might one day discover among the stars a species as good at social science as we are at physical science and as bad at physical science as we are at social science. He did not raise the question why natural selection would bother to confer either of these highly specific sets of capacities on a species. (Presumably the answer would have to be that the right gene combinations for success in physical science were just part of the luck of our remote ancestors' draw and that, having arisen by chance, these gene combinations endured because they were in some way advantageous to our ancestors. But we have already been over this ground.) Einstein once remarked that the only thing that was unintelligible about the world was that it was intelligible. He was calling attention to the (or so it seemed to him) unreasonable simplicity of the laws of nature, and he supposed, I think, that the world was intelligible because it was simple. That does not seem to me to be quite right. The ultimate laws of

nature may be simple, but that does not make them intelligible to highly intelligent people—Thomas Mann, say, or Virgil, or J. S. Mill, or Nietzsche—who lack the very specific set of cognitive capacities that enables physicists to pick their way through the flux of the phenomena to the deep simplicities. What is "unintelligible" if anything in this area is, is that some of us should possess those capacities.

Saganists, therefore, owing to their adherence to natural selection as the sole engine of evolution, believe in what I have dubbed a "special" set of characters—a set of characters that *both* conferred a reproduction advantage on some population of our remote ancestors *and* underlies our ability to do science. I, for reasons that I have tried to explain, am a skeptic about this. It seems to me that there is no very convincing argument a priori for the existence of a special set of characters and that the only argument a posteriori for its existence is that our scientific abilities could not be a consequence of natural selection unless such a set existed. For my part, however, I am going to suspend judgment about whether our scientific abilities are a consequence of natural selection till I see some reason to believe that there exists a special set of characters. Belief in a special set of characters, indeed, seems to me to be, in its epistemic features, very strongly analogous to belief in a Creator. More exactly, it is analogous to the type of belief in a Creator that is held by its adherents to rest on rational argument and public evidence—as opposed to private religious experience and historical revelation. There are, in my view, no *compelling* arguments for the existence or for the nonexistence of a Creator, no arguments that would force anyone who understood their premises to assent to their conclusion or else be irrational or perverse. There are compelling arguments for *some* conclusions: that the world is more than six thousand years old, for example, or that astrology is nonsense, but there are no compelling arguments for any conclusion of philosophical interest, whether its subject matter be God or free will or universals or the nature of morality or anything else that philosophers have argued about. Nevertheless, there are some very *good* philosophical arguments: serious arguments which are worth the attention of serious thinkers and which lend a certain amount of support to their conclusions. Among these, there are certain arguments having to do with God. The cosmological argument and the design argument, for example, appear to me to be arguments that are as good as any philosophical argument that has ever been adduced in support of any conclusion whatever. And yet the conclusions of these arguments (they are not quite the same) can be rejected by a perfectly rational person who understands perfectly all the issues involved in evaluating them.

I very much doubt whether there is any argument for the existence of a special set of characters that is any better in this respect than the design argument or the cosmological argument. It may nevertheless be that certain people—paleoanthropologists, perhaps—know that a special set of characters exists. It may be that they know this because of their mastery of a vast range of data too complex to be summarized in anything so simple as a single argument. By the same token, however, it may be that there are certain people who know that a Creator exists and know this because of their mystery of a vast range of data too complex to be summarized in anything so simple as a single argument.

My own guess is that neither sort of knowledge exists. If there are people who *know* that there is a Creator, this must be due to factors other than (or, perhaps, in addition to) the inferences they have drawn from their observations of the natural world; and no one knows whether there is a special set of characters. Belief in a special set of characters is based on nothing more than a conviction that natural selection must be the ultimate basis of all evolutionary episodes (except those so minor that, if no explanation in terms of natural selection is apparent, they may plausibly be assigned to genetic drift). And that conviction, like nineteenth-century conviction that the universe has always been much as it is at present, is one that is held mainly because of its supposed antitheistic implications. (Actually, it has no antitheistic implications, but it is widely believed that it does.) Atheists often preach on the emotional attractiveness of theism. It needs to be pointed out that atheism is also a very attractive thesis. Very few people are atheists against their will. Atheism is attractive for at least two reasons. First, it is an attractive idea to suppose that one may well be one of the higher links in the Great Chain of Being—perhaps even the highest. (This idea is attractive for several reasons, not the least of which is that most people cannot quite rid themselves of the very well justified conviction that a being who knew all their motives and inmost thoughts might not entirely approve of them.) Secondly, there are very few atheists who do not admire themselves for possessing that combination of mental acuity and intellectual honesty that is, by their own grudging admission, the hallmark of atheists everywhere. The theist, however, is in a position to be an agnostic about the existence of a special set of characters, just as someone who accepts the saganists' science is in a position to be an agnostic about the existence of a Creator. Each is in a position to say, "Well, I don't know. There may be such a thing. What are the arguments?"

