JOURNAL OF THE
AMERICAN
SCIENTIFIC
AFFILIATION

An evangelical perspective on science and the Christian faith

ORIGINS and CHANGE:

Selected Readings from the Journal of the American Scientific Affiliation

"The fear of the Lord is the beginning of Wisdom." Psalm 111:10

MEMBER epa EVANGELICAL PRESS ASSOCIATION

DEDICATION

to RUSSELL L. MIXTER

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Journal of the American Scientific Affiliation

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The American Scientific Affiliation
Elgin, Illinois

Printed in the United States of America

PREFACE

The American Scientific Affiliation (ASA) is a unique professional organization of over 2,000 scientists. It had its origin in 1941. ASA members share a common commitment to the scientific enterprise and the Christian faith. The stated purposes of the ASA are "to investigate any area relating to Christian faith and science" and "to make known the results of such investigations for comment and criticism by the Christian community and the scientific community."

To further these purposes the ASA has published a quarterly journal since 1949. The organization takes no official position on controversial issues other than its basic statement of Christian orthodoxy. Thus, a wide spectrum of articles and viewpoints have appeared on the pages of the Journal of the American Scientific Affiliation (JASA). In the past decade the JASA has come to be recognized as an outstanding forum for the discussion of crucial issues at the interface of Science and Christian thought.

Recently the ASA Executive Council determined that a publication of key articles selected from past issues of the JASA and oriented around a single, general topic might be of benefit to members, students and the Christian public. This volume is the first in a projected series. It deals with what is commonly viewed as the most critical topic in this field—Origins and Change. Many readers may feel instinctively that this topic boils down to a simple consideration of Creation vs. Evolution. It will be our hope to show that such a viewpoint is an oversimplification and quite inadequate from both a biblical and a scientific perspective.

The past two decades have seen the rise of several groups which stress a highly literal interpretation of the early chapters of Genesis as the *only* possible Christian position. They feel strongly that this position absolutely requires a recent creation ("young earth"). Thus, they are forced to seek some alternative explanation for the biological and geological evidence commonly viewed as indicating a great age for the earth. This they do by appealing to presumed effects of the Flood of Noah. Their views have been widely promulgated in a variety of publications.

Therefore, one of the major purposes of this volume of readings is to carefully exaluate the contemporary "young earth" viewpoint. Hopefully the reader will come to see that this exclusivist position is not the *only* possible Christian view of Origins and Change. Unfortunately, "young earth" advocates commonly appropriate the term "creationist" to themselves in such a way as to deny it to any other views relating biblical teaching with scientific evidence. The editorial at the end of this preface sets the concept of creation in a much broader and more appropriate framework.

The second major purpose of these readings is to show how reputable scientists have and are grappling with the relationships of their professions to their Christian faith. Sad to say, some branches of the contemporary Christian church are suspicious of the scientific enterprise, regarding it as somehow subversive of faith. A rational and patient weighing of evidence and a willingness to live with tentative conclusions are not always popular approaches with church leaders or laymen. They are, however, the essence of science. If we view the natural world as God's creation, we should not be reluctant to attempt to gain a better understanding of it by the scientific method.

The task of selecting a handful of articles from hundreds published in the JASA over the years has been difficult. Arbitrarily, only articles from the last decade were chosen. Where two or more equally good articles dealt with essentially the same topic, only one was used. Unfortunately, some important issues relating to problems of origin and change simply had not been addressed in the JASA during the past ten years. To that extent the coverage of the general topic is less than complete.

A leading figure in the ASA for many years has been Dr. Richard H. Bube, Professor of Materials Science at Stanford University. He served as President of the organization (1968) and since 1969 has greatly enhanced both the scope and stature of the JASA as its Editor. I can find no finer or clearer statement of the purpose of this volume than his editorial from the December 1971 issue of the JASA which follows.

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"In the beginning God created the heavens and the earth." Genesis 1:1

WE BELIEVE IN CREATION

It should be well known to readers of the *Journal ASA* that the American Scientific Affiliation does not take an official position on controversial questions. Creation is not a controversial question. I have no hesitancy in affirming, "We believe in creation," for every ASA member.

The Biblical doctrine of creation is one of the richest doctrines revealed to us by God. It reveals to us that the God who loves us is also the God who created us and all things; at once it establishes the relationship between the God of religious faith and the God of physical reality. It is because of creation that we trust in the reality of a physical and moral structure to the universe, which we can explore as scientists and experience as persons. It is because of creation that we know that the universe and everything in it depends moment-by-moment upon the sustaining power and activity of God. It is because of creation that we know that we are not the end-products of meaningless processes in an impersonal universe, but men and women made in the image of a personal God. It is by the formulation of "creation out of nothing" that we affirm that God created the universe freely and separately, and reject the alternatives of dualism and pantheism. To worship God as Creator is to emphasize both His transcendence over the natural order and His imminence in the natural order; it is to recognize that His mode of existence as Creator is completely other than our mode of existence as created. To appreciate God as Creator is to recognize that which He created as intrinsically good; the rationale for scientific investigation, the assurance of ultimate personal meaning in life, and the nature of evil as an aberration on a good creation are all intrinsic to such an appreciation. We believe in creation. It is unthinkable for a Christian to do otherwise.

"I believe in God the Father Almighty, Maker of heaven and earth." Apostles' Creed

WE BELIEVE IN CREATION

"For in Him all things were created, in heaven and on earth." Colossians 1:16

It is because of this foundational character of the Biblical doctrine of creation that it is unfortunate when the word "creation" is used narrowly and restrictively to refer—not to the fact of Creation—but to a possible means in the creative activity, usually to that means known as *fiat* creation. When it is implied that creation and evolution are necessarily mutually exclusive, or when the term "creation" is used as if it were primarily a scientific mechanism for origins, a profound confusion of categories is involved. The implication is given, deliberately or not, that if evolution should be the proper mechanism for the growth and development of living forms, then creation would have to be rejected. To pose such a choice is to do basic damage to the Christian position. It is to play directly into the hands of those evolutionists who argue that their understanding of evolution does away with the theological significance of Creation. If such an evolutionist is wrong to believe that his biological description does away with the need for a theological description, the Christian anti-evolutionist is wrong to believe that his theological description must make any biological description impossible.

The key to much of the evolution controversy lies in the recognition of the necessity and propriety of descriptions of the same phenomena on different levels of reality. Even a complete biological description does not do away with the need for a theological description, any more than a complete theological description does away with the possibility of a compatible biological description. Evolution *can* be considered without denying creation; creation *can* be accepted without excluding evolution. Evolution is a scientific question on the biological level; it would be unfortunate indeed if a scientific question were permitted to become the crucial point for Christian faith.

Evolutionary philosophy—shall we say rather evolutionary religion—may well be something quite different. In its anti-Christian form, such philosophical evolutionism may involve an exaltation of man, a denial of the reality of moral guilt in any theological sense, and hence an interpretation of the life and death of Jesus as nothing more than a good example. In this view, continued development and improvement are inevitably assured as man, now become conscious of evolution, completes for himself the process of the ages. Such evolutionism is a faith-system which competes for the religious allegiance of men, and against which the Christian faith is called to stand. But, if it is true that the evolutionist must realize that he has little scientific support for extrapolating biological evolution into a general principle of life, the Christian anti-evolutionist must realize that he has little religious justification upon which to attack a scientific theory dealing with biological mechanisms. How tragic it often is when Christians, seeking to avoid the errors of philosophical evolutionism, promulgate the falsehood that the efficacy of faith in the atonement of Christ effectively depends upon the dogmatic acceptance of *fiat* creation and the dogmatic rejection of any evolutionary processes.

We believe in Creation. We praise the Lord for that faith. But let us avoid either posing creation and evolution as intrinsically antithetical alternatives, the acceptance of one demanding the rejection of the other, or presenting creation as a scientific mechanism alternative to evolution, as though good science must ultimately lead to the verification of *fiat* creation and a falsification of evolution.

RICHARD H. BUBE

"By faith we understand that the world was created by the word of God." Hebrews 11:3

Part I. General Considerations

Introduction

The four readings in this section present quite varied perspectives on the general topic of Origins and Change. Maatman takes a broad, synthetic approach to Creation as a unifying principle in viewing the natural world. Willis analyzes the biblical concept of Creation as opposed to "Creationism" and reviews recognized weaknesses in the arguments for the General Theory of Evolution. Aulie critically reviews the historical and philosophical bases of Special Creation as currently propounded by "Creationist" groups. Jones, in a very personal way, examines the intellectual and emotional tensions for a committed Christian who is convinced by the evidence for General Evolution.

Dr. Maatman has contributed many articles to the JASA over the years. He has also authored the book *The Bible, Natural Science, and Evolution* (Grand Rapids, Reformed Fellowship; 1970). His present article is a stimulating correlation of the underlying unity seen in the physical sciences with the biblical teaching that God is the originator and upholder of the physical world. It well illustrates attempts to give a biblical perspective on some aspect of science.

Dr. Willis is a former President of the ASA (1975). He holds degrees in both theology and biology. His article draws from both backgrounds. It explores the meanings of the biblical terms that describe creative acts and contrasts these to the pre-conceived ideas of contemporary "Creationists." In addition, he briefly surveys the current scientific and philosophical challenges to the dogma of General Evolution.

The article by Dr. Aulie is a slightly revised version of material which previously appeared in the April and May 1972 issues of *The American Biology Teacher*. It is an extensive review of the high school textbook *Biology: A Search for Order in Complexity* produced by the Creation Research Society. Aulie shows clearly that the concept of Special Creation presented is a modernized version of ideas current in the early 1800s that are not inherently biblical.

Dr. Jones proposes a personal resolution of the scientific (not the philosophical) aspects of Evolution and a biblical Christian viewpoint. While you may not agree with his conclusions, his honesty and openness in portraying the emotional dilemma involved will be appreciated. The tentativeness of his conclusions in this unsettled area should be an example to all who ponder the problems of Origins and Change.

The Unity in Creation

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Man has always wanted to relate observations and put them under one logical roof. Thus, man tends to believe that the natural laws we formulate are themselves related to each other, and that the events in, and the properties of, the physical world can, in principle, lead either to a single natural law or to a small set of complementary natural laws. Man's tendency to accept a model of the physical aspect of the universe in which there can be uncertainty but no chaos, no incoherence in ultimate physical law, is consistent with the scriptural view of man and the remainder of Creation. When it is observed that the trend of events in the history of the physical sciences is just what God's people would expect, several conclusions follow. It is shown that one can make some decisions on how to teach physical science; that time, space, and matter as far as we are concerned are unified, that is, they must be thought of as existing together and not separately; and that there can be a Christian approach to the subject matter, not just the applications, of physical science. Other conclusions are also discussed.

Man has never been satisfied merely with making observations of the events in, and the properties of, the physical aspect of Creation. The universal desire to relate observations and put them under one logical roof is, during this scientific era, carried out by correlating observations to formulate natural laws. Man also has the tendency to believe that natural laws, like the observations upon which any one natural law is based, are not isolated from each other. Thus, all the events in, and the properties of, the physical aspect of Creation might, in principle, be related either to a single natural law or to a small set of coherent, complementary laws.

The Unification Principle

If one accepts for the physical aspect of Creation a model in which there can be uncertainty (in the Heisenberg sense) but no chaos, one is consistent with the scriptural view of Creation. God's people have always known the central principle of physical science: *A single power is the cause of whatever man observes in the physical aspect of Creation.* There is a unity in whatever man observes in the physical aspect of Creation, and therefore the central principle may be called the Unification Principle. Because of the general thrust of Scripture as well as the obvious interpretation of specific passages of Scripture, God's people have always known these things. God did not create chaos:

> For thus says the Lord, who created the heavens (he is God!), who formed the earth and made it (he established it; he did not create it a chaos, he formed it to be inhabited!): "I am the LORD, and there is no other. I did not speak in secret, in a land of darkness; I did not say to the offspring of Jacob, 'Seek me in chaos.' I the LORD speak the truth, I declare what is right." (Is. 45:18-19; all Scripture quotations are from RSV)

Everything is ordered because God upholds that which He has created:

> For ever, O LORD, thy word is firmly fixed in the heavens. Thy faithfulness endures to all generations; thou hast established the earth, and it stands fast. By thy appointment they stand this day; for all things are thy servants. (Ps. 119:89-91)

It is no accident that man can observe and formulate natural laws. Man was created so that he can carry out scientific work:

> Then God said, "Let us make man in our image . . . . . and let them have dominion. . . ." (Gen. 1:26)

This passage indicates that one consequence of man's creation in the image of God is man's ability to function as the head of Creation. As man exercises this dominion, he analyzes Creation and discovers how the forest of observations which he makes is ultimately related to the power of God. Both the Christian and the non-Christian bear the image of God and therefore both are capable of carrying out work in the natural sciences. Paul taught that all men know the power of God:

> Ever since the creation of the world his invisible nature, namely, his eternal power and deity, has been clearly perceived in the things that have been made. So they are without excuse; for although they knew God they did not honor him as God or give thanks to him . . . (Rom. 1:20-21)

Thus, all men know of God, even though some have distorted ideas of Him. Man knows God because he knows the eternal power of God. Therefore, all men have knowledge of the integrating power which is the reason for the order which makes scientific work possible. Our humanly-formulated natural laws point to the ultimate power Paul refers to. Even though not all men are conscious of this knowledge, Paul says that they have always had this knowledge. In acting upon this knowledge, all men have the urge to relate the forest of seemingly unrelated observations to the simpler and more general laws which point to that ultimate power.

In Paul's speech to the Athenians on Mars Hill he said that men who did not acknowledge God did, however, have knowledge of His power:

> So Paul, standing in the middle of the Areopagus, said: "Men of Athens, I perceive that in every way you are very religious. For as I passed along, and observed the objects of your worship, I found also an altar with this inscription, 'To an unknown god.' What therefore you worship as unknown, this I proclaim to you. The God who made the world and everything in it, being Lord of heaven and earth, does not live in shrines made by man. . . . (Acts 17:22-24)

Paul knew that God is the Creator, the Sustainer, the Ultimate Causer. He says in this passage that *this* God, the God whom Paul knew, was also the God that the Athenians knew, even though they said he is unknown and they worshiped Him in ignorance. *They knew Him because He displayed His power to them.* They could not escape this knowledge of God. In the same way today, the non-Christian tacitly admits that there is a God whenever he carries out scientific work, work that would be impossible were there no ultimate, coherent power in Creation.

An unusually clear picture of the meaning of coherence in Creation is given in the following passage:

> In [the Son] all things were created, in heaven and on earth, visible and invisible, whether thrones or dominions or principalities or authorities—all things were created through him and for him. He is before all things, and in him all things hold together. He is the head of the body, the church; he is the beginning, the first-born from the dead, that in everything he might be pre-eminent. (Col. 1:16-18)

All things hang together because their very existence depends upon Him Who is both God and man. He created everything, including the things the natural scientist analyzes, and He gives them continued existence.

Physical scientific activity is Christian when the physical scientist knows that the physical aspect of Creation with which he works is a manifestation of the power of a creating and upholding God.

Further Explanations

The relation between man, his observations, and ultimate law which is being suggested here calls for certain further explanations.

1. Kuhn exhibited keen insight when he showed that the scientific community moves from paradigm to paradigm, with "normal" science carried out only when the scientific community accepts a paradigm, a picture of how things are or a fundamental set of laws describing the physical world.[1] Kuhn claims, however, that as we move from paradigm to paradigm we are not necessarily moving toward a "true" picture of the universe. It is contended here, however, that we *are* moving toward a better and better understanding, that physical knowledge is unifiable, and that ultimately what we see is a reflection of the coherence in God himself.

Thus, the basic set of principles used to tie physics together in the nineteenth century was not the same as the set used in the twentieth century. We move to new levels. The twentieth century principles developed for physics have changed chemistry from a science in which the fundamental principles were dimly seen, if at all, to a science which is coherent. The new principles have both aided development within each of these two sciences and have brought these two sciences closer together.

2. The ideas suggested here do not improperly elevate the reasoning ability of man. Sometimes man can by deduction predict correctly observations which will be made, but often predictions are not borne out. The important fact for this discussion is that *after* observations are made they are usually shown to be related to earlier observations and natural laws already known. Also, our ability to predict is not useless: using Newton's laws, the scientific team that sent the first men to the moon predicted where the moon would be when the men arrived—and the moon was there.

3. When our observations lead us to conclude that there is a unifying power, we do not thereby prove the existence of God. What we do is *confirm* that which—according to Paul—all men know already, namely, that there is a God with eternal power.

Consequences of the Unification Principle

1. If work in physical science is fundamentally possible because of a characteristic which all men possess, then it should be possible to demonstrate to men in general the logical relation between seemingly unrelated observations. Practically, such a demonstration

can be made in teaching young people and adults of normal intelligence. Such a demonstration can be carried out if it is shown (a) that a certain experimental observation is precisely what one would expect, assuming the validity of certain elements of the student's prior knowledge, and that (b) a seemingly unrclated observation can be shown to be what one would expect given the same prior knowledge. The two observations will then have been shown to be related.

In the method proposed the demonstration must begin with what the non-scientist student already believes to be true. What the non-scientist believes may actually be incorrect by modern scientific standards (e.g., the non-scientist might hold that energy is conserved, although it is more nearly correct to say that mass-energy is conserved), but this difficulty usually means that the range of problems that the non-scientist can solve is more limited than that of the scientist. Thus, today's non-scientist can handle Newtonian, but not modern physical problems; the situation might be different in a later generation.

An example of how the non-scientist's prior knowledge can be used to predict what one would observe were the experiment performed, even though the observation is startling, follows. The student is asked to imagine that a rock is allowed to fall in a vacuum. Then he is to imagine that a second rock of the samc shape and density is dropped at the same time from the same height; he will conclude that they will hit the ground at the same time. He will conclude that they will also hit the ground at the same time if initially there is a smaller horizontal gap between them. The gap can be made smaller and smaller and the student realizes that the result will always be the same. Finally, they can touch and the time of flight should not change; thus, a rock twice the size of the one rock falls at the same rate as does the one. The argument can be extended, by properly subdividing the falling object, to show that the time of flight is independent of shape and density. In all of this, very little prior knowledge is used.

The author has prepared a syllabus for college students with no prior scientific training in which only a very few additional ideas (e.g., energy is conserved, "charged" particles can exist, the earth rotates and has a certain geography) are used for input. The developments in the syllabus are in the following areas: mechanics (Newton's laws of motion, the Law of Gravity, and the motion of projectiles); sound (its nature and some of the principles of music); electricity (static electricity, current, magnetism, generators, and motors); light (its nature, color, refraction, and other properties); chemistry; gases and liquids (nature of heat, condensation and evaporation, vapor pressure and humidity, boiling, and dew point); heating and cooling solids, liquids, and gases; meteorology (seasons, the Coriolis force, world-wide circulation of air, and rainfall and temperature patterns). To summarize, hundreds of diverse observations can be shown to be related because the observations can be predicted by deductions from a very small set of initial assumptions. The world's rainfall pattern, the electric generator, the rocket ship, the reason for paint pigment colors, the prism, and the falling object are in the same network.

2. If it is ultimately possible in principle to harmonize observations, it is then possible to rule out the possibility of certain observations which might otherwise seem possible. For example, if it is assumed (a) that the universe is three-dimensional, (b) that there is a point source of energy or a point at which lines of force begin, and (c) that the shortest distance between two points is a straight line, then the observed intensity of the force or energy decreases according to the square of the distance from the source. Thus, gravitational, electric, and (under certain conditions) magnetic forces decrease according to the inverse square law, as does light and sound intensity. Therefore, given the assumptions, a new point source of energy or line of force could be predicted to obey the inverse square law also; in the new case, intensity would not decrease according to the 2.1 power or the 1.9 power. Conversely, if intensity did decrease according to some power other than two, it might be suspected that the source is not a point source. Up to now in the discussion of the inverse square law it has been assumed that the Newtonian picture of the universe is correct. If, however, a new source decreases in intensity by some power other than two, it is possible that the basic assumptions about the nature of the universe are incorrect; this conclusion is, of course, the conclusion that has actually been made. Thus, even when predictions fail, new insights into the nature of things are obtained precisely because it is assumed that observations must ultimately hang together.

3. It has been commonly assumed that one unproved law is the law which says that scientific explanations must involve as few assumptions as possible. This law about scientific laws is the Law of Parsimony. If it is indeed true that all men know that the universe is coherent because they know that there is a God Who has eternal power, then ideally explanations should involve as few assumptions as possible. Therefore, the Law of Parsimony is not unproved.

4. In fact, we assume, although we do not always realize it, that where there is no unification possible no natural scientific work can be carried out. For example, if the Uncertainty Principle is assumed valid, then a proposal to determine the time at which a given radioactive nucleus will emit (for example) an alpha particle is not a scientific proposal. The proposal would not be scientific because assuming the validity of the Uncertainty Principle implies that we cannot correlate observations and produce a natural law which will predict the behavior of a single atomic nucleus. Here is a case where unification is not possible, and therefore scientific investigation is not possible.

5. Some men have postulated the existence of several gods who are at least partially independent of each other. The polytheistic position is inconsistent with the assumptions normally made by scientists, namely, the assumption that there is ultimately only one power. There is no god of the sea who is different from the god of the high places.

6. Are there natural divisions between disciplines? For example, is the division between biology and the physical sciences artificial or natural? If attempts to unify an area of knowledge show that unification is possible without including observations in and laws

for another area, then it seems that the two areas *separately* point to the single, coherent power of God and that the areas are naturally distinct. Thus, working out the implications of the Unification Principle could demonstrate that which is ordinarily taken to be true, viz., that the various aspects of Creation are independent in that one aspect cannot be derived from another. Reductionism would be shown to be illegitimate. In fact, as such a program is carried out it would probably be demonstrated that "law" refers to one kind of concept in one area (e.g., equations or their equivalent in the physical aspect) but an entirely different kind of concept in another area.

It is thus suggested that aspects of Creation besides the physical are also unifiable and that there are as many unification strands leading back to the Hands of God as there are naturally different aspects. The sum of all that can be traced to those unification strands is thus created reality.

7. According to the Uncertainty Principle, an observer cannot simultaneously and accurately know both the position and the velocity of a particle. If the value of one of these two variables is known exactly, then nothing is known about the value of the other variable. Is it possible for one to know that a particle is at rest with respect to some frame of reference? Presumably, something would be known about its position; at least, the position of an at-rest particle would not be *completely* unknown. Its velocity (zero) would be known accurately. But the Uncertainty Principle says that one cannot know the velocity accurately if something is known about the position. Therefore, since we can know something about the position of an at-rest particle, we cannot observe a particle to be at rest.

For our purpose, we can consider that the physical aspect of creation consists of particles and radiation. Radiation is also not at rest. Therefore, "physical" always implies motion.

Since only finite velocities are possible, time elapses when there is motion. It follows that we can know nothing about the physical aspect of Creation which is not associated with time. Thus, it seems that with the creation of the physical that time was either created or was a necessary prerequisite. This conclusion has been arrived at by considering what we can observe. Our observations of the physical *need* time. It may not be provable, but it also seems that *the time about which we ordinarily speak needs the physical aspect of Creation.* Time is not a separate category.

Space as well as time is needed for motion. The argument concerning space is parallel to the one used for time. It seems that the concept of space is also meaningless if matter and radiation do not exist.

Thus, these three seem to be bound up together: the physical, time, and space. But notice how this "binding together" has come about. It is not merely that our minds observe the union "out there." The argument hinges on *what we can know*. In the model of Creation that *we* construct, space, time, and the physical are united. In what *we* see there is coherence in what God created and upholds. But this emphasis on what God leads us to understand is precisely the emphasis given so far in our discussion of the Unification Principle. Man, created in the image of God, even though he is now sinful, is still able to see that there is unity in Creation as he realizes that his observations point to the coherent power of the Godhead.

Do time and space exist for man after he dies? We do not know. We do know that man is body-soul, and that "body" and "soul" are not separable while man lives, i.e., while his life is associated with the physical. When Christ comes again, there will be *bodily* resurrection. What seems possible, although this idea is speculative, is that time and space do not exist for man after he dies but before he is resurrected. Perhaps man is man only when he is a body-soul. On the other hand, certain scriptural statements may indicate that man exists as a soul after death but before resurrection; if so, the speculation is not correct.

8. The idea of unification can be distorted. As presented here, unification is possible just because God created. Some men have started out with the idea that God did not create. They hold to the idea of no beginning. There never was creation of life or of anything else; life evolved from non-living matter and there never was a discontinuity. Man's universal desire can be claimed by some to rest on the principle that God created, a true principle; but it is claimed by others that this universal desire rests on exactly the opposite principle, a principle that is not a true principle, but the statement of a lie.

9. Perhaps we can see that the Unification Principle aids us in achieving a Christian approach to physical science. Physical scientific activity can be made to be a Christian activity not just because of technological applications which can be made. Thus, it is not enough to say that there is something Christian about work in the physical sciences because it is the physical scientist who can teach the technologist how to avoid polluting the environment, or because it is the physical scientist who can discover principles which will enable the technologist to invent labor-saving devices. Physical scientific activity is Christian when the physical scientist knows that the physical aspect of Creation with which he works is a manifestation of the power of a creating and upholding God. Every physical observation and every physical law are to be seen in a creational, providential context.

REFERENCE

[1]T. S. Kuhn, The Structure of Scientific Revolutions, University of Chicago Press, Chicago, 1962.

Creation and/or Evolution

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The two terms in my title are regarded by many people as violently antithetical. It is my purpose to demonstrate that such is not necessarily the case. I shall attempt to show that the Biblical record of creation allows more evolutionary change than many so-called "Creationists" admit. Conversely, the scientific evidence for a totally evolutionary scheme of life is not nearly so conclusive and overwhelming as so-called "Evolutionists" often state.

Four Assumptions

Let me state the assumptions upon which I propose to build my arguments. The first assumption is that the Old and New Testaments constitute a trustworthy and accurate record of God's relation to man and the natural world. This record is divinely inspired (in the orthodox sense of the term), yet it bears the distinctive imprint of its various human writers and the sources from which they drew their information.

Secondly, the creation account in chapters 1 and 2 of Genesis, while pre-scientific and non-analytical in character, is nevertheless an accurate general description of the origin and subsequent early development of the natural world. It may not be merely written off as unrelated to the scientific evidence. However, the abbreviated and summary nature of the account and its strongly anthropocentric viewpoint should caution us against attempting any detailed correlation with the geological record.

Thirdly, the application of man's God-given capacities for logical and systematic investigation of the natural world—scientific study—is a valid enterprise. It is valid precisely because the results of creation appear to be a basically rational and comprehensible universe. However, it should be noted that the scientific study of non-repeatable occurrences of the distant past involves a very large margin of uncertainty compared to the investigation of contemporary events. Although science deals with natural rather than supernatural processes, it is not thereby intrinsically biased toward atheism.

Lastly, since we regard the Biblical record to be an accurate sourcebook and the application of the scientific method to the natural world a valid approach, there can exist no ultimate conflict in our interpretation of the two. Given our assumptions, apparent discrepancies *must* be the result of incomplete evidence or faulty interpretation of one or both sources. A major goal of the Christian scientist is to formulate and/or identify positions which satisfactorily harmonize the scientific evidence with the Scriptures, without doing violence to either.

Genesis Record of Origins

With these assumptions clarified, let us next consider the Genesis record of origins. This portion of the Bible is familiar, perhaps too familiar. With such passages, there is always the danger of reading into the text meaning that is not there. (For example, how many of you conceive of Adam as any other than a red-blooded, all-American boy? We don't get this racial bias from the text, but from our own mental interpolation.) A hyper-literal interpretation of Genesis accompanied by a wholesale reading into the text of inferred or supposed concepts characterizes much of the current Creationist movement. Christian scientists must come to grips with this approach.

The self-styled "Creationists" make much of a "literal" interpretation of chapters 1 and 2 of Genesis. Explicit in their view is a series of recent creative acts that produced a world and its array of living forms much like those of today. Creative acts are usually defined as instantaneous and involving neither natural processes nor use of pre-existing materials. Greater or lesser emphasis may be placed on a universal cataclysmic deluge which accounted for fossils and other such troublesome artifacts. This literalistic interpretation is commonly promulgated as "The Christian View of Creation." With this approach to creation in mind, let us examine the pertinent Biblical terms and their apparent meanings.

Translation of Key Words

Attention immediately centers on the Hebrew word *bara*, commonly translated "create." This word or its derivatives occur only seven times in the Genesis rec-

ord of origins (1:1, 21, 27 [three times]; 2:3, 4) and about forty times elsewhere in the Old Testament. God is always the subject of the verb and it normally refers to some unique formative action. The product may be concrete ("man"—Gen. 1:26) or abstract ("a clean heart"—Psalm 51:10). Beyond this point one cannot realistically drive the meaning of the term. It is important to recognize here that the Old Testament is the only extant Hebrew literature of its era. Thus, for such infrequently used words the opportunity to cross-check their range of meanings with the context of other literary types is absent. The point is that we do not have a precise definition of *bara* from the Bible, itself.

Does *bara* uniformly refer to an instantaneous creation without process or use of pre-existing material? Let us examine the instances where it is used. In Genesis 1:1 (" In the beginning God created the heaven and the earth."), the traditional meaning very well may apply. Unless one assumes that matter is eternal, this verse apparently records the origin of matter *de novo* and its assembly into the astronomical bodies. However, the verse is a brief, but majestic statement of results, not necessarily ruling out process.

The next occurrence is in Genesis 1:21 ("And God created great whales, and every living creature that moveth . . . ."). The context here does not define the nature of the creative act. From verse 20, one might infer that some natural process was involved.

Any argument for a restricted meaning of *bara* is badly shaken by the context of the remaining usages in Genesis. In verse 27, the verb is repeated three times in connection with the origin of the first humans. However, the previous verse states, "And God said, Let us *make* man in our image. . . ." The word "make" here is the Hebrew *asah*. It is the common term for "make" or "do" and is used hundreds of times in the Old Testament with a wide range of meanings. The subject of this verb is variously man, God, animals, etc. It commonly involves natural processes and use of materials. Furthermore, in Genesis 2:3, 4, the words *bara* and *asah* are used interchangeably in immediate and parallel context. In view of the very general meaning of *asah*, it would strain the clear statements in these passages to attempt to assign a special and restrictive meaning to *bara*.

If creation is to be understood as an event without process or use of pre-existing material, one is confronted with the description of Adam's origin in Genesis 2:7. Here the pre-existing material ("dust") and at least some process ("breathed into his nostrils") are clearly stated for even a literalist to see. The word here translated "formed" is also significant. It is the Hebrew *yatsar*, whose root meaning is to mold or form. It is commonly used of human or divine activity in the Old Testament and relates to a variety of manufacturing activities, among them pottery making. Whether in this context God was making the original human crackpot, I'll leave to your decision!

In summary, one cannot derive from the context in Genesis 1 and 2 the restricted meaning of "create" that the creationists desire. The special term *bara* is used interchangeably with common words for acts of purely human production. In fact, in Isaiah 43:7 all three of the above words are used in a perfectly parallel series to describe God's relation to the Jews! We must avoid insisting on a special definition for the word "create" which goes beyond the more general use in the Bible, itself.

The biblical record of creation does not rule out the divine employment of natural processes in either origins or subsequent development. The record simply states that behind all matter and life stands God, the Creator.

Must Creation Be Instantaneous?

The emphasis on creation being instantaneous, or at least without use of long time periods is another problem. This emphasis often is tied to an interesting theological attitude. I sadly remember a debate with a well-known conservative Old Testament scholar several years ago on these matters. He fervently insisted that a series of instantaneous creative acts over a literal period of six days was a key Christian belief related to the omnipotence of God. I can't forget the look on his face when I mischievously reduced his argument to absurdity. My observations went something like this, "If God's omnipotence is revealed by a six-day creation, then wouldn't He be more omnipotent (sic) if He accomplished it in only one day? He would be still more omnipotent if it took place in only one hour, etc., etc." In dealing with such matters we must always remember that it is not a question of what God *can* do, but what He *did* do.

The Genesis record of origins does not contain a clear statement of its purpose. We would probably agree that this purpose is religious, not scientific. However, it is not thereby scientifically in error. The common denominator of religions of the ancient world was the identification of deity(ies) with natural features or manmade images—idolatry. The repeated religious failure of the Jews was to lapse into the idolatrous customs of neighboring cultures. The Jewish prophets regularly pointed out that the God who "created heaven and earth" cannot be appropriately represented by an image or a natural feature of the creation. In other words, a clear view of the creator-role of God is antithetical to idolatry.

In our time old-fashioned idolatry is somewhat out of style. Instead of an overeagerness to see God in every tree or stone, our age would largely reason Him out of business. Here, again, the emphasis on the Creator-God is pertinent. Atheistic humanism that sees man as "the measure of all things" may be opposed by the clear statement, "In the beginning God created . . . ." It would be tragic if the definition of creation were made so restrictive as to be wholly incompatible with the record of science. This would allow our contemporaries to avoid the philosophical impact of God the creator because of our scientific obscurantism.

The biblical record of creation does not rule out the divine employment of natural processes in either origins or subsequent development. The length of time involved is not an essential factor. The record simply states that behind all matter and life stands

God, the Creator. The details of origin (creation) and subsequent change (evolution) are in the realm of science, not theology. Any attempt to read all of the scientific evidence through the narrow slit of a particular restrictive "creationist" interpretation is both unfortunate and untenable.

Dogma of Evolution

Just as some "creationists" promulgate a narrowly literalistic interpretation of Genesis, so many contemporary scientists proclaim the dogma of evolution. Before evaluating this matter, let us carefully define the term. Evolution basically means "change." As used by biologists, it refers to changes in populations of living organisms by natural processes over a span of time. There are really two levels of usage for this term, although the important distinctions between them are often blurred in common practice. *Limited evolution* (microevolution) involves the formation of new species or varieties by natural selection operating on the genetic pool of a population over a limited period of time.

By contrast, *general evolution* envisions an extension of such limited changes to account for the origin of all living and extinct species of organisms from a single source over the span of geological time. It is this broad generalization about the presumed interrelationship of all living things that is usually intended by the unmodified word "evolution." In addition, *chemical evolution* is a term frequently used today. It refers to assumed pre-biotic changes on the primeval earth which gave rise to the first organism(s) by purely natural means.

Judging from the outcries by leading biological and scientific societies and leaders regarding textbook controversies, general evolution is yet a strongly-held contemporary dogma, if not a sacred cow. Introductory biology textbooks commonly treat the theory as proven beyond all shadow of doubt. Statements such as, "the vast majority of scientists accept evolution," suggest that scientific truth is determined by the ballot box. From my own experience in 21 years of teaching, few students (or faculty for that matter) are aware that a significant minority viewpoint exists. I mean from a scientific, not a religious basis. Let us consider some of these criticisms of the general evolutionary theory.

Criticisms of General Evolution

Several contemporary biologists have attempted to make the point that most of the evidence presented for general evolution, in fact, substantiates only limited evolution. General evolutionary theory is primarily a grand extrapolation of this evidence. Limited evolution is rather clearly demonstrable, whereas general evolution should be regarded much more hesitantly at present.

In the preface to his book *Implications of Evolution*, G. S. Kerkut, a leading invertebrate zoologist at the University of Southampton, England, succintly summarizes the situation,

> May I here humbly state as part of my biological *credo* that I believe that the theory of Evolution as presented by orthodox evolutionists is in many ways a satisfying explanation of some of the evidence. At the same time I think that the attempt to explain all living forms in terms of an evolution *from a unique source*, though a brave and valid attempt, is one that is premature and not satisfactorily supported by present-day evidence. It may in fact be shown ultimately to be the correct explanation, but the supporting evidence remains to be discovered. We can, if we like, believe that such an evolutionary system has taken place, but I for one do not think that "it has been proven beyond all reasonable doubt." In the pages of the book that follow I shall present evidence for the point of view that there are many discrete groups of animals and that we do not know how they have evolved nor how they are interrelated. It is possible that they might have evolved quite independently from discrete and separate sources. (pp. vii-viii).

Dr. John T. Bonner of Princeton University, in his review of Kerkut's book in the *American Scientist*, responded with deep feeling to Kerkut's approach,

> This is a book with a disturbing message; it points to some unseemly cracks in the foundations. One is disturbed because what is said gives us the uneasy feeling that we knew it for a long time deep down but were never willing to admit this even to ourselves. It is another one of those cold and uncompromising situations where the naked truth and human nature travel in different directions. (p. 240).

A quite different criticism of aspects of general evolution has been raised by several mathematicians in recent years. The thrust of their criticism was that computerized mathematical models of evolutionary phenomena did not fit the evolutionary time scale. There simply hasn't been enough time to account for all the presumed evolutionary changes based on a mechanism of natural selection of mutant characteristics. Moreover, they objected to the concept that blind selection (chance) could result in cumulative improvements in populations. No mathematical models could encompass such a situation. In other words, the proposed means are inadequate to account for the presumed results of general evolution.

A formal symposium featuring a frank confrontation between some of these mathematicians (led by Dr. Murray Eden of M.I.T.) and well known evolutionary theorists was held in 1966. The proceedings of this symposium were published under the revealing title of *Mathematical Challenges to the Neo-Darwinian Interpretation of Evolution*. The verbatim transcript of the discussions following each position paper revealed just how closed was the circle of evidence considered by some evolutionary thinkers.

Loren Eiseley, giving the introductory address at the symposium identified the problem,

> . . . we should give serious thought to the question of whether we have reached a certain point of hesitation in our seemingly clear explanation of the way evolution comes about. Have we really answered all the questions; . . .? . . . In connection with some of these obscure problems of related mutations, or variations that have to be related almost from the beginning in order to be effective, he [Darwin] was not as confident in some of his expressions as the neo-Darwinists. . . . The point, it seems to me, . . . lies . . . over in another domain of the organismic approach, the problem of whether there are some aspects of life, and of chemistry under the control of life, which are not yet totally accountable for with the means at our command. (pp. 3-4).

Here, he is clearly addressing the almost cocky attitude of some molecular biologists today who insist that life

is *only* an extension of chemistry and physics. Eiseley gently suggests that such a conclusion may be a trifle premature in light of many unexplained phenomena of life.

The fossil record is appealed to as conclusive evidence that general evolution has occurred according to the classic pattern. It is not always made clear that while fossil remains are "facts," the interpretation of their interrelationships in time and space is often tenuous. Frequently, lines of descent for a series of fossil "species" (such as the horse) are based on fossils found at random in widely remote regions of the earth. To justify such questionable interpretations, appeal is made to hypothetical dispersion routes, corridors and filters. Elaborate biogeographical schemes have been propounded of which P. J. Darlington's *Zoogeography: The Geographical Distribution of Animals* is a classic. All such schemes envision an essentially stable system of continents which changed in only minor geographic details.

The revolutionary development of the geophysical theory of plate tectonics during the past decade has now established that the continents indeed have moved extensively and continue to do so. The older idea of continental drift is again in vogue, but now with a reasonable scientific mechanism. Evolutionary schemes based on former biogeographical concepts are now hopelessly obsolete. Hypotheses about the adaptive radiation of various plant and animal groups, relict populations, etc., are now undergoing wholesale revision. A recent volume in this area, *Evolution, Mammals, and Southern Continents,* is one of the first books on historical biogeography to appear since continental movement became a fact. Anyone familiar with the former schemes is shocked to discover just how many settled issues have suffered major surgery or been abandoned. Clearly, it is premature to be dogmatic about the implications of at least the terrestrial fossil record at this point in history.

Philosophical Inadequacies of Darwinian Theory

Too frequently, scientific considerations of evolution deal exclusively with the hard data and their interpretation. Such is the framework of scientific training. Philosophers of science, however, view the subject with a much broader perspective. It is from this angle that some of the most serious objections to Darwinian evolution come. Many names are associated with this attack, but Dr. Marjorie Grene, of the University of California at Davis, is the most readable from my perspective. In her book *The Knower and the Known* in a masterful chapter entitled "The Faith of Darwinism" she charts the philosophical inadequacies of Darwinian theory. I would recommend her writings to anyone seriously interested in this subject. A few quotations may whet your appetite.

Relative to the oft-cited case of industrial melanism and English peppered moths, she states:

> Here, say the neo-Darwinians, is natural selection, that is, evolution, actually going on. But to this we may answer: selection, yes; the colour of moths or snails or mice is clearly controlled by visibility to predators; but 'evolution'? Do these observations explain how in the first place there came to be any moths or snails or mice at all? By what right are we to extrapolate the pattern by which colour or other such superficial characters are governed to the origin of species, let alone of orders, classes, phyla of living organisms? But, say the neo-Darwinians again, natural selection is the only mechanism we observe in present-day nature. But again, if this were so, we should still have no right to say that the only mechanism we see at work now is the only one that has been at work in all the long past of the living world. Nor, for that matter, is it the only 'mechanism'. (pp. 193-194).

As a biologist and a Christian committed to the Scriptures as God's revelation, I believe that the concepts of creation and evolutionary change, properly understood, are compatible.

Her most telling criticisms deal with the inadequacy of natural selection to really "explain" the facts of life:

> It is precisely the insistence on the equation of life with adaptation that defines the limits of Darwinism, and it is doubt of the all-inclusiveness of adaptation as a concept definitive of life that motivates the most effective objections to the Darwinian synthesis. . . . One may indeed ask whether all adaptations have arisen by Darwinian-Mendelian means; but one may also ask, as some eminent biologists do, whether evolution, on a large as well as a small scale, is essentially a matter of adaptation at all. . . . There are, indeed, all the minute specialized divergences like those of the Galapagos finches which so fascinated Darwin; it is their story that is told in the *Origin* and elaborated by the selectionists today. But these are dead ends, last minutiae of development; it is not from them that the great massive novelties of evolution could have sprung. For this, such dissenters feel, is the major evolutionary theme: great new inventions, new ideas of living, which arise with startling suddenness, proliferate in a variety of directions, yet persist with fundamental constancy—as in Darwinian terms they would have no reason in the world to do. Neither the origin and persistence of great new modes of life—photosynthesis, breathing, thinking—nor all the intricate and co-ordinated changes needed to support them, are explained or even made conceivable on the Darwinian view. (pp. 196-197).

Perhaps the most revealing evaluation of evolutionary theory she gives is from the philosophical standpoint.

> Yet, if all this is so, why is the neo-Darwinian theory so confidently affirmed? Because neo-Darwinism is not only a scientific theory, and a comprehensive, seemingly self-confirming theory, but a theory deeply embedded in a metaphysical faith: in the faith that science can and must explain all the phenomena of nature in terms of one hypothesis, and that an hypothesis of maximum simplicity, of maximum impersonality and objectivity. Relatively speaking, neo-Darwinism is logically simple: there are just two things happening, chance variations and the elimination of the worst ones among them; and both these happenings are just plain facts, things that *do* or *don't* happen, *yes* or *no*. Nature is like a vast computing machine set up in binary digits; no mystery there. And —what man has not yet achieved—the machine is self-programmed: it began by chance, it continues automatically, its master plan itself creeping up on itself, so to speak, by means of its own automatism. Again, no mystery there; man seems at home in a simply rational world. (pp. 199-200).

Summary

In summary, the actual Biblical statements about creation are not as definitive nor as restrictive as to

process and time as many creationists demand. Taken at face value, the Genesis account seems to describe the divine origin of a variety of distinctive forms of life. These forms subsequently produced descendants by purely natural processes. The general theory of evolution postulates an ultimate relatedness of all living forms because of a common ancestry and origin. Natural selection operating on random mutations in populations is proposed as the effective method to produce the present diversity of life. However, both the ultimate biological relatedness of all forms and the effectiveness of the proposed mechanism are seriously being questioned today. Kerkut, in the closing paragraph of his book sumarizes the current situation.

> There is a theory which states that many living animals can be observed over the course of time to undergo changes so that new species are formed. This can be called the "Special Theory of Evolution" and can be demonstrated in certain cases by experiments. On the other hand there is the theory that all the living forms in the world have arisen from a single source which itself came from an inorganic form. This theory can be called the "General Theory of Evolution" and the evidence that supports it is not sufficiently strong to allow us to consider it as anything more than a working hypothesis. It is not clear whether the changes that bring about speciation are of the same nature as those that brought about the development of new phyla. The answer will be found by future experimental work and not by dogmatic assertions that the General Theory of Evolution must be correct because there is nothing else that will satisfactorily take its place. (p. 157).

Several hypotheses which would harmonize the biblical statements with the current scientific evidence exist. One is particularly attractive to me. It proposes that the major forms of life were indeed brought into existence by some unique and non-repeatable mechanism (creation?). Thereafter, natural selection or other natural factors led to diversification within broad limits. Determination of the range of these limits is a subject for scientific investigation and, thus, must remain an open question for the present. This approach actually fits the general data of paleontology as well as the general theory of evolution does. In addition, it serves to explain the evident absence of transitional forms between major groups of organisms and the lack of evidence for phyletic evolutionary origins.