Confident and logically acute theists are not going to be impressed

by arguments for the nonexistence of God. Because they are logically acute, they will see that, while some of these arguments may be worthy of serious attention, they are not compelling in the very strong sense I spelled out above. Because they are confident, they will not abandon a world-view of which that belief is an integral part for anything less than a compelling argument. Similarly, confident and logically acute saganists are not going to be impressed by arguments for the nonexistence of a special set of characters. Because they are logically acute, they will see that, while some of these arguments may be worthy of serious attention, none of them is compelling. Because they are confident, they will not abandon a world-view of which that belief is an integral part for anything less than a compelling argument.

In the past, theism has made important contributions to science. It has, in fact, been very plausibly argued that modern science did not (as the saganists suggest) arise in the teeth of clerical opposition but is rather a *product* of Western Latin Christianity, as closely connected with it (causally and historically, not logically) as is Gothic architecture. Those who accept this thesis, however, sometimes say that the umbilical cord connecting science to Mother Church has long since been cut, and that science now proceeds quite independently of the religious or antireligious convictions of its practitioners. I wonder if the case of evolutionary biology doesn't show that this is at least a partial falsehood. Suppose I am right in suggesting that there are grave difficulties with the idea that natural selection is the only mechanism behind macroevolution and the evolution of certain specifically human cognitive capacities. Suppose that the allegiance of saganists—and saganism is certainly widespread among evolutionary biologists—to these two evolutionary theses is due not to scientific considerations but to the atheism that is a central component of saganism. Consider, finally, the following two evaluations of the situation in evolutionary biology. The first quotation, rather a famous one, is from the *Encyclopédie française* (1965). Its author is the naturalist Paul Lemoine, professor at the Museum of Paris:

> The result of this exposé is that the theory of evolution is impossible. Basically, despite appearances, no one believes it anymore, and one says—without attaching any other importance to it—"evolution" in order to signify "a series of events in time"; or "more evolved" or "less evolved," in the sense of "more perfected," "less perfected" because such is the language of convention, accepted and almost obligatory in the scientific world. Evolution is a sort of dogma which the priests do not believe in anymore, but which they keep up for the sake of their flocks. It is necessary to have the courage to say this in order that the men of the next generation may direct their research in another way.[18]

Now taken as a sober sociological thesis about the beliefs of scientists, this must be regarded as Gallic overstatement. Many of the priests, perhaps a large majority, really do believe sincerely in their dogma. But there is an important truth behind the overstatement—or so it seems to me in my ignorance. The truth is that the theory of macroevolution by natural selection alone is doing no scientific work, and that adherence to it consists mainly in talking in a certain way. This quotation, by the way, gives the lie to the saganist thesis that the only resistance to the theory of evolution by natural selection is provided by theological obscurantists. As a matter of fact, there has been, ever since Darwin, a respectable body of scientific opinion opposed to the Darwinian account of evolution. For some reason, such opposition has been more prominent on the continent of Europe than in the English-speaking countries.

My second quotation is from the Australian biochemist Michael Denton:

> The overriding supremacy of the myth [sc., that natural selection accounts for all evolutionary phenomena] has created a widespread illusion that the theory of evolution was all but proved one hundred years ago and that all subsequent biological research—paleontological, zoological and in the newer branches of genetics and molecular biology—has provided ever-increasing evidence for Darwinian ideas. Nothing could be further from the truth. The fact is that the evidence was so patchy one hundred years ago that even Darwin himself had increasing doubts as to the validity of his views, and the only aspect of his theory which has received any support over the past century is where it applies to microevolutionary phenomena. His general theory, that all life on earth had originated and evolved in the gradual successive accumulation of fortuitous mutations, is still, as it was in Darwin's day, a highly speculative hypothesis entirely without direct factual support and very far from that self-evident axiom some of its more aggressive advocates would have us believe.[19]

18. Paul Lemoine, quoted by Etienne Gilson in *From Aristotle to Darwin and Back Again* [a translation by John Lyon of Gilson's 1971 *D'Aristote à Darwin et retour*] (South Bend, Ind.: University of Notre Dame Press, 1984), pp. 88–89.

19. Denton, *Evolution*, p. 77. Denton's book is indispensable reading for anyone interested in the scientific difficulties faced by the Darwinian theory of evolution. Since this essay was written, another indispensable book has appeared: Phillip E. Johnson, *Darwin on Trial* (Washington, D.C.: Regnery Gateway, 1991).

May we not speculate that atheism is impeding progress in evolutionary biology? If there are actually other mechanisms at work in evolution than natural selection, and if atheism is emotionally (though not, of course, logically) wedded to the idea that natural selection is the only mechanism of evolution, perhaps a leaven of theists among evolutionary biologists would make a genuine search for such a mechanism possible. Perhaps, in fact, a more general allegiance among its practitioners to the important truths contained in the book of Genesis could be of real service to science. If that is possible, however, it is not probable. Owing to the general perversity of human beings—a feature of our species whose explanation can be found in St. Paul's reading of the third chapter of Genesis—there is likely to continue to be only one kind of interaction between the book of Genesis and science: silly squabbles between Genesiac literalists and saganists.[20]

20. Parts of this essay were delivered as the Kraemer Lecture at the University of Arkansas, Fayettesville, Arkansas, in March 1989.