Most importantly, such an approach allows for new scientific data to be accommodated without the necessity of a major revision of one's theoretical foundations. This latter point is crucial, as witness the exhaustive efforts of certain "creationists" to discredit any and every type of evidence for a great age of the earth. They are forced into such desperate actions because the concept of a recent earth is a key plank in their philosophical platform. To borrow the language of the "uptight" generation, our broad hypotheses should "hang loose," avoiding rigidly fixed positions which, like the Maginot Line of the 1940's, may be outflanked by a novel offensive.

As a biologist and a Christian committed to the Scriptures as God's relevation, I believe that the concepts of creation and evolutionary change, properly understood, are compatible. One need not sacrifice the accuracy of the Genesis account or the validity of the scientific record in any shotgun marriage. Thus, the divine origin of the forms of life by methods at present unresolved is not in opposition to present scientific evidence. Nor, on the other hand, is the occurrence of extensive evolutionary change over great periods of time irreconcilable with the Biblical record. The "golden mean" of truth in this area will be found neither with the hyperliteralism of some creationists nor with the narrow dogmatism of the more numerous neo-Darwinians.

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The Doctrine of Special Creation

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This study examines the anti-evolutionary views that are promulgated in the high school biology text recently published by the Creation Research Society. Three main features of the doctrine of special creation—the design argument, catastrophism, and the ideal type—are examined in a historical context. It is argued that this creationist model, here distinguished from the Judaeo-Christian doctrine of creation, is essentially non-Biblical in character.

The creationist model in the textbook is very similar to the interpretation of similarity and variability that prevailed in the late 18th and 19th centuries. Moreover, with its emphasis on fixity, creationism represents in large measure an extension of Greek philosophy. It was part of the biology that, until the publication of Darwin's Origin of Species, *was strongly influenced by the thought of Plato and Aristotle. By contrast, the theory of evolution could only arise where, in the West, the antecedent ideas of progress, origin, linear time, and future fulfillment were part of the Judaeo-Christian tradition.*

The Judaeo-Christian doctrine of creation and the theory of evolution may be complementary, but they can never be alternative views of organic nature.

Part I. The Design Argument

The handsome textbook *Biology: a Search for Order in Complexity* (Moore and Slusher, eds., 1970) will startle all ASA members who have been taking the teaching of evolution for granted. (See other reviews in the *American Biology Teacher* 33 [7]: 438-442; and *Journal ASA* 23 [4]: 150-152.) The authors assert that "special creation" is as reasonable and scientific an account of origins as the theory of evolution and that it should be given equal time in high school biology classes. This book therefore raises anew the entire question between religion and science.

Actually, the special-creation doctrine, as presented in this textbook, is quite old. It was widely held during the first half of the 19th century. In order to assess the implications of the doctrine for our time—whether we agree or disagree—we need to see what it was in the past. The antecedent views will be discussed in the course of examining the doctrine's main points.

The Book and Its Sponsors

This book was produced by the Creation Research Society, which holds that "science should be realigned within the framework of Biblical creationism," according to a recent CRS leaflet.

Although the CRS textbook is attractive, its publication has dismayed those who had hoped the evolution controversy was at last over in American education. The care and expense that have been invested in this *apologia* for a 19th-century view are astonishing: 20 writers, all with graduate degrees (many in the sciences), contributed to its development. Yet although the book is an anachronism, it may be welcomed by some church-related schools and by school board members who are worried about atheism among the young. And there may even be readers of this journal to whom the arguments may appeal as an

alternative to the theory of evolution. They may say to themselves: surely if so many qualified people—not a preacher in the lot—have gone to all this trouble, there must be something to what they say. Thus, this book may well rekindle an old controversy.

If so, let us hope that decorum may prevail. In the history of biology, different investigators often have interpreted the same data from opposite points of view. Those investigators who argued with calm, goodwill, and reason, now seem the more dignified, even though their interpretations were later replaced. By contrast, those who resorted to invective and exaggeration, even when in the right, in retrospect seem only entertaining. In any case, let us be calm.

We have here a splendid opportunity to note the strong historical antecedents of the "special creation" doctrine—stronger, perhaps, than the authors imagine. What, after all, is "creationism"? May it be viewed as a scientific theory, as distinguished from a theologic doctrine? We may also appreciate the complex factors involved in resistance to change.

The older high school biology textbooks differed widely from the approach ushered in by the Biological Sciences Curriculum Study in 1960. The CRS text carries a strong resemblance to the former; that is, biology is presented as an established body of knowledge rather than a method of inquiry into organic nature. Nor does the book reflect the major innovations in teaching methods—process and inquiry—that revolutionized high school biology in the 1960s and are now penetrating the new elementary-school science curricula.

Nevertheless, except for the sections on creationism and on evolution, together with certain factual errors and questionable emphases, the book is a well-organized source of information on what is traditionally called biology. Moreover, the authors have achieved a style that writers of texts may well envy. It is interesting to read.

The major arguments for creationism appear for the most part in unit 9, "Theories of Biological Change," and this section is read first by those who want to know what the fuss is all about. Elsewhere the authors' views obtrude from time to time; some of these passages I shall examine below.

Pages 3-13, on the scientific method, is a thoughtful introduction to the text. But how would the authors document the view on p. 9 (reasserted on pp. 4, 12, 61) that "the Greeks did no extensive experimentation because of a prejudice against work?" Can they be referring to Galen, whose vivisection experiments, as described in his *Natural Faculties* (book 2) and *Anatomical Procedures* (books 7, 12, 14), were far-reaching in their impact on later biology? Contempt for manual labor does not necessarily imply disregard for experiments. That the Greeks placed less emphasis on experiments, in the sense in which we use the term, has more to do with the questions they asked of nature than with any notion that experimentation was "degrading work," as we are told on p. 4. Moreover the Greeks did not find regularity and pattern in nature "through a study of cause and effect relationships" (p. 12). Their scientific method—as represented, for example, in Aristotle's *Generation of Animals* (book 1) and *Parts of Animals* (book 1)—was quite different from the modern scientific method, now associated with the phrase "cause and effect," that began to emerge during the Renaissance.

What is "creationism"? May it be viewed as a scientific theory, as distinguished from a theologic doctrine?

This section on zoology deals with animals "with backbones" and "without backbones"—a surprising division, in view of the creationist presuppositions. This was the division made by Jean Baptiste Lamarck (1744-1829), who was an "evolutionist."

THE DESIGN ARGUMENT

In at least nine passages the CRS authors assert that providential design may be discerned in nature. Examples are the purpose of the Creator as observed in the direction of plant growth (p. 12); the apparently purposive behavior of the amoeba (p. 65); the variability of flowers, birds, songs, and animal behavior (p. 147); the taxonomic categories of plants (p. 183); the marvels of human vision (p. 281, 443); the sexual reproduction of bacteria and the life cycles of algae (p. 173-174, 396); and particular adaptations of plants and animals (p. 476).

Because teleology is anathema to modern biology, these passages will be taken as marks of an unscientific attitude. In the context of the book, however, the authors do not argue that design is *always* a substitute for scientific research or a full explanation of biologic phenomena. They do include a considerable fund of chemic, physiologic, and genetic information concerning organic processes that once were given a teleologic explanation. Nevertheless, their teleologic passages perhaps represent the core of the long controversy over special creation. They illustrate why it is so easy to misunderstand the theologic problem of design in nature. High school students may now conclude that if God created *Spirogyra* with its own special life-cycle (p. 396), then natural processes did not, for the two interpretations are mutually exclusive.

Definition of Design

These passages express the traditional view of design, which implies that the end precedes the means. According to this view, the preordained end is executed in the form of a structure or process by (i) an immaterial agency--that is, some vitalistic force residing in the organism; or (ii) an intelligence, or God, external to the organism, as therefore an expression of divine providence. The CRS authors advocate the latter version. In the former version, and sometimes in the latter, the importance of secondary causation is reduced. (Vitalists are not necessarily theists, and vice versa.) Design is often suggested when the observer experiences a feeling of wonder as he contemplates the exquisite and intricate character of a particular adaptation.

The design argument is even older and more prestigious than the doctrine of special creation. For example, the vitalistic version is a unifying theme in Galen's *On the Usefulness of the Parts of the Body,* in which he approved the Aristotelian view that "nature

does nothing in vain" (May, 1968, II, p. 501). Galen argued that the forethought exhibited by the skillful way in which the structures of the eye are joined together surely expresses the "wisdom of the Creator," which he ascribed never to an external intelligence, for he was not a theist in the usual sense, but sometimes to a beneficent "Nature" (May 1968, II, p. 463-502). Modern biology has rendered unnecessary this vitalistic version of design, but it cannot rule out divine providence, as Darwin recognized in his own discussion of the eye (*Origin*, 1st ed., p. 188, 189).

But to affirm that biology cannot rule out divine providence is not the same as saying, as the CRS authors seem to say, that providential design is an *a posteriori* conclusion one draws from observing events in nature. We do not observe design in nature. Rather, our minds seem to be so constructed that we can perceive regularities to which, if we have religious presuppositions, we apply the concept of design. Furthermore, to make of design a biologic principle, as in these passages in the CRS book, is to reduce the need to interpret biologic processes as precursors of the adaptation that evokes wonder. Modern biology is then in jeopardy. The CRS position must lead inevitably to the view (although the authors do not go this far) that biologic processes cannot express cause-and-effect relationships; that is, they must be merely a series of discrete and unrelated events. If design is a sufficient and exclusive explanation of how an amoeba moves (p. 65), then it is all right to study its environmental conditions but we can never be sure that they are causal agencies that influence such behavior.

By contrast, biology cannot say that such causal agencies, whether operating within the life-span of a single organism or joining together many different organisms over long periods of time, as in evolution, do not themselves, from the theologic point-of-view, represent the expression of divine providence in design. While the CRS authors reject the latter—the evolutionary process—their position cannot sustain the former, as they hope, because they apparently hold that the argument for design is *a posteriori*. That is, they argue from observed effects *to* design, a wholly conjectural procedure that can never be theologically satisfying.

The question of design worried Asa Gray (1810-88), the American friend of Charles Darwin (1809-82), even more than did the new questions concerning the *Genesis* account of creation. When he found out, in 1857, what Darwin was up to (F. Darwin, 1887, I, p. 477-482), he hurried off a letter to ask whether natural selection were now to become a substitute for divine providence. Darwin assured him that natural selection was not such an agent; it only described various actions in nature, much as a geologist uses the term "denudation" (F. Darwin, 1903, I, p. 126; Dupree, 1968, p. 247; Greene, 1961, p. 296, 297). If design were to explain variation, Darwin went on, then the number and direction of Fantail feathers would have been created to suit some pigeon-fancier (F. Darwin, 1887, II, p. 146).

Gravity

There was a striking parallel in the 1860s between the religious objections first raised against natural selection and those formerly raised against the idea of gravity, which was feared in the time of Isaac Newton (1642-1727) as unfriendly to religion. Gray saw at once the parallel between Darwin and Newton but had to agree, in his review of the *Origin*, that gravity was no longer a religious question concerning design (Dupree, 1963, p. 44).

In this respect the CRS authors apparently are not worried about any threat to theism posed by a physical agency. It may be pertinent to inquire why. If natural selection, which is a biologic process, is a threat to theism, why should not gravity, a physical process, also be considered a threat, particularly since it is more universal in its applications? After all, if gravity holds the planets in orbit, then the Almighty is not on the job. Why not simply say that Mars was "designed" to travel in an elliptical orbit?

Darwin pointed out in the first edition of his *Origin* that using the term "design" is not an explanation but a restatement of the fact (p. 185, 186, 452). He wondered whether those who argued for special creation really believed that at "innumerable periods in the earth's history certain elemental atoms have been commanded suddenly to flash into living tissue" (p. 483). Darwin was trying to suggest that merely using the term "design," however appropriate it might be as an expression of faith, leaves unanswered the question of method. In the third edition (ch. 4) he complained that, since no one objected to gravity, his critics should not erroneously interpret natural selection as an "active power or Deity."

Gray soon came to terms with Darwin and became one of his staunchest supporters. He maintained his religious orthodoxy, although the question of design continued to fascinate him. He examined in depth this most complex question in two essays—"Design versus Necessity" and "Natural Selection and Natural Theology"—in which he seemed to conclude that Darwin had eliminated only an *inherent*, finalistic version of the design argument (Dupree, 1963). This argument states that it is possible for us to observe in nature the only, the final, and the ultimate purpose of the Creator, such as beauty in flowers. In other words, one could just look at a plant and decide what the Almighty had in mind. Moreover, this purpose is the essence and meaning of each organism and structure. If so, then what Darwin had done was to eliminate from biology not the Biblical view of divine providence but Aristotelian final causation as a sufficient and exclusive explanation of biologic events.

We do not observe design in nature. Our minds seem to be so constructed that we can perceive regularities to which, if we have religious presuppositions, we apply the concept of design.

Value of Religious Thought

While teleology may be at times a useful and even a necessary accompaniment of a full interpretation of a biologic event, it cannot be, as the CRS implies, a

sufficient condition for such an explanation. Today we try to eliminate teleology from a scientific description of a biologic event. But we should not gainsay the power of the design argument in the history of biology, even though it is fashionable in our age to ignore the contributions that religious ideas have made to science in the past. We are more aware of how biology has changed religion (Greene, 1963). Beginning in the 17th century and continuing as late as the opening decades of the 19th century a strong trend in biology, with prominent themes from the Greek past, saw the study of the handiwork of God as a religious responsibility. The works of the Rev. John Ray (1627-1705), the Rev. William Paley (1743-1805), and the Rev. William Buckland (1784-1856) are prototypes of this trend. Whatever its negative aspects—the strong tendency to propaganda and the dubious analogy between nature and revelation—it was an energizing force that helped to set in motion the scientific enterprise.

When we interpret animal behavior in terms of design (p. 147) we may only be following a habit we have inherited from Aristotle. And when we add that an animal behaves in such and such a way so as to fulfill the Creator's wish we are imposing on nature an *a priori* view we have derived from religion. Both are legitimate expressions of the sensitive mind.

Let us give the ancients their due. They remind us that the model of nature put together by modern science may not represent ultimate reality. But we must render to science, also, its due, which is to determine the material connections among contingent events. The trick is to disentangle these components—Aristotelian, religious, and scientific; but this, I think, has not been done in the context of the CRS text. I question whether religious truth is served by implying that anthropomorphic final causes, themselves Aristotelian in conceptual origin, may be observed in the operations of nature.

If natural selection, which is a biologic process, is a threat to theism, why should not gravity, a physical process, also be considered a threat?

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Part II. Catastrophism

Chapters 21 to 25 (unit 9) contain the heart of the authors' argument for special creation. Although no doubt they wish this section to be the strongest, yet in some points it is the weakest. There is an unevenness of organization not apparent in the first eight units—as though the authors were not quite sure what arguments would carry the most weight. Apparently there were no geologists on the writing staff.

The authors argue for the instantaneous creation of the major groups of organisms in the not remote geologic past (p. xix, 398, 413-416). According to their view of species, all present-day living organisms are lineal descendants of these primordial creatures. There is variability, but this does not denote kinship, for there is no hereditary relatedness betwen different species in time (p. 147, 398, 419, 430, 451).

While acknowledging the controversial nature of their view, they hold that it fully supports the account of origins given in *Genesis* by Moses. They find evidence for their interpretation in the fossil and geologic record; groups of organisms succeed one another in the rocks, there are no transition fossils, and discontinuities indicate that major changes occurred in the past by geologic agencies no longer in operation (p. 7, 393, 404). Noah's flood was the most important and recent of these agencies (p. 412, 414). Moreover, we are invited to believe that Noah's flood scoured out Grand Canyon and deposited the fossils in the wake of this swift, paroxysmal convulsion, that engulfed the whole Earth (p. 405, 412, 418).

Thus, special creation is to the authors a scientific "theory"; it is more persuasive than the alternative view held by the persons to whom they refer as "evolutionists." Undaunted by more than a century of scholarship

in geology and paleontology and a half-century in genetics, they argue that no evolutionary change has occured in time—for the major groups of organisms were created fully formed, *ex nihilo*, in tbe beginning. The chicken, in short, has come before the egg.

Diluvial Geology

With unit 9 we are at once back in the early decades of the 19th century, when Noah's flood was viewed as a major agency of geologic change. Just as the design argument epitomizes the age-old discussion between science and religion, so catastrophism was the means by which the special-creationists usually accounted for the changes they were obliged to recognize in the past history of the Earth. To assess the authors' point of view we must therefore place it in the context of rapidly shifting concepts in geology and biology during the decades immediately preceding the publication of Darwin's *Origin of Species* in 1859 (see Gillispie, 1959).

The 17th century had seen the dramatic introduction of change and natural law into the hitherto static heavens. During the 18th century, scientists such as Georges Buffon (1707-88) and James Hutton (1726-97) began to recognize that change also had characterized the Earth. When stability and permanence thus gave way to change in time—first in the heavens and then on the Earth—it was inevitable that the same interpretation would be applied to living things as well.

Soon after the turn of the 19th century, diluvial geology emerged as a serious attempt to account for very real problems in Earth history. In this the Mosaic tradition was a major, but by no means the only, guiding influence. The fossil remains of extinct animals, the curious locations of immovable boulders, and the puzzling features of river valleys all demanded explanation. Diluvial geology sought to equate a supposed natural event of worldwide scope with a direct, providential intervention. The proponents of this view thought the facts of geologic history might establish the historical reality of the Noachian deluge and so remove any threat to religion posed by geology.

There are three scientists whose work may be cited as representative of the period of about 1812-57—the period in which, I believe, the effort of this book may be set. They illustrate, first, the types of problems—the age of the Earth, directional change, and causal agencies—that had to be defined before the Darwin revolution could be achieved; and, second, the international character of the preliminary solution.

Most students of Earth history during those years continued to think the Earth was comparatively young. They also recognized that the Earth must have gone through many changes in the past. They were led therefore to the conclusion that such changes must have been sudden and dramatic. Georges Cuvier (1769-1832) of France gave this view—catastrophism—new prestige, in 1812, with his work on fossil vertebrates, *Recherches sur les Ossemens Fossiles de Quadrupédes*. He was sure that within such a short time-interval only a series of land-upheavels and paroxysmal deluges could account for the sudden extinction of whole species of animals. The impressive skeletons of mastodons and *Megatherium* entranced his public. Cuvier also included an engraving of an extinct elephant that was once engulfed in Siberian ice—as a result, he thought, of a dramatic drop in temperature following northern extension of a deluge. The authors refer (p. 404, 406) to this elephant as an argument for their view.

Undaunted by more than a century of scholarship in geology and paleontology, and a half-century in genetics, the authors argue that no evolutionary change has occurred in time — for the major groups of organisms were created fully formed, ex nihilo, *in the beginning.*

Cuvier's catastrophism must be set in the context of his impressive and permanent contributions to comparative anatomy. He stated the main arguments of this doctrine: a relatively short age of the Earth, the progressive and sequential character of the fossil record, and a series of terrestrial paroxysms.

The authors might also approve of the Rev. William Buckland, an energetic and competent English geologist of the period. His books, including *Reliquiae Diluvianae* (*Relics of the Food*), of 1823 are outstanding examples of the catastrophists' attempts to reconcile science with the Bible. He summarized evidence, from animal bones in caves, that England had been visited by Noah's flood. Buckland discussed in detail how hapless antediluvians must have been swept in by diluvial detritus. Actually, animals frequently haunted these caves to feast on imprudent intruders, whose bones were left behind for burial and eventual exhumation by eager diluvialists. The view offered in unit 9 reminds me particuarly of Buckland's treatise of 1836, *Geology and Mineralogy;* the 6th Bridgewater Treatise, it was part of a series commissioned in the 1830s to demonstrate the "Power, Wisdom, and Goodness of God, as manifested in the Creation." Despite his Noachian presuppositions, Buckland displayed substantial geologic knowledge, particularly his command of the layering of strata and their sequential fossil remains. Arguing for a universal deluge, he tried to show how the successive fossil record matched the *Genesis* account, and he recited evidence everywhere of providential design, including even the coal that insured England's economic prominence.

However, the authors would probably find Hugh Miller (1802-56) somewhat disconcerting. Also an acute observer and certainly no dilettante, he was not as confident as Buckland. In his *Testimony of the Rocks* (1857), Miller devoted two lengthy chapters to "The Noachian Deluge." In these pages he turned a critical eye on the legends and geologic arguments for this supposed event. He rejected the evidence for a universal deluge and argued the folly of sending Noah's flood around the world. He held that Noah's flood was a local event that had occurred somewhere in what is now the Middle East. Buckland's caves had therefore been visited by a flood of much more modest and local proportions. Hugh Miller rather marks the end of the serious 19th-century attempts to equate Earth history with *Genesis*.

An even more important publication was the *Principles of Geology*, in 1830-33 (first edition), by Charles Lyell (1797-1875), whose uniformitarian views the authors dismiss. More than anyone else in his time, Lyell saw the past in terms of agencies now in operation. Leonard G. Wilson (1967, 1969, 1972) has pointed out how Lyell was able to remove the qualitative distinction between the past and the present by a reassessment of these agencies, that included the erosive force of flowing water, the action of volcanoes, and the deposition of sediments. Lyell replaced violence with tranquility, extended the age of the Earth, and thus gave Darwin all the time he needed. This achievement alone is one of two reasons why I find it inconceivable that the authors, however brave their effort, can now bring about any major redirection of biology-teaching to the conceptual framework of this period before Darwin.

In perusing unit 9 I could not help but think that had the authors consulted these books more fully they might have strengthened their arguments and avoided serious pitfalls. From Cuvier and Buckland they might have derived a more coherent argument for diluvialism; and from Miller, if not from Lyell, perhaps a wholesome urge to steer clear of Noah's flood altogether. For instance, I find it difficult to understand, on p. 405, the ingenious explanation of why the remains of the more complex animals are found higher in the rock strata than are the less complex. Apparently the more complex, such as an elephant, though of considerable weight, would have swum to the top during Noah's flood, whereas the simpler, such as lizards, though lighter in weight, would have plummeted forthwith to the bottom. I can find nothing like it in the writings of Buckland or Miller. It is also difficult to visualize how aquatic animals, that comprise a substantial portion of the fossil record, would have been done in by a flood.

From Cuvier and Buckland they might have derived a more coherent argument for diluvialism; and from Miller, if not from Lyell, perhaps a wholesome urge to steer clear of Noah's flood altogether.

We are informed on p. 412 that Noah's flood was a "major catastrophe of world-wide proportions." Yet two pages later we are reminded that Cretaceous shales in Glacier National Park "show no evidence of disturbance except in small areas." Now it seems to me that such an epic flood should have torn things up. Moreover, if Noah's flood scoured out the Grand Canyon, would the authors be able to find marks of this flood on say, the upper slopes of Mt. Whitney, or perhaps on Mt. Hood? After all, "the mountains were covered" (*Genesis* 7:20). But Lyell did not find that such a single devastation could account for the present or past characteristics of the Mississippi valley, which he visited in 1845-46 (Lyell, 1849, II, ch. 34). If he were correct, how then could the flood account for the Grand Canyon—much less any changes at higher elevations?

Footprint Hoaxes

On p. 417-418 we are told of alleged footprints of large men who lived with dinosaurs in Texas and with trilobites in Utah. I suppose these tracks are meant to substantiate the *Genesis* 4:6 account of "giants in the earth." But Keith Young, professor of geology at the University of Texas at Austin, has informed me (letter, 24 May 1971) that on several visits to the Glen Rose, Texas, location he has never seen, nor has he been shown, such "human" footprints, though there are dinosaur tracks to be seen there. Moreover, he observes that these "human" tracks show no pressure points as the result of walking, whereas the dinosaur tracks do show the flow of mud as the animal shifted its footing when walking; there is no narrowing of the "human" instep; and the "human" tracks are chiselled evenly, whereas the dinosaur tracks, made in soft mud, show deformation due to the rolling-in of the mud.

As for the "human-like sandal print" at Delta, Utah: R. A. Robison, professor of geology at the University of Utah, has informed me (letter, 1 June 1971) that the supposed "footprint" has probably resulted from a fracture pattern that commonly occurs in certain sedimentary layers there. Moreover, the "footprint" occurs in company with trilobites, brachiopods, and echinoderms—creatures of the ocean, which is a strange habitat indeed for antediluvian man.

William Buckland and Hugh Miller, who were among the ablest geologists of the 19th century, routinely distinguished between marine and fresh-water sediments and between fossils and artefacts. They would have been quite able to recognize a hoax when they saw one.

A similar misreading of the rocks occurred in the 18th century with the discovery of the skeleton of a "man who witnessed the flood." Because Noah's flood cleansed Switzerland, reasoned Johann Jacob Schneuzer (1672-1733), physician and fossil hunter, then human bones would have been left behind—although plants, of course, were more worthy of preservation. Success came in 1725 when he dug a skeleton from a quarry; he prepared an engraving of it and proclaimed that he had found "Homo Diluvii Testis." He happily notified the Royal Society of London, which soberly published his report in the *Philosophical Transactions* [1726, vol. 34, p. 38-39] Scheuzer's story of his "ancient sinner" escaped serious challenge for 100 years until Cuvier, who could tell one skeleton from another, republished Scheuzer's engraving with a complete analysis. If the bones once belonged to a man who drowned in the flood, what happened to the forehead, Cuvier wanted to know? Why were the eye sockets so large, and where were the teeth? Cuvier showed that it was only an extinct salamander. So much for the "man who witnessed the flood." [Cuvier, *Recherches sur les Ossemens Fossiles,* 3rd ed., 1825, vol. 6, p. 431-444; 4th ed., 1836, atlas, vol. 2, plate 253; Jahn, p. 193-213 in Schneer.]

Geographic Distribution

The authors ought to have had another look at Louis Agassiz (1807-73), the Swiss-American zoologist who always opposed evolution. His *Studies on Glaciers*, first published in French in 1840, is now available in a splendid English edition (1967). Agassiz' ice displayed a considerable amount of diluvial mud

That some orders and species have not changed appreciably in geologic times has been known since the early part of the 19th century. . . . Because some animals and plants have not evolved, it by no means follows that others have not.

from 19th-century thought by accounting for peculiar events that really had occurred in the recent geologic past, such as the transportation of those boulders. Lyell, and even Buckland, soon incorporated Agassiz' views into their own (Lyell, 1854, p. 154-155, ch. 15; Rudwick, p. 151). And according to Gray, glaciers were a physical agency that, by prompting the migration of plants and animals, led to their present distribution (Aulie, 1970; Dupree, 1968, p. 250-252).

I should now like to ask: how would the authors account for the present existence of alpine plants high in the Rocky Mountains, if presumably they all had perished in Noah's flood? Inasmuch as they cannot live on the warm valley floor, are we to believe that they were created where they are now found at the conclusion of Noah's flood? If so, that would be adding to the *Genesis* account of creation.

Straying from a literal interpretation of *Genesis* is what Agassiz did when he sought to accommodate the fossil record with the known facts of the present distribution of animals. According to his version of special creation, he held to a series of catastrophes, and denied that animals were created in a single place, that is, in the vicinity of the Garden of Eden. "Of such distinct periods, such successive creations, we know now at least about a dozen," and there may have been at least twenty, he thought—substantially more than Moses allowed, it would appear (Agassiz, 1850a, p. 185). Because Agassiz denied that physical agencies could influence the distribution of animals, he viewed his glaciers as catastrophic evidence of divine power—"God's great plow," he called them (Lurie, p. 98). They caused extinctions, and they led, not to migrations, as Gray and Darwin concluded, but to subsequent creations. Animals were therefore created where they are now found, and in much the same proportions (Agassiz, 1850b, 1851).

The Lingula Problem

A major weakness in the authors' position is on p. 416-417 where we are told that the longeivity of such animals as the *Lingula* (a shellfish) and the opposum, that show little change through millions of years, is further evidence against evolution. Apparently we are supposed to conclude that, because these animals have not evolved, then all other animals have not evolved, either. Widely distributed in the fossil strata, these animals do form series of similar specimens from an early geologic period to the present. It is quite true that they show little evolutionary divergence. Probably the oldest brachiopod, *Lingula* has flourished for 500 million years since Ordovician times, and strongly resembles its present-day cousin (See Darwin on *Lingula* in *Origin*, 1859, p. 306, and 1872, p. 308). And the Cretaceous opposum of 70 million years ago is very much like the form now living. But this is actually evidence against the position of the authors, inasmuch as they hold that catastrophes, notably Noah's flood, obliterated entire species in the past (p. 393, 412). Why therefore is the longevity of these animals *not* an argument against their position, if all creatures perished, save those in the ark?

That some orders and species have not changed appreciably in geologic times has been known since the early part of the 19th century. Even before Darwin published the *Origin* their longevity was seen as not favorable to the special-creation doctrine (Lovejoy, p. 391-394); this point was made in 1858 by Thomas Henry Huxley (1825-95) in his article "On the Persistent Types of Animal Life," in which he included in his long list the sturdy *Lingula* (Huxley, 1858-62). Huxley suggested that the durability of these animals did not support the hypothesis of catastrophes and subsequent special creations. Their survival, he noted, rather supported the view that they had experienced uniform conditions throughout their geologic history.

Such continuous series of similar fossils can tell us nothing about the manner of origin of the first member, whether it arose by a sudden act of creation, or whether it had dissimilar antecedents. We can only say that in their case no evolutionary divergence has occurred (See Darwin on longevity, 1872, p. 193, 330-331). And because some animals and plants have not evolved, it by no means follows that others have not. A reasonable explanation for the longevity of *Lingula* and the opposum might therefore be, as Huxley perceived, that they encountered no substantial competition or physical stress in their particular ecologic niches.

The authors might counter, however, that these animals rode to safety with Noah and then migrated to the geologic site where they are now found. But Hugh Miller, whose piety we should not doubt, remarked (1857, p. 347) that if all living animals are descendants of passengers in the ark, then they would have had to be ferried across the Atlantic by a miracle not recorded by Moses, not to mention the initial journey to safety.

The geographic distribution of living organisms is scarcely mentioned in the text and is one of the major weaknesses in unit 9. And no wonder: it was the examination of this question, to which Agassiz' ice provided so useful an insight, that brought about a further substantial modification of the special-creation doctrine in the 1850s (Aulie, 1970). The authors miss the important relationships among extinction, adaptation, and distribution, toward the resolution of which in Darwin these early 19th century investigators pointed the way.

Catastrophism sought to maintain a short time-span for the Earth by accounting for observable changes in terms of sudden convulsions. Lyell lengthened the age of the Earth by arguing effectively for gradual, long-term changes. Those persons who today are drawn to the former view ought to weigh the arguments put forward in Lyell's *Principles of Geology*. It is Lyell, not Darwin, whose monumental achievement remains a challenge to the reestablishment of this 19th-century doctrine.

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Part III. The Ideal Type

Two problems faced during the 19th century by adherents of the special-creation doctrine were (1) the anatomic similarities between different vertebrates and (2) variability within a single species. Indeed, biologists have sought to understand these matters since the time of Aristotle. The Darwinian solution was a common ancestry with hereditary relatedness. We must now examine the authors' solution of these ancient puzzles. In so doing, we are again back in the decades before Darwin, where we shall find the most important difference between the creationist and evolutionary viewpoints. The diffcrence is more profound than this textbook implies.

In at least 14 passages the text expresses the view that both similarity and variability were established at the time of the creation. Examples are the Creator's outline of order as seen in groups of plants (p. 183); the assertion that each molluscan type was created as such (p. 237); the primordial separation between echinoderms and vertebrates (p. 243); the idea that a fossil plant form represents a "kind" (p. 393); limited variation within each group of organisms (p. 147, 419, 458); that the *Genesis* "kind" also represents limited variability (p. 393, 403, 410, 429, 430); that man and the ape were created according to the same plan (p. 434); and reference to a fossil ancestral human "type" (p. 437). These passages would seem to be a faithful expression of the first two chapters of *Genesis.* So far so good; but two further passages must cast doubt on this interpretation.

On p. 396, in a section on the life cycles of seed plants, we are told that "the Creator used different patterns or systems in various plants and that none is therefore any more primitive or advanced than the others." And on p. 422, in an interpretation of vertebrate homologies, we learn that

> Creationists believe that when God created the vertebrates, He used a single blueprint for the body plan but varied the plan so that each "kind" would be perfectly equipped to take its place in the wonderful world He created for them.

A question immediately arises: what texts in the Bible would the authors put forward as documentation for "blueprints," "patterns," and "systems"? Of course, there are none. (The famous word "kind" in *Genesis* 1 probably represents only a general, reproductive relationship, certainly not an eternal model. Only *John* 1:1-3 and 2 *Corinthians* 4:18 are suggestive, but in context the meaning of each is entirely different.)

Platonic Idea of Homology

The view expressed in these two passages in the text resembles that held by the anatomists of the early part of the 19th century—particularly Richard Owen (1804-92). He recognized that certain similarities between bony structures of different animals are more important than others. He applied the term "homologies" to these similarities in his book *On the Nature of Limbs* (1849). Owen decided that vertebrate skeletons, including fishes, reptiles, birds, mammals, and man, were modifications of a single "archetype" that existed as a divine reality, wholly apart and beyond nature. For example, the similarity in the bones of the appendages of a dugong, a horse, a mole, a whale, and man seemed to him to be expressions of the *same* eternal archetype for *different* locomotor functions.

Owen's term, homology, remains in modern biology but in a different sense, for it denotes structural similarity as an index of common ancestry. Owen's ideas represent the culmination of a European tradition in anatomy that, in the decades before Darwin, sought to understand uniformities in nature in terms of transcendent principles. This interpretation was derived historically from the thought of Plato.

What texts in the Bible would the authors put forward as documentation for "blueprints," "patterns," and "systems"? There are none.

In the *Republic* (books 6 and 10) and *Timaeus* (30c-31a, 48e-53d), Plato insisted that the "real" world is not the same as our world of sense experience. The former is not subject to time and change, because it contains eternal and immutable "ideas." The latter—the visible world that we inhabit—is less real, because it contains transient and changing copies of these ideas. Similar animals are therefore varying manifestations of a single idea (*eidos*) that has an existence of its own, quite beyond the realm of the verifiable. Furthermore, the regularity we perceive in nature has resulted because the Demiurge (God), a kind of divine craftsman, has imposed order on preexisting Chaos by using these ideas as "models" (Frazer, 1967; Robin, 1967). Objects we see in nature are therefore flickering images of ideas —mere shadows cast by the eternal light on the walls of a cave, according to Plato's famous allegory (*Republic*, book 8).

This is a profound conception. It may be traced, with its Aristotelian modifications, as a guiding influence in biology from Greek times until the publication of the *Origin of Species*. It was a prominent theme in comparative anatomy in France, Germany, and England in the latter part of the 18th century and through the first half of the 19th century. Transcendental anatomists used the terms "archetype," "ideal type," "type," and "unity of plan" when conceptualizing similarity and variability.

Platonic and Aristotelian thought was a powerful tool: through its use morphology became central to zoology and provided much of the empiric data for the later theory of evolution. For example, Platonic doctrine pervaded Owen's explanation of homologies, by which he showed, correctly, that vertebrate skeletons *are* constructed on a common plan. And in his denial of evolution (or transformation) he was quite clear that the source of this similarity was an eternal idea, beyond nature (1849, p. 86):

> The Divine mind which planned the Archetype also foreknew all its modifications. The Archetypal idea was manifested in the flesh, under diverse such manifestations, upon this planet, long prior to the existence of those animal species that actually exemplify it.

Moreover, he even invented a diagram of what this archetype must be like. The authors' explanation of homologies, as shown in their statement on p. 422, quoted above, is strikingly similar to that of Owen, given here—except that Owen, unlike them, acknowledged Plato as the source of his interpretation (1849, p. 2). Moses really did not take up the problem of vertebrate homologies.

The Mollusk Problem

According to the text, only one "type" or "blueprint" was required for the creation of all seven classes of vertebrates (p. 422, 533-535). But apparently the Almighty required (p. 237) a separate blueprint for each of the five molluscan classes (p. 529). A certain heavenly efficiency might have been introduced into these proceedings if the authors had thought to attribute to the Creator just one blueprint for all the mollusks. And is the human "type" mentioned on p. 434, 437, 439 the same as the vertebrate "type" on p. 422?

The mollusks have posed important problems in morphology since the time of Aristotle. The authors might have consulted what Thomas Henry Huxley had to say about them, even though he became an arch-foe of special creation. In 1846-50, when the young Huxley was taking part in a South Seas expedition, he made a special study of the cephalous Mollusca (squids, snails, slugs) in an effort to understand their basic homologies. In so doing he effectively transformed the Platonic type into the type concept in use today. Rejecting the metaphysical approach, he regarded the "type" as simply an empiric summary of the structural congruities found in a group of related organisms (Huxley, 1852).

I am relieved to see, on p. 447, that the authors did not succumb to the temptation to apply one and the same archetypal idea to both vertebrates and invertebrates. The diagrams showing a generalized salamander and a generalized crayfish reflect, in fact, Huxley's conceptual approach, that is now firmly fixed in modern biology. Each diagram is an empiric abstraction (and is therefore effective as a pedagogic device).

But these diagrams are reminiscent of the controversy in French biology in 1840 concerning the extent to which the idea of the "type" may be applied to both vertebrates and invertebrates. Etienne Geoffroy Saint-Hilaire (1772-1844), who had been making extensive comparative studies of the anatomy of vertebrates and invertebrates (including cephalopods), argued that a single ideal type might do for both groups. Cuvier thought not; and he remarked (1830), with a touch of asperity, that Geoffroy's discussions of anatomic similarity between vertebrates and cephalopods had not gone far beyond Aristotle's. Geoffry, to no avail, insisted (1837) that his view was not really an extension of Greek doctrine.

The *coup de grâce* was delivered to Owen's anatomic application of the type idea in 1858 by Huxley, who showed that embryologic evidence simply would not support its claims. Since then, homologies have been determined in terms of developmental derivation, rather than by adult anatomic similarities. And this embryologic "type" rests firmly on the foundation laid by Darwin, who removed it from the cosmos and gave it an empiric existence in the real past.

Platonic Idea of Species

The authors' view of species is also Platonic in conceptual origin. According to the special-creationists, all species are discrete entities. They are essentially nonhistorical, for their existence is accounted for by separate, independent events *ex nihilo*. There is no connection, or relatedness, between them—certainly not an hereditary one—save an ideal connection between each eternal idea, or "type," that coexists with the Creator. The reality is the unchanging, eternal type, of which visible species are ephemeral manifestations. Variations must therefore be understood as oscillations around an unchanging, metaphysical mean.

The *Origin of Species* may be regarded as an argu-

ment against this view of species, that was dominant through the 18th century until the middle of the 19th century. To be sure, the application of the Platonic notion of the "type" took many forms; but this conception may be discussed as essential in the work of the leading naturalists of the time, including Carolus Linnaeus (1707-78), who emphasized the constancy of species; Owen, in whom the special-creation doctrine reached its zenith in England; Agassiz, who was the leading American exponent; Cuvier and Geoffroy, in France; and, for a time, Lyell, Huxley, and Joseph Dalton Hooker (1817-1911), in England. The Platonic type was in fact the only concept available to them for dealing with similarity and variability until the theory of evolution was established (Mayr, 1963, ch. 1, 2).

The authors' view of species is Platonic in conceptual origin. The reality is the unchanging, eternal type, of which visible species are ephemeral manifestations.

The Finch Problem

The concept of the Platonic type may help us understand the authors' interpretation of variability. On p. 454 the authors describe a reexamination that has been done recently of more than 1,200 Galápagos finches at the California Academy of Sciences museum in San Francisco. We are told that "all the assigned species intergrade with one another." Furthermore, if they are arranged according to body and beak size "a perfect gradation would be found betwen the species having the leargest beak, *Geospiza magnirostris*, and the species having the smallest beak, *G. fuliginosa*." This is supposed to be evidence that the Galápagos finches actually belong to the same species.

Apparently, if Darwin had only recognized this gradation he would not have been led astray. But when we consult his *Voyage of the Beagle* (1962, p. 380) we find that it is precisely this gradation that caught his attention:

> The most curious fact is the perfect gradation in the size of the breaks in the different species of *Geospiza*, from one as large as that of a hawfinch to that of a chaffinch . . . instead of there being only one intermediate species, . . . there are no less than six species with insensibly graduated beaks.

Thus the significance of the authors' discovery of gradation in these finches is not at all clear, in view of the fact that Darwin was struck by it in October 1835.

The authors are referring, perhaps, to the study by Lammerts, who considers "these birds as all in one species broken up into various island forms" ["The Galápagos Island Finches," in Lammerts, 1970]. His study should be compared with that of Bowman [1963], who also raised questions about the uniformity of gradation and the relative importance of various adaptive factors. But Bowman did not minimize the importance of the variability, nor did he say the finches all belong to the same species. I am grateful to H. William Lunt, for drawing Bowman's work to my attention. As for the special-creationist's failure to consult carefully Darwin's published views: I have already had occasion to deal with two such lapses [Aulie, 1968, 1970].

But what is significant is the contrasting view of the variability by special creation and by Darwin. The constancy of species was emphasized by early-day special-creationists, just as it is by the present authors. These constant species were created, we are told on p. 458 (also p. 147), with "much potential variability"—whatever that is. Variability cannot mean any significant biologic activity now occurring—certainly no hereditary divergence—because it reflects merely the designing action of the Creator. Thus, variations are capricious fluctuations in a category of thought.

On the other hand, Darwin was not circumscribed by Platonism. He could fasten his attention not on the mystical, unchanging type but on the visible variant itself as a product of some biologic activity. He could then ask himself (1) why those beaks could be arranged evenly according to size across six separate species of finches, instead of one; and (2) why those six species were now in fact constant? He saw the Linnaean fixity as a problem to be solved. For Darwin the constancy of species was an empiric observation rather than a principle of metaphysics.

I do not object to the use of the Platonic "idea" when the theory of evolution is rejected. Indeed, the Platonic idea is the only alternative to evolution for an understanding of the nature of species. But I do object to the implication in this textbook that "blueprints" and "types" are an accurate exegesis of the Bible. They are not. Owen, who was orthodox in his religion, took care to cite Plato. Were these "blueprints," "patterns," "systems," and "types" coexistent and eternal outside the deity, or were they ideas within the divine mind? In either case their use recalls Plato's Demiurge, wrestling with a recalcitrant Nature while consulting these eternal "models" for the regularity to be imposed. The authors' conception of God should not be equated with Plato's Demiurge, but we should be aware of the philosophic origin of the "type" and be wary of its theologic implications. (To the ancient Greeks, the Platonic system was in essence a dualism composed of eternal form and matter. Creation therefore meant that the Demiurge imposed form [ideas] on an organized *something* that was already in existence. This dualistic view of reality was much discussed in Christianity's earliest period, and implicitly disallowed in the Nicene Creed and the Apostles' Creed.)

To affirm that all things were created by God is not the same as saying that the Creator employed a blueprint for their creation. The former assertion is derived from the Judaeo-Christian tradition; the latter is merely an extension of Greek doctrine.

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Part IV. Evolution and Christianity

Epigenesis

There is a striking parallel between the present reluctance to accept evolution and the resistance to the idea of epigenesis in the 18th century. Both ideas involve change in the organic world. In the introduction to a 1785 French edition of the works of Lazzaro Spallanzani (1729-99) on embryology, the Swiss naturalist and clergyman Jean Senebier (1742-1809) based the concept of preformation on *Genesis*. He claimed that God had created, in the beginning, all the organisms, fully formed and alive, that ever would inhabit the Earth. Preformation therefore meant, for him, the preexistence of the organism prior to its parent. With impressive microscopic evidence at his disposal, be it noted, he could then argue that during development there was no differentiation, for none was needed: no production *de novo* of tissues and organs, but a gradual unfolding of what was already there.

Senebier let it be known what he thought of those who argued otherwise: they were atheists, the lot of them. He went on to explain (1785, p. xxxi):

> As for the moment of creation of these fetuses which must people the earth with man, animals, animalcules, and plants through its duration, I can only fix it at the moment of creation. The sacred historian informs us that God ceased from creating at the end of the sixth day. The experience of all the centuries informs us that God has created nothing anew [*de nouveau*].

Epigenesis, with its emphasis on internal transformations by a sequential, orderly differentiation, was, for Senebier, clearly a threat to theism. It meant that all living organisms had not, after all, been created *ex nihilo* in the beginning. Logically, it meant a series of encapsulated creatures in miniature. An acorn contained a diminutive oak—with yet other acorns, enough for a whole forest. Encapsulation ("ovism," as described here) was indeed the most elaborate and complex of the various versions of preformation extant in the 18th century. The devout were assured that Mother Eve carried tucked away in her ovaries all the members of the human race who were predestined to walk the earth—one egg inside the other, so to speak. Presumably the world would end when they were used up (Adelmann, 1966, II, p. 894 *passim*).

Epigenesis (including, of course, chemical preformation) has become so deeply embedded in biology since Senebier's time that no one today questions the idea that organisms develop gradually from an ovum, even though this can scarcely be observed with ease. Not even the authors see a threat to theism in their epigenetic treatment of development (p. 126-137).

It is therefore appropriate to wonder whether the authors are not inconsistent in denying evolution, on the one hand, while fully accepting epigenesis, on the other. If the basic kinds of organisms "were placed on the earth by direct action of the Creator" (p. 398), why not all organisms, also in the beginning? Inasmuch as the special-creation doctrine denies evolution-were right: development is due to efficacious changes

Perhaps the processes in development we now regard as epigenetic are really only apparent—a beguiling thought. Perhaps, then, the preformationists were right: development is due to effacious changes in opacity, to the shifting of position, and to unequal growth rates, by enlargements and extensions, of tissues and organs that are already there—incidentally, a not-unreasonable explanation before epigenetic mechanisms were identified (Haller, 1758, II, p. 172-190, translated in Adelmann, 1966, II, p. 878-884).

Happily, Senebier is remembered today for his meticulous experiments on photosynthesis during the 1780s, not for his dismay over what happens in an egg. The resistance to epigenesis, like the earlier resistance to gravity and the later resistance to evolution, was only a temporary step, albeit a retrogressive one. But it could be no more than a delaying action. It is as though science could not return to a former position.

Notwithstanding the continuities we must discern in the history of biology, I can think of no instance where a new conceptual view, once embraced, was rejected for a return to that of a previous age. This is the second reason why I cannot see how the authors, however sincere they may be, can expect much success in their efforts to return biology to the early part of the 19th century. Science, like time, is a forward movement.

Plato, Aristotle, and Darwin

We have seen that, historically, the special-creation doctrine views nature primarily in Platonic and Aris-

totelian terms. Animals are arranged on an ascending order of distinct taxonomic entities. There are variations on each level, to be sure, but each "type" of organism has an independent existence with no hereditary relationship with its neighbors. The levels represented by these animals are viewed as increasing upward in structural complexity and moral worth, toward man, who enjoyed an exalted position at the pinnacle of creation.

It was this vision of nature during the 18th and 19th centuries and now in the text under review that to a large extent was equated with the account of divine creation in *Genesis*. This vision was congenial to the superficially pious, but the meaning of divine creation was thereby obscured. For this hierarchic view of organic nature was really an expression of the Greek tradition, particularly Plato's *Timaeus* and Aristotle's *History of Animals*; it could have perforce little in common with the Biblical doctrine of divine creation. Those who failed to recognize the Greek component in the doctrine of special creation, falsely based on *Genesis*, therefore thought erroneously that Darwin's theory of evolution was an assault on the Bible. Thus we may understand the dismay evoked by the introduction of new ideas. For those who thought the Lord had created the animals all at once, instead of at successive intervals, even the idea of a series of catastrophes could jar their sense of stability. The discovery of fossils of animals now extinct raised the disturbing question of why the Lord, having once created such handsome creatures, should find it necessary to get rid of them. (Some thought they had been created to confound the horrid geologists.)

Darwin broke this static view of nature. By focusing on populations that interact in space and time he made unnecessary the Platonic types and Aristotelian hierarchies. Moreover, man could no longer occupy an exalted perch on Aristotle's "scale of nature." Darwin introduced a dynamism never before known: modern ecology became possible, and there were even implications for biology-teaching. The arbitrary division today of an introductory biology course into the two segments of botany and zoology represents a survival of this older, hierarchic view in which every living thing is fixed in its place.

As we have also seen, "special creation" has been falsely equated with the Biblical tradition. As an interpretation of organic nature with roots in Plato and Aristotle, it should be distinguished from the doctrine of "Creation," which is a Judaeo-Christian affirmation of *creatio ex nihilo*: the world came from nothing, not from a preexistent something. Creation implies the religious mystery of divine sovereignty and transcendent holiness, which thereby assure that nature is coherent, knowable, predictable, and good. A careful reading of Darwin indicates that he was aware of the difference. In fact, he allowed for (I do not say he asserted) "Creation" on p. 188, 189, 484, and 490 of the first edition of the *Origin*, and this allowance was retained in all other editions as well (for example, in the last few paragraphs of each edition).

The doctrine of Creation carried three important ideas: (i) ultimate origin *ex nihilo;* (ii) linear time; and (iii) future fulfillment. (See *Genesis* 1, 2; *Psalms* 19, 90; *Isaiah* 44:24; *John* 1:1-3; *Romans* 8:18-23; *Colossians* 1:15-20; *1 Thessalonians* 4:13-18; *2 Peter* 3; and *Revelation* 10:6, 22:13.) This doctrine assumed new importance during the 16th and 17th centuries, when natural philosophy began to recognize a clear distinction between the created and the Creator. Natural philosophy banished the ancient gods, goddesses, and "spirit" from nature, which thereupon lost its animistic components yet remained sacred because of its divine origin. Nature could then become an object of scientific study in the modern sense, for it could be viewed as a system of matter in *motion*, controlled by natural law, and separate from the Deity. This meant a radical shift from the Greeks' unvarying, cyclic, and finalistic view of nature (Burtt, 1954; Collingwood, 1960).

It is ironic that the possibility of progressive change was advanced by the Judaeo-Christian tradition, and that the authors would now uphold a return to Greek doctrine.

The doctrine of creation contributed to the idea of progress—which implies that nature has a history and a goal. This also means that nature can experience novelty, and with it the possibility of change for the better in time (Gilkey, 1965). We perceive a linear, progressive sequence in the fossil record, and we identify adaptation as a biologic fulfillment of change in linear time. The idea of progress—necessary for the theory of evolution—was strengthened by the secularization of an attitude toward nature that was drawn initially from the Judaeo-Christian tradition (Wagar, 1967). It is therefore no accident that the theory of evolution arose in the West.

Galileo Galilei (1564-1642) saw nature as a created object, and he recognized the significance of change in time—evidenced by comets, sunspots, novae—for the possibility of scientific progress. He was also clear on the "use of Biblical quotations in matters of science" (1651) in what still remains a useful discussion of the relationship between science and religion. As Alfred North Whitehead (1861-1947) remarked, "the faith in the possibility of science, generated antecedently to the development of modern scientific theory, is an unconscious derivative of medieval theology" (1925, p. 19).

It is the prospect of progressive change in time that haunts the authors of this book. This is the same view of change that caused alarm in the time of Galileo and Newton and that caused Senebier to take fright at an egg. It is ironic that the possibility of progressive change was advanced by the Judaeo-Christian tradition, and that the authors would now uphold what must be, in effect, a return to Greek doctrine. They think it may be possible to resolve the paradox of what Asa Gray once called the "designed and the contingent" (Dupree, 1963, p. 225). But theirs can only be a minority opinion, for contemporary Protestantism as a whole has long since made its peace with Darwin.

Science and Christianity Both Suffer

The interpretation of *creatio ex nihilo* I have been discussing was obscured, to some extent, by the natural theology of the 18th century, and certainly by the doctrine of special creation in the early decades of the 19th century. I fear this textbook will obscure it even more. A theologic doctrine—Creation—of high importance in the history of science has been equated with the science of a bygone age. We shall have, therefore, neither true religion nor modern biology. Christianity must now depend on the accuracy of geologic claims made more than a century ago. And biology must absorb again the main elements of Plato and Aristotle.

The doctrine of special creation obscures the troublesome yet edifying questions of the responsibility of man to his Creator and of man's responsibility to his fellows and to nonhuman nature. As Hugh Miller warned: "The true question is, not whether or no Moses is to be believed in the matter, but whether or no we in reality understand Moses" (1857, p. 351).

Acknowledgements

Leonard G. Wilson, of the University of Minnesota, gave me his comments on my interpretation of catastrophism. Arthur L. Herman, of the Philosophy Dept. of Wisconsin State University, Stevens Point, commented on my interpretation of Plato. Douglas S. Wilson lent me his copy of Hugh Miller. H. William Lunt, formerly of Chicago State University, Frank E. Miller, of Bloom Township High School (Chicago Heights, IL), Maybelle T. Ryan, of Kennedy High School (Chicago), and Walter P. Trost, of the YMCA Community College in Chicago, voiced useful opinions while I was preparing the article.

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Evolution: A Personal Dilemma

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Remarkably little appears to have taken place over the past 10 years or so in Christian thinking on evolution. The same camps are still there, their front lines looking remarkably like those of a decade ago. Much the same propaganda is put out by the respective combatants, and the lines of battle look as solid and stagnant as they have done in recent memory.

Whether or not we appreciate the battlefield allusion, we cannot easily deny the underlying reality of warfare. It can be argued of course that, while evangelicals do disagree over the mechanisms and scope of evolution, they are basically agreed over the reality and omnipotence of the Creator-God and over the fundamental importance of creation as a major theological truth. This undoubtedly is the case, even if the statement as it stands is unduly simplistic. In spite of this however, the creation-evolution controversy remains a deep-rooted cause of division among evangelicals.

This article, as its title suggests, is a personal view of the debate. It is not intended to be an academic exposition either of biblical or scientific issues. It is simply an expression of the feelings of one person who, by virtue of his standing as a human biologist and Christian, finds himself constantly surrounded by evolutionary thinking and also more specifically by evolutionary humanistic thinking. For me therefore, the evolutionary debate cannot be shelved as of merely theoretical interest. Neither can I adopt an intellectual position which does not make sense for me as a human being. And neither can I content myself with a belief which is of little relevance in solving contemporary ethical and social issues.

The end result is that I find myself on the horns of a dilemma. I have no easy answers one way or the other. But I do not despair. Perhaps there are others in a similar position to myself, dissatisfied with the usual evangelical answers and looking for a new way out of the dilemma—whatever that might be.

The Controversy

The majority opinion among some sectors of the evangelical community still seems to be that the choice between creation and evolution is an "either-or" one. *Either* creation *or* evolution. Such an option precludes compromise of any kind. Indeed compromise is regarded in its perjorative sense, in that to compromise on this issue implies a denial of certain basic biblical truths.

One of the major reasons for this attitude, it seems to me, is that emotional and philosophical considerations have been allowed to hold sway at the expense of theological and scientific principles. On the one hand this means that for many scientists (generally those who are humanists anyway) the theory of evolution has been transformed into the dogma of evolutionism. This provides them with what to them is a satisfying philosophical and humanistic alternative to the doctrine of special creation. Evolutionism contains within itself the potential for explaining the whole of the cosmos in strictly natural terms, with the result that the need for a god or for any supernatural agency apparently disappears. There are many variations of evolutionism, some of which have religious ideas built into them. In its extreme form however, it is distinctly atheistic and, for many people, serves as a god-substitute. It is hardly surprising that evangelicals with a high view of Scripture vehemently oppose evolution in this guise. It is just as well to remember though that evolutionism is a philosophical extension (some would say travesty) of the more scientific evolutionary theories.

At the other extreme we meet those Christians for whom the literal interpretation of the early chapters of Genesis, in the context of a static world-view, almost completely rules out the possibility of change in living forms. Such a position cannot, by its very nature, be influenced by the findings of science and in particular of the so-called historical sciences such as geology and palaeontology. Consistency demands that these sciences be reinterpreted, with biblical data (generally the Noahic flood) and catastrophic concepts as the starting point, as opposed to contemporary scientific concepts with their dependence upon uniformitarianism and immense periods of time. Almost invariably, the advocates of this type of position are strongly anti-evolutionary, viewing it in essence as

specifically anti-Christian, with creationism the only valid Christian alternative to evolution. This position additionally leads to a Christian vs science stance, with science conveying overtones of atheism.

It is not my intention to argue the pros and cons of either extreme position here, except to remark that both are agreed on one point. Both view evolution as a philosophical system. To the one, it affirms the freedom of nature and autonomy of man; to the other, it is a denial of God as God. Unfortunately, advocates of both points are frequently guilty of failing to define the way in which they are using the term "evolution", with the result that no distinction is made between its scientific and philosophical connotations. To fail to distinguish between observation and hypothesis in scientific thinking, or between limited and broad generalizations in science is simply misleading, especially when the end result is presented as an incontrovertible law with universal applicability. On the other side, it is not unduly helpful to ignore the legitimate scientific aspects of evolution because these do not fit neatly into a particular interpretation of the early chapters of Genesis.

Many of the controversies within the creation-evolution realm result from ambiguities over the use of the term "evolution". System-building is a philosophical past-time, and philosophical thinking invariably predominates over scientific thinking when evolutionary issues are in the balance. Unfortunately, this is a general tendency applying to both humanists and Christians. The result, almost invariably, is confusion and much unnecessary controversy.

Probably all of us desire to see life in terms of some vast system, by which any and every aspect of life can be satisfactorily explained. There can be little doubt that an evolutionistic synthesis provides such a framework for many scientifically inclined humanists. The temptation for Christians is to build an alternative system based upon a relatively static view of creation. But is this what Christians should be doing? This, to me, is the crux of the creation-evolution controversy, and yet as far as I can see it is the one issue that is studiously avoided.

Evolutionary Theory

In order to answer this question, we need to examine very briefly one or two aspects of evolutionary thinking. In its scientific usage, evolution embraces either the *special* theory of evolution or the *general* theory. Of these, the special theory refers to the relatively small changes that can be *observed* to occur in living species of animals and plants with the production of new species. The general theory, by contrast, asserts that all the living forms in the world today have arisen from a single source which itself was derived from a nonliving form. Simplistic as is this distinction, it draws our attention to two important points. The special theory is a strictly experimental discipline, with the result that its scope is limited and its generalizations few. The general theory however, is a far more speculative affair, making vast assumptions and suggesting far-reaching hypotheses. The one is science in its narrow, disciplined sense; the other is science in its broad, predictive sense. The one is capable of rigorous scientific testing; the other is not and never will be.

The dividing line between the general theory of evolution and philosophical evolutionism is a fine one. Moreover it may on many occasions be difficult to determine, while on others it may be blatantly ignored. I want to suggest that the principal distinction between them lies in the reliance which is placed on the assumptions and speculations. In the scientific arena the speculations are regarded quite openly as speculations. They have a purpose in holding together a scientific idea long enough for it to be tested in some way. Subsequently they are discarded if found wanting, or modified and strengthened if proved useful. In the philosophical arena speculations are readily transformed into essential concepts. Their speculative nature is soon forgotten and they emerge as indispensable principles.

The Christian is free to view the scientific validity and usefulness of evolutionary theories in an objective manner, and is therefore able to retain the distinction between the scientific and philosophical aspects of evolution.

The reliance we place, therefore, upon the assumptions and speculations of the general theory of evolution depends on our philosophical presuppositions. For the humanist they are essential if he is to possess a coherent and unified picture of the world. Hence evolutionary theory undergoes a mutation to become evolutionism. However, a Christian with a biblically-orientated view of the world is free to accept or reject such assumptions. The Christian possesses a degree of freedom unknown to the humanist who, as we have seen, is driven by his philosophical premises towards an evolutionistic position. The Christian is free to take a far more objective view of the scientific evidence. This indeed is a precious liberty in such a difficult area, and it behooves him to value this freedom highly and to use it aright.

A Christian today is in a position where he can accept or reject the current assumptions underlying scientific theories of evolution. There is one proviso however, and this is that as long as he is thinking scientifically his sole criteria must be scientific ones. The possibility of rejection of evolutionary ideas is open to him, as it should be to all scientists. Nevertheless, in scientific terms, the rejection of one hypothesis follows from its inadequacy to account for available evidence and, in turn, leads to the emergence of a more satisfactory hypothesis. Both old and new hypotheses are subject to the same scientific principles of experimental testing. The controlling principle is the scientific evidence. From this it follows that evolutionary theories cannot be regarded as permanent or impregnable, that is, as long as they are viewed scientifically. Such a statement does not allow us to jump to the opposite conclusion either, that their demise is imminent. The Christian is free to view their scientific validity and usefulness in an objective man-

ner, and is therefore able to retain the distinction between the scientific and philosophical aspects of evolution. It can also be argued that, if these aspects of evolution are distinguished, the detailed mechanism of evolution will be of no concern to the Christian *as a Christian.*

Alternatives to Evolutionary Theory

If these points are accepted, they will have a number of consequences for the Christian. As a start he will strive hard to view evolution in precise terms, so that he will see clearly where alternatives are required and the nature of such alternatives. For instance, in rejecting the anti-Christian stance of evolutionary humanists, he will be in a position to decide which emphases are of a religious nature and which are scientific in character.

The importance of this distinction cannot be overemphasized, because while it is honouring to God to reject a false religious position it is far from honouring to Him to reject experimental findings in the name of Christ. Linked with this is the nature of the suggested alternatives to evolution. Simply because it is felt that evolutionism with its humanistic presuppositions must be replaced with a God-centered view of the created universe, it does not follow that evolutionary theory must be replaced with catastrophic creationism. The former is essentially a religious-philosophical issue; the latter should be a scientific one. In practice however, both are frequently treated as religious-philosophical issues, thereby confusing categories and blurring the true challenges to Christian thinking.

The confusion of categories which may arise can be illustrated by asking what are the biblical alternatives to evolution. In the eyes of the biblical writers this world is dominated by God, not by an evolutionary process nor by autonomous man nor by an emerging Christ-like consciousness. God created, God sustains and God directs. From this it follows that in the religious-philosophical sphere God is the Christian's alternative to evolution—the two are mutually exclusive. It behooves Christians therefore, to think far more constructively about the cosmic role of Christ in the universe—a realm traditionally left to liberal theologians.

At the scientific level, I must call myself an evolutionist . . . at the religious-philosophical level I am more than happy to call myself a creationist.

Far more controversial perhaps are the possibility and nature of alternatives to evolution at the mechanistic-scientific level. From what I have already said, Christians should not feel any need to find "Christian" alternatives, although as I have also said, Christians (and others) should not be complacent about the alleged adequacy of currently accepted evolutionary ideas.

I do not believe there are alternatives at the mechanistic level which are specifically Christian. This brings me back to the question I raised previously, and which I suggested then was the crux of the creation-evolution controversy. Should Christians view as their chief task in this controversy the erection of systems of thought designed to combat evolutionary thinking at the level of mechanism? My view is that, in striving to provide such systems, they are misguided. I have a number of reasons for saying this. In the first place, whatever the biblical writers do or do not tell us about the mechanisms of creation, it is in the form of very general principles. Second, even if we today are able to discern the direction in which these principles are pointing, the task of applying them at a detailed level and in terms of current scientific concepts will involve an enormous amount of speculation. This in turn must inevitably be dependent upon a whole host of extra-biblical principles and data. Third, any system based upon general "biblical" principles, however valid it may be in theological terms, cannot by its very nature be experimental and hence cannot be scientific in this sense. This is because the principles, if they are truly biblical ones, are immutable. They are not dependent upon experimental evidence for their validity, and they are not subject to the testing-retesting, proof-disproof approach of scientific experimentation.

A Personal Dilemma

If I reject the creationist systems put forward as alternatives to evolutionary systems, where do I stand? To answer this question I find it necessary to resort to the distinction I have already made between scientific and philosophical views of evolution. At the scientific level I must call myself an evolutionist, not because I particularly like this designation nor because I view evolutionary ideas as unchangeable. Rather, I can find no better explanation at present for the bulk of the available evidence on the development and relationships of living forms. At the religious-philosophical level I am more than happy to call myself a creationist, believing implicitly in the biblical data on the sovereign work of God in creation.

A number of objections will immediately be raised to this position. It can be argued that I am compartmentalizing my thinking, holding as I do two beliefs which some consider to be incompatible. To an extent of course I am compartmentalizing my thinking, but only because the nature of the issues is such that their integration into a single system of thought is not readily possible. This is one aspect of my personal dilemma. No one wants to live with tension, and yet tension may be inevitable in this area. No one wants to live with unresolved questions, and yet there may well be questions in this area incapable of resolution at present.

My position is an open ended one and hence unsatisfactory in the eyes of many. Note however, that its open endedness is essentially on the scientific issues where, in my opinion as a scientist, open endedness is mandatory. Even very general scientific principles are subject to revision and, occasionally, rejection. Whether or not this ever happens with evolution I am in no position to judge, but I must keep my options open particularly regarding some of its more detailed mechanisms. How open ended are creationist views? The biblical data are not open ended, biblical interpretation on Genesis 1-11 is somewhat more so, while creationist schemes are very much more so. Even on the religious side then, the matter is not as black and

white as some would have us believe. Nevertheless, open endedness is not always easy to accommodate in one's thinking, and it constitutes another segment of my personal dilemma.

It will be asserted by some that I am unfaithful to biblical revelation and that my view of the Scriptures is not as high as it should be. In other words, it may be argued that I am not thinking in a truly evangelical fashion. This I would resolutely deny. All I am saying is that the Bible does not speak in an experimental scientific manner. It cannot, because it is God's revelation to man and not man's attempt to unfathom the riches of God's world by a strict system of experimentation. Man needs both these, man uses both these, and God ordained that both should be exploited to the full. This principle is not abrogated in the creation-evolution area, simply because misunderstandings and genuine difficulties abound in it. This is a part of my personal dilemma too, because the body of Christ is being torn asunder by claims and counter-claims about fidelity to God's word.

Then there is a final twist to this controversy which puts my personal dilemma in a nutshell. As I look at man from the perspective of both a human biologist and a Christian, how do I see him? When confronted by the numerous problems facing man today, what principles do I resort to in an attempt to solve them? Do I find help in evolutionary concepts, or not? According to some evolutionary humanists, the principles uncovered in studying evolutionary trends should point the way forward for modern man.

It is at precisely this juncture that the limitations of evolutionary thinking become all too obvious. I (and many others) cannot find in man's evolutionary past the principles which will help unravel the complexities of the ethical decisions facing us today. In this regard evolution as a value generating system is bankrupt. We have to look elsewhere for help, and for the Christian of course this is to the Bible. In terms of what I have said previously, we should not expect to obtain value judgments from evolution. And we do not when it is presented as a scientific theory. The only value judgments ever present in evolution are those injected into it from outside, and whenever that occurs we are dealing with some form of evolutionism.

If this is the case, evolutionary theory may have far less relevance for our understanding of man, even in a biological sense, than is generally supposed. We need to ask, for example, whether the evolutionary description of the human brain provides us with much meaningful information about the way in which human beings behave today. Is it, perhaps, more profitable to study the modern brain than the sequence of primate brains which may have preceded the modern one? I will not attempt to answer this question here, as it raises very many intriguing issues. It is, nonetheless, a question to be treated seriously.

Then again, there is the highly subjective issue of my reaction to the time-span of an evolutionary past. Without touching on the validity or otherwise of these time-scales, the meaningfulness of them for life now is debatable. To me, they are no more than of abstract academic interest; they have nothing of the impact of the dynamic of biblical history. Perhaps there is no reason why they should. Nevertheless, their remoteness perplexes me, and I am left wondering about their meaning.

It should be obvious by now that, while I have no ready solutions to the creation-evolution controversy, I am more at home with creation. This is part and parcel of my world-view. Unfortunately it is not part and parcel of the scientific heritage to which I also belong, and I cannot dismiss this heritage and remain true to myself or to that view of God's world which it gives me. I feel something of a stranger in two quite different worlds, two worlds of which I—as one of God's creatures—am very much a part. It is this sense of alienation which is at the heart of my personal dilemma.

Part II. Specific Issues

A. Biological Problems

Introduction

The three articles that follow consider different biological aspects of Origins and Change. Dr. Haas, a chemistry professor and recent President of the ASA (1977), reviews the experimental approaches and their presuppositions involved in current research on the origin of life. He attempts to provide a Christian perspective on such studies. The view is advanced that such investigations may be regarded as a search for the divine process used in Creation. An appeal for freedom of thought is made in examining the question of life origins.

Dr. Cramer deals with the often misunderstood and/or misstated idea that the General Theory of Evolution and the Second Law of Thermodynamics are mutually contradictory. He shows that this erroneous view fails to recognize that the Second Law allows restricted areas of the universe to experience a decrease in entropy (increase in order), while requiring that the total amount of entropy (disorder) in the whole universe must always increase. Therefore, the Second Law cannot effectively be used against Evolution, although the distinctly different argument from mathematical improbability is quite legitimate.

Dr. Herrmann's article is a brief review of Molecular Biology, a field which has provided mechanistic explanations for many biological phenomena. Many Christians have been fearful that such mechanistic explanations will negate any reason to believe in the existence of God. Herrmann attempts to allay such fears, and by contrast, to show that our concept of the Creator may be enhanced by the insights of Molecular Biology.

Biogenesis: Paradigm and Presupposition

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The major experimental approaches and presuppositions employed in current biogenetic investigation are examined from a Christian perspective. Some objections in Christian thought to biogenetic studies are examined. The view is offered that these studies are worthwhile in demonstrating the plausibility of particular models posed for the Creation process. An appeal for freedom of thought in examining the question of origins is made.

Prologue

The module hovered over planet Htrae, then gracefully set down within 300 yards of the designated landing point. The voyage had taken over 9 years, but a technique for slowing life processes allowed the two astronauts to pass the time in a quiescent state with body reactions occurring at only 1/10,000 of the normal rate. As they descended from the space craft they carried with them a number of miniaturized analytical instruments—a gas chromatograph, mass spectrometer, electron and x-ray diffraction apparatus, nuclear magnetic resonance spectrometer and an electron miscoscope. These devices were put quickly to work relaying data to Mission Control in Houston from samples in the vicinity of the landing site and later from many areas on Htrae using the Htrae Rover. Htrae, a relatively young planet 200 million years old, was considered to have an environment at birth and during life very similar to that of Earth. A dozen other teams of astronaut-analysts were on planets of similar origin whose age varied from 1 million to 1 billion years. They pursued a common task—to gain a

picture of the scope and nature of carbon containing molecules on the planet at that point in its history. When the data from all these molecular cameos were combined, a history of Earth's organo-chemistry from simple molecules to self-replicating systems was evident. President John F. Kennedy, III gave the first announcement of the results of the 77 trillion dollar project to a hushed, expectant nation.

Somewhat west of Tombstone, Arizona an opaque encompassing bubble rises some 400 feet above a 260 acre region onto which has been telescoped all the general surface conditions considered to have existed on the primitive Earth—mountains, sterile seas, reducing gases, ultraviolet radiation, cosmic radiation, lightning in infinite variation. This vast apparatus may be turned on at point zero in organic molecular history and sampled on land and sea from time to time to assess the course of molecular evolution until well after the first living form is observable. A quantum-mechanical tuning device allows the experimenters to accelerate the relative rates of chemical reaction by as much as 10^9 during uneventful periods in history and to slow reaction by a factor of 10^3 at significant points in organo-history. A complete biogenetic picture was obtained in less than three years and 3946 doctoral theses emanated from the project.

These idealized experiments characterize in part the complexity (and perhaps the absurdity) of origin of life studies, yet man in his God-ordained task to subdue the Earth continues the quest to gain insight with respect to his molecular beginnings.

Introduction

Although the concept of chemical evolution may be traced back to Lucretius in *De Rerum Natura* (about 58 B.C.), it was not until the third decade of this century that A. I. Oparin[1] and J. B. S. Haldane[2] independently proposed a model for the origin of life which was capable of scientific investigation. They suggested that carbon-containing gases present in the primordial atmosphere were transformed by natural stimuli such as heat, sunlight, and electrical discharge into more complex carbon compounds which collected as "dilute soups" in the seas, reacting to provide more complex molecules, then protobiological and ultimately, biological material—the process taking place in a time scale of millions of years.

Scientific interest in the Oparin-Haldane model was limited to a few scattered experiments over the next quarter century. It was not until the 1950's that the advent and financial support of the space age and broad interest in cell biochemistry provided impetus for the significant amount of investigation currently under way.[3]

The origin-of-life problem is atypical when compared with day-to-day chemical questions in that it focuses on a series of events thought to occur over an immense span of time in a period of limited accessibility to modern investigation. The method of attack, degree of certainty of conclusions, and presuppositions may vary from those formed in questions explored in a laboratory setting.

In this paper we consider the presuppositions and methodological approaches characteristic of workers in this field and see how they have fared in Christian thought.

One may plead that our efforts in biogenetic investigation be allowed to continue unhindered by political, philosophical or religious authoritarianism.

Paradigm

There are several general experimental approaches currently employed in biogenesis investigation. One method involves "synthesis of life" studies where the concern is to find a set of reactions that, under *controlled* laboratory conditions, convert relatively complex matter into living material. Here the concern is not "how did life originate?" but rather the demonstration that such an event can occur at all. Presumably this approach, if successful, would provide encouragement and direction for historical studies.[4]

A second direction seeks to determine general reaction conditions and types of chemical species which react *spontaneously* to form living substances. This basically theoretical approach places emphasis on finding the minimal set of conditions without concern for original earth conditions.[5]

The third approach is more comprehensive in that one works in the context of apparent primitive Earth conditions in an attempt to establish "the historic process," or better "a process" by which life may have originated. The Oparin-Haldane model is followed and experiments carried out to evaluate the plausibility of particular reaction sequences leading to the "simplest forms of life". This constructional-historical approach has provided significant insight in understanding the spontaneous formation of molecules of biological importance. The future will judge the value of efforts currently underway to establish the complex patterns of organization and cell formation from smaller molecules.

Presuppositions

Investigators in the field have been quick to recognize the tenuous nature of their efforts and have variously described the broad working assumptions on which their investigation is based. In the widest sense it is assumed that the universe is ordered, that the pattern of natural behavior observed today has operated through the Earth's history,[6] that the laws of logic and mathematics are true by definition or by axiomatization of basic principle, and that these laws are applicable to the world of experience.[7] It is also assumed that natural phenomena must be explained (at least in the context of scientific method) without recourse to the supernatural.[6]

There are at least three presuppositions which relate specifically to biogenesis studies. The first considers life on earth to have a beginning—a time of origin. Another suggests that the origin of life on the primitive Earth involved a series of relatively probable chemical and physical events and did not critically depend on the chance occurrence of very rare events. A third assumes that the compounds which occur ubiquitously in contemporary life were also essential to the origin of life.[8]

These operational assumptions require a view of "scientific truth"—how one recognizes it, arrives at it,

finds its limitations and how it shapes our choices. At one level truth may appear to be objective and impersonal, to have meaning only where capable of verification. This view however overlooks the role of man's mind in the knowledge process. Man constantly invokes his personal judgment and acts on the basis of things he holds to be true. He is influenced by educational background and cultural setting and well may be motivated in his efforts by a heuristic search for rational beauty. While truth for the scientist is not that of the poet, there is a little of the poet in all scientists.

Most scientists take their theories to represent real events in the world. They have little patience for the intense and often contradictory philosophical analysis of language and methodology which would limit the scope and meaning of their effort. Barbour has drawn together many elements of the discussion into a helpful statement.[9]

> The scientific enterprise is a many-faceted phenomenon. Its genius has been precisely the interaction of components which oversimplified accounts have portrayed in isolation. It involves both experiment and theory, neither of which taken alone constitutes science. It requires both logical processes and a creative imagination transcending logic. Its theories are evaluated at once by empirical agreement, rational coherence, and comprehensiveness. Individual activity and originality are significant but occur within the tradition of a scientific community and under the influence of its paradigms. Scientific language does refer to the world, but only symbolically and partially, sometimes using analogies or models of limited scope.
>
> The resulting theories are not guranteed to be the truth; any of them may in the future be amended, modified, or in rare cases, overthrown in a major "revolution." Yet scientific theories do have a reliability, and the scientific community does eventually achieve a consensus, seldom found in other types of inquiry. Although some aspects of scientific knowledge change, many aspects are preserved, contributing to an over-all cumulative advance that differs from that of other disciplines.

Christian Perspectives

Although specific comment on the topic of biogenesis has been limited, the topic of origins has dominated the science-Christianity dialogue for over a century. The complexity of the subject and the diversity of response continue to provide frustration and division in the Christian community.

From a Christian view the assumptions of origin, order and uniformity are derivable from the broad sweep of Scripture encompassing the doctrines of Creation and Providence. Indeed some would attribute the rise of modern science in the 16th and 17th century to the theistic convictions prominent in the lives and culture of many of those active in science at that time.[10]

The presupposition that eliminates the supernatural from intervention in the biogenetic process is no doubt offensive to some, yet reflects more the limitation of scientific methodology in describing the role of God in Creation than an apparently atheistic mind–set on the part of the investigator. Science does not deny "providence" or "miracle"; it is just blind to them.

Evangelical objection to the "possibility" of abiogenic molecular evolution follows two general lines of argument. One is based on the biblical text and theological formulations which stress the "rapidity" of creation, the inability of scientific models to explain "Adam and Eve" or the "image of God" and an apparent scriptural limitation on man's ability to understand his beginnings. This thread of Christian thought places the epic of origin either entirely in the realm of miracle or so interwoven with the miraculous as to be inaccessible to scientifc study.[11] Both Scripture and scientific data are used to support this view.

One scriptural argument is based on parallels between Christ's miracles and the Genesis account of creation and the language of Scripture which implies a short time span for God's creative activity in contrast to that (presumably) required for the Haldane-Oparin Model. Clearly the Bible is critical to those who profess it to be the authority for their lives. Yet, not all commentators draw these same conclusions from Scripture, but consider that science can contribute to man's quest for understanding in this domain.

Further, it is eminently unclear just which criteria may be used to decide where Providence (capable of scientific study) and Miracle (incapable of study) intersect, especially at the time of origin.

In this respect Kline has suggested

> . . . the avoidance of unnecessary supernaturalism in providence during the "six days" accords well with the analogy of subsequent divine providence for the latter is characterized by a remarkable economy in its resort to the supernatural.[12]

Kline develops this principle on exegetical grounds in demonstrating the inadequacy of traditional scriptural interpretations that hold the 24 hour-day theory or any strictly chronological interpretation of Genesis 1.[12]

The scientific argument is used to draw attention to defects in the work and conclusions of biogenesis investigators or to expose the complexity of the problem and the paucity of results.[13] Surely, scientific effort requires constant critical scrutiny to maintain integrity in the context of the current state of knowledge, yet a strategy involving a biogenesis "truth squad" seems unproductive in the long run. One must react (presumably negatively) to each paper that appears (a never-ending task) if a successful defense against biogenesis is to be maintained. One has the problem of what to do when work cannot be discounted. Again there may be no basis for deciding whether scientific arguments against biogenesis have any more validity than those proposed in support. For example, there is considerable interest in the possibility that oscillating reactions exhibited by a variety of biological systems may provide mechanisms by which a chemical reaction could have been induced.[14] One must now rush to the task of demonstrating the implausibility if not the impossibility of this approach even though an understanding of the phenomena in "simple" chemical systems is still in an early stage.

Another objection to biogenetic investigation concerns the assumption of the principle of uniformity. It is felt that the forces and laws operating during that period were different in some respects from those we see today, thus rendering invalid any attempt to extend present molecular behavior to the time of origin. However, significant scientific and scriptural evidence to support this view is lacking.[6]

An alternative approach currently being advanced by some Christians involves the attempt to demon-

strate that scientific data fit a "modern creationism" view more closely than "modern evolutionism." While this approach is preferable to one which simply attacks the other side, it suffers from the problem of attempting to prove something incapable of direct proof. One can only construct a model and then demonstrate the extent to which the data provide support. The danger that *a model* will become *the model* for orthodoxy is all too clear from church history.[15]

Toward Complexity

Some attention has been given to the nature of the "driving force" which culminated in living forms. Is there an innate molecular direction, or did life arise as the result of a long series of random, improbable molecular events?

The first view is receiving increasing attention. Kenyon and Steinman have described the driving force as *Biochemical Predestination.*

> . . . by this I mean that the association of units toward the ultimate development of the living cell is determined by the physiochemical properties possessed by the simplest starting compounds from which these systems evolved. . . . the ultimate characteristics of the living cell can be traced back to the nature of the starting compounds from which it was produced . . . we should not look on the appearance and development of the living cell as an improbable phenomenon but rather as one which followed a definite course governed and promoted by the properties of the simple compounds from which the process began.[16]

Paleontologist Pierre Teilhard de Chardin incorporated this view in developing his encompassing "cosmogenesis" view.

> Teilhard feels that at some point, which he calls Alpha, primordial matter came into being that has within it (through the creative act of God) the propensity to become complex and unified. Electrons and protrons have as it were, a built-in affinity for each other and in time form more complex atoms. Atoms in turn form increasingly complex molecules and macromolecules. Molecules coacervate to form pre-cells and these entities eventually form living cells—and so on up the evolutionary scale.[17]

Needham has commented

> Laboratory work therefore has in general strengthened the view that biological reactions are the innate spontaneous properties of materials which are synthesized spontaneously under natural conditions and that life originated and evolved for this reason. . . . Applied to the eobiological systems the contention is that life has always been precisely the most probable, opportunist exploitation of the most spontaneous pathways.[18]

While these formulations are not without problems, they may well represent the limit of man's ability to characterize God's creative direction. The concept of Biological Predestination should receive serious consideration by the Christian philosopher and theologian as well as the scientist.

Epilog

One feature that distinguishes chemical evolution from its Darwinian counterpart is that there is a strong likelihood that a plausible process can be demonstrated in the finite future using the historical-constructionistic approach, while considerably less confidence is exhibited in the ability to view major transitons in life forms after the Darwinian model. Perhaps in this generation, as the landmark efforts of the Spiegelman group on self-replicating RNA are expanded, we shall see if the current optimism is more than wishful thinking.[19]

Three presuppositions of biogenesis studies: (1) life on earth had a beginning, (2) the origin of life on earth involved a series of relatively probable chemical and physical events and were not critically dependent on chance occurrences of rare events, and (3) present-day compounds were also essential to the origin of life.

As Scientist-Christians we should follow and engage in these efforts with critical, but open minds. We have in Scripture *the* basis for understanding the fullness of reality; it is here that creation is described in terms of purpose, meaning and direction. As Christians we gain deepening insights at this level as we mature in our faith. As scientists we attempt to extend our understanding of the process of creation by viewing nature in the context of scientific method. One may plead that our efforts in biogenetic investigation be allowed to continue unhindered by political, philosophical or religious authoritarianism. In the words of Carpenter:

> I am free, I am bound to nobody's word, except to those inspired by God; if I oppose these in the least degree, I beseech God to forgive me my audacity of judgment, as I have been moved not so much by longing for some opinion of my own as by my love for the freedom of science.[20]

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General Evolution and the Second Law of Thermodynamics

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Wilder-Smith

The idea that the Theory of Evolution defies the Second Law of Thermodynamics appears to be making an impression in some circles. I do not know the full history of the idea, but I first encountered it as an excerpt from A. E. Wilder-Smith's book *Man's Origin, Man's Destiny*[1] which was published sometime ago in *Christianity Today*. That excerpt drew accurate fire from a collection of physicists and engineers who correctly indicated that a complete misunderstanding of the "law" was involved. Despite authoritative criticism, Dr. Wilder-Smith still apparently retains his position.

The *Journal ASA* 22, 117 (1970) contains a review by a chemist of Wilder-Smith's book. I was disappointed to note that this argument was mentioned with tacit approval. A biologist, in the same issue, also notes the idea with more cautious approval.

I no more concur with the General Theory of Evolution than any of the proponents of this view, but it is a mistake to defend oneself with faulty arguments. I hope to show why this view is faulty. It is then the reader's responsibility to face the truth honestly and act accordingly. There are significant questions of the meaning of theories and laws which could be raised, but the basic issue to which I wish to speak involves the internal consistency of scientific thought. Thus, I shall by-pass some philosophic difficulties and deal only with the central mistake.

Not Technical

The mistake is not at all technical. Ordinarily the Second Law is stated, "The amount of disorder in the universe always increases or remains unchanged for any process." Technically, one substitutes the word "entropy" for "disorder", but the correspondence is sufficiently close that no confusion will result from using "disorder". Also technically, the case where disorder does not change is probably physically unrealizable and certainly it refers to cases (which are of no interest to us) where interacting systems are in equilibrium so that no changes at all take place. Thus, we can state the law, "The amount of disorder in the universe increases for all processes", and be reasonably confident that we are making scientific sense. The error lies in overlooking the *absolutely crucial* phrase "in the universe". Let me give an example of how crucial this is.

Cooling Water

A warm glass of water can be cooled by placing it in a refrigerator. If you looked only at the water, you would have to conclude that the Second Law had been violated. How so? The agitation of the molecules (which is related to temperature) decreases with decreased temperature. Thus the entropy (disorder) of the water *decreases*. For any given temperature change and quantity of water, this entropy decrease can be precisely calculated. How can this be if the law demands an increased entropy for all process? The answer is that you have forgotten to look at the rest of the "universe". The *decrease* of disorder in the water is *more than cancelled out* by the *increase* in disorder in the molecules of air outside the refrigerator. The refrigerator pumps heat into the ouside air causing a large increase in the entropy of the room. The point then is this: Improperly limited parts of the universe do not necessarily obey the Second Law of Thermodynamics. The Law is followed only when a sufficient part of the universe is included.

If we are to believe that General Evolution contradicts the Second Law, we must then also conclude that all living organisms continually violate the Law.

Freezing Lake Michigan

It may be argued that my example was an artificial process and that evolution is supposed to be natural or operative without human intervention. Then let me choose another example. It can hardly be denied that Lake Michigan undergoes a yearly entropy change. Every winter large quantities of ice are formed. The total entropy changes involved are many times greater than those for the glass of water, yet they still involve only the cooling of water. I do not anticipate disagreement when I say that this is as "natural" a process as can be desired. Yet here again, if only the entropy change of the lake upon freezing is noted, you will conclude that you see a violation of the Second Law. Again, if attention is given to the changes in the atmosphere, differences in radiation received from the Sun, infra-red radiation from the Earth etc., the Second Law will be found to hold true.

Protein Molecule

Therefore, we must conclude that an evolutionary process which creates an *isolated* area of decreased entropy (increased order) does not at all defy the Second Law of Thermodynamics. If we include all involved systems, we will see that the law holds. The hypothetical case of a protein molecule formed in a thin "broth" of "organic" materials by evolutionary processes can serve as an example. The molecule is a much more ordered situation for the atoms which form it than that in which they previously existed. But the disorder of the "broth" will *increase* when the molecule is formed and its increase will more than compensate the decrease due to the formation of the molecule.

All Living Organisms

It should be noted that the processes of all living organisms are processes of organization. Thus, all living organisms are continually *increasing* the order of the molecules and atoms which they take in for nourishment. If then we are to believe that General Evolution contradicts the Second Law, we must then also conclude that all living organisms continually violate the Second Law. Both conclusions are, of course, erroneous. Nevertheless, this continual, large scale, ordering in a universe which is supposed to be running down is sufficiently curious to have arrested the attention of a few physicists. At least one theoretician has made an attempt to explain this in terms of quantum mechanical models.[2]

Mathematical Improbability

The argument from the Second Law is sometimes confused with the argument from mathematical improbability, but they are, in fact, distinct. The general theory of Evolution is a fantastically improbable theory in a mathematical sense and I think this is an important weakness. I know of no other theory which at all approaches the improbability of General Evolution. Unfortunately, the argument from the Second Law of Thermodynamics is not in the same sound position.

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Implications of Molecular Biology for Creation and Evolution

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Survey of Molecular Biology

In 1953 Watson and Crick[1] proposed the double-helical structure of DNA, the polynucleotide molecule carrying the cell's genetic informaton. Four types of heterocyclic nitrogenous substances (bases) were bound into its structure by means of the sugar 2-deoxyribose, and phosphoric acid. The combination of a given base, a sugar and phosphoric acid is called a nucleotide (See Figure 1). The crucial feature of the proposed model (Figure 2) was that the two chains of nucleotide building blocks were complementary. Every time an adenine nucleotide (A) is present in one chain, the opposite chain bears a thymine nucleotide (T). Likewise, every time a guanine nucleotide (G) appears in one chain, the other chain bears a cytosine nucleotide (C). The unique pairing is the basis of precise duplication of the genes which is so necessary for the hereditary mechanism. Gene duplication occurs by separation of these two chains and the synthesis of a new matching strand for each, so that there are then two double-stranded structures where before there had been only one. Each "daughter" molecule now carries the exact arrangement of nucleotide units as the "parent" molecule, because the unique pairing of the nucleotide units prescribes that this be so. This is of utmost importance because the linear sequences of nucleotide units are eventually translated into linear sequences of amino acid units for all of the protein molecules which make up the living cell.

By 1960, experiments in many laboratories indicated that the cell's protein molecules were synthesized by a process involving transcription of the DNA

sequence into a second polynucleotide, messenger RNA, which, in conjunction with various elements of cell sap including complex structures called ribosomes, could cause incorporation of radio-active amino acids into protein-like polypeptide material (See Figure 3).

The great breakthrough in understanding this process came about when Nirenberg and Matthaei found that synthetic RNA molecules could catalyze the protein synthetic process in these simple cell-free systems

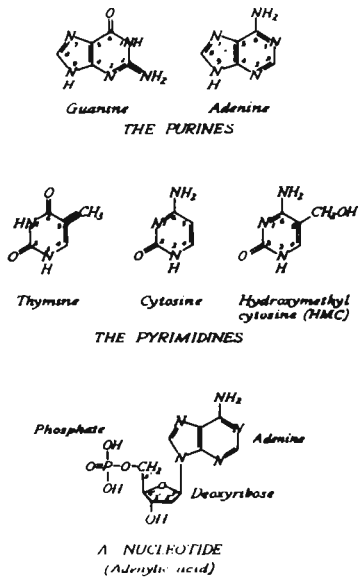

Figure 1. The combination of a heterocyclic nitrogenous base with the sugar 2-deoxyribose and phosphoric acid forms one of the nucleotide building blocks of deoxyribonucleic acid (DNA)

derived from bacteria.[2] The synthetic polynucleotides, produced with an enzyme called polynucleotide phosphorylase, could be made with various combinations of the component building blocks of natural RNA and then the protein synthesized subsequently from these compounds in the cell-free system could be analyzed. In this way it was discovered that the code signal for the insertion of a given amino acid into a protein structure was a sequence of three nucleotide units of the polynucleotide. For example, three

Figure 2. A representation of the double-helical model of DNA, illustrating the complementary base-pairing of adenine (A) with thymine (T) and quanine (G) with cytosine (C).

uridine nucleotides (a trinucleotide) in a sequence of the RNA specifies the positioning of one molecule of the amino acid phenylalanine in the sequence of the protein.

Later a more precise method of determining the coding sequence (the "codon") corresponding to a given amino acid was discovered, based upon the known involvement of a second type of RNA, transfer RNA (t-RNA) in protein synthesis (See Figure 3). This molecule was shown to occur in many forms—at least one for each amino acid found in proteins—and to function by adapting its amino acid to the codon through a complementary sequence of nucleotides in its own structure. It was found that even in the absence of protein synthesis, the specific t-RNA molecules bind to complexes of ribosomes and messenger RNA. Furthermore the messenger RNA could be replaced not only by the synthetic polynucleotides used in the earlier experiments, but also by simple trinucleotides of precise structure. In this method a

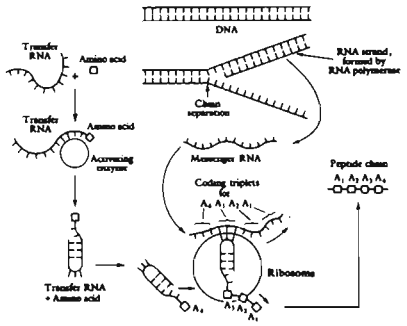

Figure 3. The scheme for protein synthesis. DNA is "read out" in the form of messenger RNA, which travels to the cytoplasm and binds to structures called ribosomes. Here, a series of transfer RNA molecules, at least one type for each protein amino acid, carry their appropriate amino acid to the ribosome and align with a specific coding sequence on the messenger to form the proper sequence of the protein chain.

given trinucleotide representing a single codon could be examined for its ability to cause binding of various t-RNA molecules with their attached amino acids to the ribosome structure. Those t-RNA molecules which bound must have have been able to recognize that codon as the position for insertion of their particular amino acid. In this way it was possible to assign each codon to a specific amino acid.

The Genetic Code

Figure 4 represents the genetic code as worked out for the bacterium *E. coli*. Several interesting features are apparent with respect to evolution. The first is the phenomenon called degeneracy. Note that for most of the amino acids there is more than one codon, e.g., phenylalanine is coded for by both UUU and UUC. The third position can vary and specificity still be retained. Because of this variation, it has been suggested that the original code was a doublet instead of a triplet code. Variation in the 3rd position would also allow for the cell to undergo mutational change without that change being necessarily lethal. CT stands for codons which cause termination of a peptide chain (chain termination) and CI stands for chain initiation. Here the amino acid methionine serves as the initiating amino acid and in this case the methionine is

first formylated before initiating peptide synthesis. There are also some interesting relationships between amino acids and their codons. Similar amino acids (similar side chains) have similarities in their code words, e.g., all non-polar amino acids (phenylalanine, leucine, isoleucine, valine) have U as the second code letter. Also, aspartic acid and glutamic acid, closely related structurally, both have GA as their first two letters. This suggests another evolutionary possibility: the specific code words for the various amino acids

The implications of a universal genetic code are interesting, fascinating or threatening, depending on your viewpoint.

arose because of some physicochemical relationship between the codon's nucleotides and the amino acid which it specifies. This possibility has been explored by several workers.[3,4]

A Universal Code

Extension of these experiments to other bacteria, to intermediate forms and to mammals has led to the general conclusion that the genetic code is universal—that the same code words are used in both lower and higher organisms. For example, with rabbit reticulocytes, 22 codons have thus far been shown to be translated into amino acids identical to those in the *E. coli* bacterial system. The data, though incomplete, point to a universal code.[5]

Likewise, the protein-synthetic mechanisms in prokaryotic and eukaryotic systems appear to be quite similar. For example, the chain initiating codon which in the bacterium *E. coli* involves a special form of transfer RNA, which places the amino acid methionine in the chain at that point, is also utilized by yeast, by wheat germ, by mouse liver and rabbit reticulocytes. Other features of the mechanism also appear similar.

The implications of such a mechanism are interesting, fascinating, or threatening, depending on your viewpoint. The existence of a universal code would imply that there was indeed a single precursor of all living things, a primitive system capable of replication and information transfer from which all the present living forms developed.

A Specific Model

In fact, mechanisms have been proposed for the origin of such a system given the necessary building blocks which appear to have been present on the primitive earth. Quastler, in his *Emergence of Biological Organization*[6] suggests one such mechanism. As we have indicated, the genetic material, DNA, is made up of two polynucleotide chains whose most unique feature is the complementary pairing of the nucleotide building blocks, A to T and G to C.

In Quastler's proposal for the origin of the nucleic acid system (Figure 5), nucleotide building blocks react with each other to form single polynucleotide chains. This process would be very slow in the absence of enzymes, but Quastler estimates that there would still be 400 periods during geological time available for this reaction. The single chains thus formed may then react further with additional nucleotide units, by the nucleotide pairing principle, to form intermediate structures which are partly single-chained and partly double-chained. This reaction is much more favorable than is the original reaction to form the single polynucleotide chain. Completion of this reaction leads to fully double-chained structures which may then reversibly separate to form single chains.

	First position	Second position				Third position
		U	C	A	G	
Amino acid codons	U	Phe	Ser	Tyr	Cys	U
		Phe	Ser	Tyr	Cys	C
		Leu	Ser	(CT)	(CT)	A
		Leu	Ser	(CT)	Trp	G
	C	Leu	Pro	His	Arg	U
		Leu	Pro	His	Arg	C
		Leu	Pro	Gln	Arg	A
		Leu	Pro	Gln	Arg	G
	A	Ile	Thr	Asn	Ser	U
		Ile	Thr	Asn	Ser	C
		Ile	Thr	Lys	Arg	A
		Met (CT)	Thr	Lys	Arg	G
	G	Val	Ala	Asp	Gly	U
		Val	Ala	Asp	Gly	C
		Val	Ala	Glu	Gly	A
		Val (CT)	Ala	Glu	Gly	G

Figure 4. The genetic code as worked out for the bacterium *E. coli.*

The unique feature of such a system is that it gives rise to a kind of "information," in the sense that the first polynucleotide chain to be formed has a far greater chance for survival than any later arrivals. Thus it is able to compete more favorably for nucleotide units, since the reaction of the polynucleotide chain with nucleotides is favored over the original synthesis of the polynucleotide. The first chain thus becomes the progenitor of a unique polynucleotide system made up of itself and its "sister" chain, in which each nucleotide unit is the opposite pairing partner for the other chain—i.e., A opposite T and G opposite C. The information content of the system, as Quastler sees it, is of the nature of an "accidental thought remembered." The original arrangement of

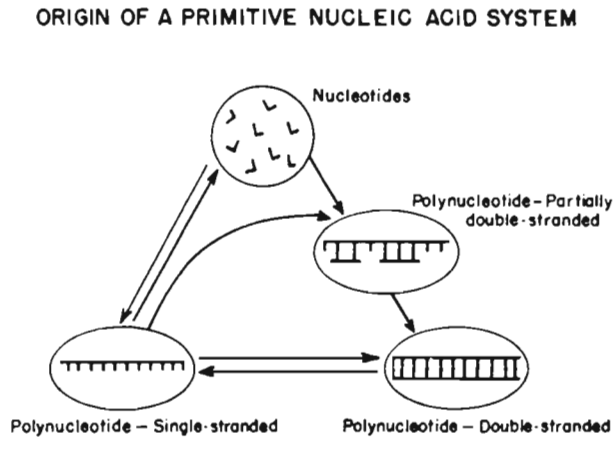

Figure 5. Quastler's model for the origin of a nucleic acid system. Nucleotides react to form single-stranded polynucleotides. The latter can undergo a more favorable reaction to form partially double-stranded structures which eventually give rise to a double helical polynucleotide with a complementary base-paired structure.

nucleotide units in the polynucleotide chain might have been arrived at by purely random interaction, but once the chain is formed, that particular arrangement and that of its sister strand are the only allowable structures. A good analogy would be the numbers of a combination lock. Prior to their choice for the combination, the numbers are of no consequence. But after being introduced as the numbers of the combination they are now information.

The importance of Quastler's argument lies in its demonstration of the way in which the evolutionary

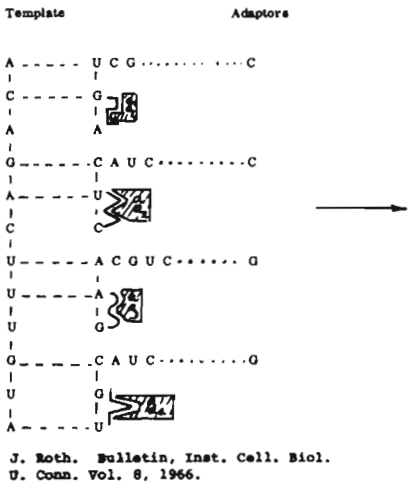

Figure 6. A proposal for the attachment of primitive counterparts of amino acid transfer RNA molecules to the template of a polynucleotide system, with the eventuality of the synthesis of amino acid polymers.

principles of selection and competition can be applied at the chemical level. For here, from apparently random events, a system may be seen to arise that is capable of reproducing and propagating itself and hence acting as a kind of primitive genetic information.

Explanation of Protein Synthesis

The extrapolation of this scheme to an explanation for present mechanisms of protein synthesis may be made on the same principles of chemical evolution (Figure 6). Polynucleotides could react with amino acids with some degree of specificity[3,4] to give adapter molecules similar to the amino acyl, t-RNA's of present protein synthesis. Complementary base pairing of these molecules to the original polynucleotide system would provide the opportunity for the system to couple amino acids in a variety of different arrangements, depending upon the sequence of the original polynucleotide, and, if one or more amino acid sequences proved to have enzymatic activity, there would be the tremendous advantage, by virtue of the self-duplicating property of polynucleotides, for this system to "remember" it.

Thus even the informational content of a living system may have arisen, in its simplest form, from the apparently random way in which the nucleotide building blocks of the first successful system were incorporated into a polynucleotide polymer. Considering the available data on the universality of the code and a theoretical framework for its origin, the description of life's origins in a purely mechanistic sense would appear to lie within the grasp of modern molecular biology.

Other Explanations

However, this should not lead to any feeling on the part of the scientist that his explanation of origins excludes other explanations—e.g., a theological one. Jacques Monod may object in his *Chance and Necessity*[8] to the idea of a "necessity rooted in the very beginning of things," but there is certainly no valid reason to exclude such a possibility. The Scriptural view of origins in fact places its primary emphasis on this very idea of purpose and meaning in the creation; life was made with precision and order, with quite precise ends in view.

Part of the concern of many Christians about evolutionary theory is that they fear that a mechanistic explanation negates God. But this problem has been dealt with in an excellent fashion by Donald MacKay in his booklet *Science and Christian Faith Today*.[9] God's activity includes not only his originating activity (Genesis) but also his sustaining activity. The Apostle Paul writes in Colossians 1, speaking of Jesus Christ, "in Him all things hold together" (Col. 1:17) and the writer to the Hebrews speaks of Christ "upholding all things by His Word and power." (Heb. 1:3) MacKay points out that the phrase "upholding all things" might better be translated "holds in being all things" emphasizing God's immanent activity, without which the universe would not just stop but rather without which it would *cease to exist.*

The picture of God as a kind of machine tender seems completely inadequate in light of this verse. Rather, God's activity is more like that of a master artist, who paints—in a dynamic fashion—a constantly changing picture. Something like this is suggested by the picture that a television receiver presents. The

Even the informational content of a living system may have arisen from the apparently random way in which the nucleotide building blocks of the first successful system were incorporated into a polynucleotide polymer.

analogy is especially useful because it emphasizes the dynamic aspect of God's activity—"holding in being" the universe. For by simply ceasing his activity, it would be obliterated much as the television picture may be totally altered by simply flipping a switch. By bringing the focus to God's immanent activity, we see also the inapplicability of such arguments as "evolution leaves no room for the God of action, precluding his function except in areas of fast-disappearing links." The true picture is that God acts in *all* of Reality, not just where we cannot apply a scientific explanation. It is all His! As MacKay says "the whole multi-patterned drama of the universe is His." Also, the emphasis of Scripture is that God has ordered his Creation not by virtue of producing a perfect mechanism but rather because of His complete faithfulness. It is the ultimate basis for things, the *raison d'etre,* with which the Bible is dealing in its consideration of origins, and the character of the Creator is therefore its primary concern.

Science gives us the view of *how* life may have come about. Its view is descriptive, and does not in

any ultimate sense *account* for what it describes. The most we can say based on present data is that God may have used an evolutionary mechanism to achieve the purposes delineated in Scripture.

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B. Geological Problems

Introduction

Geological and paleontological evidence is widely accepted as "proof" for a great age of the earth and extensive changes in living organisms. However, in recent years several Christian scientists have argued vigorously that this evidence has been misinterpreted. In general, they have sought to explain most geological and all paleontological phenomena as the result of the Flood of Noah described in Genesis 6-8. Their position is termed "Flood Geology." It is associated with views of a "young earth" (recent creation) and a relatively fixed nature of organisms. The two selections here critically review this novel position from a geological perspective.

Dr. van de Fliert has had extensive geological field experience in stratigraphy and paleontology in connection with oil explorations in South America and the Orient. He is a member of the Christian Reformed Church of the Netherlands and is a member of the Board of the International Association for Reformatory Philosophy. This article is a slightly revised version of material which previously appeared in the January-April 1968 issue of the *International Reformed Bulletin*. The revisions were made by Dr. Roger J. Cuffey of The Pennsylvania State University. The article is a critical review and rebuttal of the "Flood Geology" position presented in the book *The Genesis Flood* by Whitcomb and Morris. "Flood Geology" is shown to be both scientifically incorrect and biblically unnecessary.

The dialogue between Drs. Moore and Cuffey reviews the paleontological evidence for change. They take sharply opposing positions as to whether this evidence is a valid argument for or against organic evolution. Dr. Moore was co-editor of the high school textbook *Biology: A Search for Order in Complexity* produced by the Creation Research Society (CRS). He has also been Managing Editor of the CRS Quarterly. Dr. Cuffey is a professional paleontologist and an active member of the ASA. The original format has been somewhat reorganized so that Dr. Moore's position is followed by Dr. Cuffey's critique of it and then Moore's rebuttal. Dr. Cuffey's position is then stated, followed by Moore's critique. Readers should note that Moore's rigid insistence on the "fixity of species" and Cuffey's equally strong support for a totally evolutionary relationship of all organisms represent only two of the spectrum of viewpoints possible from the evidence reviewed.

Fundamentalism and the Fundamentals of Geology

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Introduction

With increasing astonishment, I read through the book *The Genesis Flood–The Biblical Record and Its Scientific Implications*, by Henry M. Morris and John C. Whitcomb, Jr.[1] If I had been told a few years ago that an apparently serious attempt would be made to reintroduce the diluvialistic theory on Biblical grounds as the only acceptable working hypothesis for the major part of the geological sciences I would not have believed it. I would have considered it just incredible that a professor of Old Testament and a professor of Civil Engineering would write it, and that the foreword would be written by a professional geologist.

The serious fact is that it has been written and published in a volume of more than 500 pages of excellent paper and illustrated with 28 photographs. To stress the pretended scientific value of the work, favorable comments of a theologian and various representatives of natural sciences–a geologist, a geophysicist, an archaeologist, a biologist, a geneticist, a chemist, and an engineer–are printed on the cover.

It is almost incredible that such an effort, which must have cost an enormous amount of work and money, has been made for such a bad procedure as this. I have felt very reluctant to write against it, but finally agreed to do so, yielding to stress from different sides.

There are two main reasons for this article. The first is that the authors of *The Genesis Flood* have written on the basis of their belief in the Holy Scriptures as the reliable Word of God. This belief I share. Second, it is my sincere conviction that it is a fundamental and extremely dangerous mistake to think that our belief in the reliable Word of God could ever be based on or strengthened by so-called scientific reasoning. Any attempt to harmonize the historical geology of today with the account of the first chapters of Genesis represents a colossal overestimation of science–as well as a misunderstanding of the Genesis record–an overestimation which is as great as that of those scientists who completely reject God as the Creator. If we thus overestimate science, we lose the battle before it is started. The Bible does not give outlines of historical geology nor accounts of scientifically controllable creative acts of God! If we think the Bible does provide these, we have brought God's creative work down to scientific control, down to the visible things, contrary to the teaching of the Bible that "through *faith* we understand that the worlds were framed by the word of God" (Hebrews 11:3a). We deal a death-blow to the Christian religion when we bring the Holy Scriptures down to scientific level by teaching that the Bible should give us a kind of scientific world-picture or axiomata of historical geology, or of Western science of history, or physics, biology, jurisprudence or whatever science it be. Thus, we lose the Bible as a reliable Word of God completely, because we then make its teachings dependent on the poor state of our scientific knowledge today . . . which will change tomorrow!

The overestimation of science fails to see its possibilities and its limits. It means the corruption of true scientific working, both in the evolutionistic thinking of those who do not believe in God, and also in the thinking of Christians who do believe in God. These latter corrupt scientific work thoroughly when they start from a pretended biblical (in fact, imposed by them on the biblical teaching) elementary historical geology, into which then the geological data will have to fit! This is no less pseudo-scientific than that kind of evolutionistic reasoning that ignores God, and therefore presents truly a very bad case for orthodox Christianity today!

Scientific Pretension and Scientific Foundation

Before I start a more technical treatment of a few important geological questions, I want to make a few critical remarks of a general character concerning the pretended scientific value of *The Genesis Flood.*

First, writing a book with such significant claims or conclusions requires a thorough knowledge of the geological sciences and their principles. Neither author –one a theologian, the other a civil engineer–is a geologist. Everybody knows that in the present state of scientific development it is practically impossible for one person to master more than one branch of science. Now, the list of modern publications cited in the book is impressive but at the same time misleading. The way in which part of this literature is used proves that the real problems have often not been understood. A theologian should know how dangerous it is to lift a text out of the context and to treat it separately. This is true not only for interpreting the Bible but also for explaining scientific publications. To lift a certain sentence out of a publication, and to use it for something quite different than the original author meant, is scientifically dishonest. I realize that the authors of *The Genesis Flood* did not *intend* to do this at all, and in a few cases they even admit that the author they cite used his words in a slightly different way, but in

others they give evidence of not having understood the exact bearing to which they refer. Thorough scientific work makes extremely high demands on professional knowledge!

If I had been told a few years ago that an apparently serious attempt would be made to reintroduce the diluvialistic theory on Biblical grounds as the only acceptable working hypothesis for the major part of the geological sciences, I would not have believed it.

The Essential Importance of the History of Science and Theology

Second, it is really astonishing that the authors of *The Genesis Flood* do not seriously take into account the history of the "warfare between theology and geology". They sound as if this were the first time that the idea was put forward that the deluge was responsible for the major part of the fossiliferous strata in the earth's crust, whereas this idea was perhaps a respectable hypothesis early in the history of the development of geology but was soon shown to be false by evidence accumulated as the science of geology began to grow. This *history* of geology is an essential part of the study to be made, and has to be taken into account as an event which God has revealed to us in the middle of the twentieth century.

Is it any wonder, if we neglect this history, that we make the same mistakes as our fathers did one, two, three or even more centuries ago? When I saw the pictures of the pretended—but definitely not—human footprints in Cretaceous strata of Texas with the comment: 'Note the tremendous size which immediately reminds one of the Biblical statement that there were "giants in the earth in those days" (Genesis 6:4),[2] I was immediately reminded of the times before Cuvier when bones of elephants found in the earth were also considered to be evidence of the Genesis flood and declared to be remains of the giants of those days. Even the undeveloped science of that time was thought to confirm the reliability of Scriptures, and it is said that these bones were nailed to the doors of churches for the sake of strengthening the faith of simple Christian believers! I recall the days when Scheuchzer found his famous fossil which he named '*Homo diluvii testis*', the 'man witness of the deluge'.

But Cuvier, the father of comparative vertebrate anatomy, by scientific methods ascertained elephant bones to be elephant bones and Scheuchzer's "Homo" to be the skeleton of a Miocene salamander. Where then was the foundation on which those simple Christian believers built their faith? And what are Professors Whitcomb and Morris doing now for those Christians who do not know about geology but believe in the Holy Scriptures as the reliable Word of God? The so-called scientific foundation which they want to lay under the Christian's faith can be easily shown by unbelievers to be no more than loose sand. They could have known it too, if they had simply made a *serious* study of the history of the (largely man-made) problems between the Bible and geology!

Uncritical Criticism of Geological Principles

Third, the last general remark I want to make concerns the uncritical attitude of the authors regarding their own reasoning. The whole book intends to levy a fundamental attack on the so-called uniformitarian principle in the geological sciences. They do not realize that, in part, their reasoning is based on the same starting point. In part, also, they fight against windmills, because most present-day geologists do not accept this principle exactly in the sense as it was understood by Lyell (who was no evolutionist when he wrote the first edition of his Principles[3]), but use it in the sense of a constancy of physical and biological laws, which does not at all exclude, for example, periods with climates differing from that which we know presently, or alternating longer quiet periods with shorter 'catastrophic' or paroxysmal episodes.

Besides, one could even agree that Lyell himself was not dogmatic in presenting his uniformitarian principle. His uniformitarianism is what Professor Dr. R. Hooykaas has called a 'methodological principle'[4], but not one that pretends to have 'eternal validity'. In the 3rd Volume of the first edition of his *Principles*, Lyell wrote on page 6:

> In our attempt to unravel these difficult questions, we shall adopt a different course, restricting ourselves to the known or possible operations of existing causes; *feeling assured that we have not yet exhausted the resources which the study of the present course of nature may provide, and therefore that we are not authorized, in the infancy of our science,* to recur to extraordinary agents.

Now, in order to do justice to Lyell, it is necessary to know what he meant when he wrote these lines, and what he meant by extraordinary agents. The answer is not difficult, because on p. 3-6 of the same volume he offers examples. First of all, Lyell refers there to the controversy "respecting the origin of fossil shells and bones—were they organic or inorganic substances?" To this point he remarks:

> That the latter opinion should for a long time have prevailed, and that these bodies should have been supposed to be fashioned into their present form by a plastic virtue, or some other mysterious agency, may appear absurd; but it was perhaps, as reasonable a conjecture as could be expected from those who did not appeal, in the first instance, to the analogy of the living creation, as affording the only source of authentic information. It was only by an accurate examination of living Testacea, and by a comparison of the osteology of the existing vertebrated animals with the remains found entombed in ancient strata, that this favourite dogma was exploded, and all were, at length, persuaded that these substances were exclusively of organic origin.

As a second example, the controversy concerning an aqueous or igneous origin of basalt and other crystalline rocks in mentioned. This was an essential point in the early controversy between Neptunists and Plutonists. Lyell says:

> All are now agreed that it would have been impossible for human ingenuity to invent a theory [the Neptunist theory] more distant from the truth; yet we must cease to wonder, on that account, that it gained so many proselytes, when we remember that

> its claims to probability arose partly from its confirming the assumed want of all analogy between geological causes and those now in action.

And then Lyell put the important question concerning the methodological principle in these words:

> By what train of investigation were all theorists brought round at length to an opposite opinion, and induced to assent to the igneous origin of these formations?

And the answer is:

> By an examination of the structure of active volcanoes, the mineral composition of their lavas and ejections, and by comparing the undoubted products of fire with the ancient rocks in question.

He concludes with a third example, the question of whether the great alteration of the level of sea and land, proved by the occurrence of marine fossils in strata forming some of the loftiest mountains in the world, has resulted from the drying up of an ocean covering the whole earth or from the elevation of the solid land. "A multitude of ingenious speculations" failed to explain the former hypothesis. But when "in the last instance" the

> question was agitated, whether any changes in the level of sea and land had occurred during the historical period . . ., it was soon discovered that considerable tracts of land had been permanently elevated and depressed, while the level of the ocean remained unaltered. It is therefore necessary to reverse the doctrine which had acquired so much popularity, and the unexpected solution of a problem at first regarded as so enigmatical, gave perhaps the strongest stimulus to investigate the ordinary operations of nature. For it must have appeared almost as improbable to the earlier geologists, that the laws of earthquakes should one day throw light on the origin of mountains, as it must to the first astronomers, that the fall of an apple should assist in explaining the motions of the moon.

After having given these examples, Lyell says that the geologists of his time are, for the most part, agreed on questions "as to what rocks are of igneous and what of aqueous origin—in what manner fossil shells, whether of the sea or of lakes, have been imbedded in strata" etc. and are "unanimous as to other propositions which are not of a complicated nature; but when we ascend to those of a higher order, we find as little disposition as formerly to make a strenuous effort, in the first instance [repeated here!], to search out an explanation in the ordinary economy of Nature".

Sound Theorizing in Geology and the "Spirit of Speculation"

In chapter I of Volume III of his *Principles,* entitled "Methods of Theorizing in Geology", Lyell simply distinguishes two opposite ways of thinking. One starts from scratch with geological reasoning without first making a careful study of the "ordinary economy of nature". This method has led to untenable speculations and even absurdities; the history of geology provides several examples. This lesson of history should finally be accepted, not merely on incidental points (such as the nature of fossils, the igneous origin of various crystalline rocks, etc.), but as a principle. The second method in contrast starts with a careful study of the present economy of nature, and then sees if the results of the geological processes of the past are really different from those of those going on at present. This methodological principle has to be applied to every aspect of geology and his reproach to Cuvier and his school, for example, is that they apply it only partially but not consistently. Such critics are described in the following:

> We hear of sudden and violent revolutions of the globe, of the instantaneous elevation of mountain chains, of paroxysms of volcanic energy, declining according to some, and according to others increasing in violence, from the earliest to the latest ages. We are also told of general catastrophes and a succession of deluges, of the alternation of periods of repose and disorder, of the refrigeration of the globe and of sudden annihilation of whole races of animals and plants, and other hypotheses *in which we see the ancient spirit of speculation* revived and a desire manifested to cut, rather than patiently to untie, the Gordian Knot.

I repeat that Lyell's uniformitarianism was not dogmatic; he did not exclude the possibility that paroxysms or processes differing from those presently operating might have taken place in geological history. Note the important restriction in his words, "in the infancy of our science".

This restriction we also find in the concluding remarks of the Chapter:

> But since in our attempt to solve geological problems we shall be called upon to refer to the operation of aqueous and igneous causes, the geographical distribution of animals and plants, the real existence of species, their successive extinction, and so forth, we were under the necessity of collecting together a variety of facts, and of entering into long trains of reasoning which could only be accomplished in preliminary treatises. These topics we regard as constituting the alphabet and grammar of geology; *not that we expect from such studies to obtain a key to the interpretation of all geological phenomena,* but because they form the ground work from which we must rise to the contemplation of more general questions relating to the complicated results to which, in an indefinite lapse of ages, the existing causes of change may give rise.

Lyell had indeed been looking for the methodological basis on which a sound geological science could be built, rather than a geology full of the uncontrollable speculations which had been current for a long time prior to his writing.

Basic Uniformitarianism and the Authors of *"The Genesis Flood"*

Lyell's starting point, like that of Cuvier and many others, is the constancy of law, of structural order in created things. This, of course, is the only basis on which we can hope to speak reliably on the geological past. On this point, the authors of *The Genesis Flood* stand on exactly the same methodological basis as does Lyell. A few examples will illustrate.

There is no doubt that they consider fossils to be remnants of animals and plants which actually lived on earth under circumstances comparable to those we know presently. It is only on the basis of structural constancy that the authors can suggest that huge, but in form superficially human-like, footprints in Cretaceous strata are considered as evidence for the contemporaneity of man and dinosaurs!

A second example is the way in which the authors of *The Genesis Flood* argue in favor of what they call "the most significant of these Biblical inferences", which is "a universally warm climate with ample moisture for abundant plant and animal life"[5] before the deluge. For the sake of confirming this inference, the results of present day geology concerning ancient climates are good enough apparently to indicate that there were some periods when there existed a mild and warm climate over the greater part of the world. But these results are based entirely on uniformitarian reasoning. How can we ever infer a warm climate in the geological past, except on the basis of criteria which we derive from studies of the fauna and flora, or physical or chemical processes, which are characteristic of areas of warm climate we know on earth today? The distribution of coral or other reefs, for example, in the marine environment, and the absence of annual rings in the secondary wood of trees, are only two of these criteria.

Any attempt to harmonize the historical geology of today with the account of the first chapters of Genesis represents a colossal overestimation of science—as well as a misunderstanding of the Genesis record—an overestimation which is as great as that of those scientists who completely reject God as the Creator.

A third example to show how the authors of *The Genesis Flood* depend in their reasoning on the priori assumption of the constancy of law, structure and even processes, is found in their speculation that the "superficial appearance of evolution" of similar organisms in successively higher strata could be the result of the "hydrodynamic selectivity of moving water". After a reference from Krumbein and Sloss[6] about criteria on which the settling velocity of large particles is dependent, they write:

> These criteria are derived from consideration of hydrodynamic forces acting on immersed bodies and are well established.
>
> Particles which are in motion will tend to settle out of proportion mainly to their specific gravity (density) and sphericity. It is significant that the organisms found in the lowest strata, such as the trilobites, brachiopodes, etc. are very "streamlined" and quite dense. The shells of these and most other marine organisms are largely composed of calcium-carbonate, calcium phosphate and similar minerals, which are quite heavy; heavier, for example, than quartz, the most common constituent of ordinary sands and gravels. These factors alone would exert a highly selective sorting action, not only tending to deposit the simpler (i.e., more nearly spherical and undifferentiated) organisms nearer the bottom of the sediments but also tending to segregate particles of similar sizes and shapes, forming distinct faunal stratigraphic "horizons", with the complexity of structure of the deposited organisms, even of similar kinds, increasing with increasing elevation in the sediments.

And further:

> Of course, these very pronounced "sorting" powers of hydraulic action are really only valid statistically, rather than universally. Local peculiarities of turbulence, habitat, sediment composition, etc., would be expected to cause local variations in organic assemblages, with even occasional heterogeneous agglomerations of sediments and organisms of wide variety of shapes and sizes. But, on the average, the sorting action is quite efficient and would definitely have separated the shells and other fossils in just such fashion as they are found, with certain fossils predominant in certain horizons, the complexity of such "index fossils" increasing with increasing elevation in the column, in at least a general way.[7]

These are only three out of a hundred or more examples which could be given of this use of uniformitarian (the present is the key to the past) reasoning to argue for a catastrophist conclusion!

The geological nonsense in the above reasoning is so flagrant that I don't want to discuss it. Speculative hypotheses are dangerous enough already when brought into connection with the Bible, but this is even worse than speculation. What the authors of *The Genesis Flood* should learn from Lyell's example is the fear of speculation and the necessity of a serious search for the foundation on which a reliable geological science could be based!

A little-noticed fact is that the antagonism between uniformitarianists and catastrophists (like, for example, Lyell and Cuvier) is not nearly so fundamental as it would seem. Both geologists agree that the laws of chemistry, physics, and biology—as we know them—are applicable also for historical-geological times.

This is an unavoidable a priori for a science that presumes to speak at all about the history of the earth. How paradoxical it may sound; only on the basis of the constancy of law and structure can we reliably speak about changes in the development of the earth's crust and its fossil content. In other words, the processes of which the geologist studies the results must be (perhaps not in intensity and scale) essentially of the same created order as that which we actually live in and form part of. If this were not so, the whole of historical geology would be in principle beyond the scope of human scientific possibilities.

On this fundamental point, the authors of *The Genesis Flood* agree with modern geologists, at least as far as the process of forming the fossil-bearing strata in the earth's crust is concerned. The tragedy is that they have not realized that in this way they have fused the dynamite under their pseudo-scientific building, exploding their so-called 'Scriptural framework for historical geology'.

On the basis of this principle, the fundamental question is to be answered by careful observation and analysis of the world's sedimentary strata and structural relationships. Are these the result of a catastrophic process, such as the authors of *The Genesis Flood* conceive? Or are they the result of processes whose intensity and scale are generally comparable to those going on today, as modern historical geologists have concluded?

There is no doubt about the answer in the present state of our knowledge; the broad lines of present-day historical geology are to be considered as well observed facts.

The Trustworthiness of the Geological Time-Scale Disputed

Let us now turn to a few fundamental facts and principles of present-day geology. First of all, consider those that concern the stratigraphic column and the geologic (relative) time scale.

As an introduction, note a few quotations from the summary of the chapter, "Modern Geology and the Deluge" in *The Genesis Flood.*

We read on page 206:

> The geological time series is built up by a hypothetical superposition of beds upon each other from all over the world.

That this superposition should be "hypothetical" (which here clearly means "not factual") is argued with a quotation from a geological text book:[8]

> If a pile were to be made by using the greatest thickness of sedimentary beds of each geological age, it would be at least 100 miles high . . . It is, of course, impossible to have even a considerable fraction of this at one place. The Grand Canyon of Colorado, for example, is only one mile deep . . .
>
> By application of the principle of superposition, lithologic identification, recognition and unconformities, and reference to fossil successions, both the thick and the thin masses are correlated with other beds at other sides. Thus there is established, in detail, the stratigraphic succession for all the geologic ages.

Then the authors of *The Genesis Flood* continue:

> This frank statement makes the method by which the geologic time scale was built up quite plain. Since we have already noted that lithologic identification is unimportant in establishing the age of a rock, it is clear the "fossil successions" constitute the only real basis for the arrangement. And this means, in effect, that organic evolution has been implicitly assumed in assigning chronological pigeonholes to particular rock systems and their fossils.

There follows a second quotation from Von Engeln and Caster, which apparently should confirm this conclusion:

> The geologist utilizes knowledge of organic evolution as preserved in the fossil record, to identify and correlate the lithic records of ancient time.[9]

This is commented on as follows:

> And yet this succession of fossil organisms as preserved in the rocks is considered as the one convincing proof that evolution has occurred! And thus have we come round the circle again.

The trend of this reasoning is clear: Historical geology is basically unsound because it has been trapped in circular reasoning. First, geologists determine the order of succession of fossils in the earth's crust on the basis of the superposition of the strata, but at the same time they declare the position of the strata reversed—by some tectonic process—when at another place the succession of fossils is found reversed! What is more, and even worse: Behind this is the 'hypothesis' of evolution, of "a gradual progression of life from the simple to the complex, from lower to higher" (pp. 132, 134).

Moreover:

> . . . quotations from outstanding evolutionary authorities both in geology and biology, demonstrate the great importance of the paleontological record to the theory of evolution. In turn, the principles of evolution and uniformity are seen to be of paramount importance in the correlation of the geologic strata. These principles are absolutely basic, both from the point of view of the history of the development of modern geology and from that of present interpretation of geologic field data. The circular reasoning here should be evident and indeed is evident to many historical geologists (p. 134).

How corrupted and preconceived present-day historical geology really should be is then formulated in the following words:

> The basis for the apparent great strength of the present system of historical geology is here clearly seen. Provision is made ahead of time for any contrary evidence that might be discovered in the field. The geologic time scale has been built up primarily on the tacit assumption of organic evolution, which theory in turn derives its chief support from the geologic sequence thus presented as actual historical evidence of the process. Fragments of the sequences thus built up often appear legitimately superposed in a given exposure, but there are never more than a very few formations exposed at any one locality, occupying only a small portion of the geologic column. Formations from different localities are integrated into a continuous sequence almost entirely by means of the principle of organic evolution (p. 136).

I give these rather long quotations in order to show in what light such a sentence as "The geological time series is built up by a hypothetical superposition of beds upon each other from all over the world" should be read, and furthermore to give an example of the mixing up of truth and untruth in the way of arguing of the authors of *The Genesis Flood* when it concerns one of the fundamentals of geological science.

Lyell's starting point, like that of Cuvier and many others, is the constancy of law, of structural order in created things. This, of course, is the only basis on which we can hope to speak reliably on the geological past. On this point, the authors of The Genesis Flood *stand on exactly the same methodological basis as does Lyell.*

The Natural Exposure of Normally Superimposed Rock Sequences

The actual situation is that the geological time-scale is based on a factual superposition of rocks yielding a factual superposition of paleontological criteria which has been proved to be the same all over the world. In order to make this clear, we will have to deal first with natural exposures—with the way nature exposes the sedimentary rocks, which contain those documents of the history of the earth's crust which the stratigrapher investigates.

When Von Engeln and Caster state that "if a pile were to be made by using the greatest thickness of sedimentary beds of each geological age, it would be at least 100 miles high" and that it is "of course im-

possible to have even a considerable fraction of this at one place", it should be noted that they are speaking of "the *greatest* thickness of *each* geological age".

Two qualifying remarks should be made about this point. First, the *average* thickness of sediments of a certain age is far less than the value of the greatest thickness. Second, if at one place a geological age is represented by its greatest thickness, it is very unlikely that sediments of another age would attain their maximum thickness at the same locality.

However, it is extremely unlikely—virtually impossible—to have a considerable fraction of a pile of sediments reduced in this way, and representing all geological ages, at one place.

For example, consider the world famous example of the Grand Canyon of the Colorado River, where Paleozoic rocks, still in horizontal position, unconformably overlie tilted Algonkian or intensely folded and metamorphosed Archean Rocks at one locality. As a result of what geologists call epeirogenic movements, this area has been uplifted vertically without changing the original horizontal position of the Paleozoic rocks. Following the uplift, the Colorado River has cut deeply into the rocks to expose, in the steep walls of the canyon, the beautiful vertical succession of more than 1000 meters of Paleozoic strata. In this exposure of a normal uncomplicated succession, the superposition is simple and clear. The Archean basement rocks lie at the bottom of the canyon. Progressively higher up on the walls within the canyon we found the Algonkian sedimentary rocks, then the older Paleozoic rocks, and finally—around the canyon rims—the younger Paleozoic rocks.

Very often, however, things are more complicated. Frequently, the original subhorizontal position of the sediments at the time they were deposited has not been preserved; as a result of differential movements in the earth's crust, the sedimentary sequences have been tilted, broken, or folded, so that the layers usually show a dip (varying from a few degrees up to a vertical position). Topographically, these differential movements may give rise to subaerial elevations (mountains) and depressions (lowlands). The mountainous areas are subjected to erosion, which results in the development of new topographic surfaces cutting the bedding planes of the layered sedimentary rocks at an angle. Eventually, erosion may lead to so called "peneplains" or subhorizontal erosion surfaces of vast extent. These peneplains thus may expose thick sequences of sedimentary rocks, in thickness far exceeding those of the Grand Canyon and of which superposition is as undoubtedly established.

In the Grand Canyon, we find a sequence (some 1000 meters thick) of horizontal Paleozoic rocks exposed—in the steep canyon walls—in only the very short lateral distance traversed as we ride from the bottom of the canyon to the high rim overlooking the canyon.

In a large region of subhorizontal topography (a peneplain) underlain by nonhorizontal—dipping, folded, or basinal—sedimentary layers, on the other hand, nature may have exposed sequences of rocks amounting to many thousands of meters in thickness. In such a situation, we can no longer speak of a *local* superposition. We can, for example, walk for hundreds of kilometers across a series of low-dipping sediments in the "Paris Basin", from Triassic rocks in Luxemburg to Middle Tertiary rocks in Paris. Local differences in topographic elevation (a few up to perhaps 100 meters) are insignificant compared to the distance of a few hundred kilometers and the thickness (about 2000 meters) of the sediments which are exposed at or near the surface. In the case of the Paris Basin, which covers a great part of France, we have a huge bowl-shaped structure, consisting of strata dipping gently towards the centre, which implies of course that the younger strata are exposed in the central, the older in the peripheral, parts of the basin. There can be no doubt about the superposition of the strata in the Paris Basin. The formations are only very gently deformed, and a tectonic reversal is entirely excluded.

A comparable but much larger structure, with low-dipping Mesozoic and Tertiary strata, is found in the Gulf Coast Area of Mexico, Texas, Louisiana, and Florida in North America. This is a huge structure of low-dipping strata, in which the superposition is unquestionably normal and also very well known (as a result of thousands of bore holes which have been drilled in the search for oil in these areas). Again, here we cannot reasonably speak of just one locality or one place. But surface and subsurface data permit an unquestionable correlation, layer by layer, and thus the establishment of the sequence of normally superimposed strata attaining a thickness of many thousands of meters.

No evolutionary theory whatsoever could or would ever suggest a reversed position of the strata in the Paris Basin in Europe or in the Gulf Coast Basin in North America! The paleontologist would thereby saw through the branch on which he sits.

The stratigraphic column has been built up essentially on the basis of sedimentary sequences in many relatively stable areas where tectonic disturbances and metamorphism played a minor role and where therefore a reversed position of the strata could a priori be eliminated. On the basis of solid knowledge from these simple areas, the tools have been obtained which permit us to understand more complicated regions. This is an example of the procedure followed by every geologist when he enters a new or unknown area; he first looks for the simpler structures which permit the establishment of the stratigraphic sequence, which in turn is a basic tool for unraveling complicated tectonic structures.

In summary, I want to emphasize that the way nature exposes huge sequences of strata is usually not by cutting deep canyons or valleys into highly upheaved horizontal strata at one place, but instead by differential crustal movements followed by peneplaining erosion (which uncovers older strata in mountainous areas and also furnishes sedimentary materials which are then deposited—often containing fossils—to form younger strata). As a result of such tilting and other crustal movements, great areas of dipping, but unquestionably normally superimposed, strata are now found at or near the surface, and are therefore accessible to the geologist. The huge sequences of sedimentary strata which can be studied in such relatively undisturbed positions over great areas all over the world form the solid factual basis for the establishment of the time stratigraphic column.

The Primary Superposition in Highly Disturbed Areas

However, much more is to be said. When discussing what they called "Methods of resolving contradictions", the authors of *The Genesis Flood* write:

> Furthermore, even where superposed strata are exposed, it rather often happens that the fossils appear to be in reverse order from that demanded by the evolutionary history, which paradox is commonly explained by the assumption that the strata have been folded or faulted out of their original sequence (p. 135).

It is an old story which is told here. It was already elaborated in Professor Aalders' book[10]. And it seems that this favorite argument of professors of Old Testament is supported even by some geologists; the authors of *The Genesis Flood* give the citation of C. H. Rastall, lecturer of Economic Geology at Cambridge University, saying:

> It cannot be denied that from a strictly philosophical standpoint geologists are here arguing in a circle. The succession of organisms has been determined by a study of their remains embedded in the rocks, and the relative ages of the rocks are determined by the remains of organisms that they contain (p. 135).[11]

Now, Mr. Rastall may be a good economic geologist; he is definitely not a good philosopher because his statement is simply not true!

What are the facts? A reversed position of strata is the result of strong disturbing movements after deposition. Complicated tectonic deformation occurs when the sediments are deposited in an area which is or becomes highly mobile, in contrast with relatively stable regions.

Since the reversed position of the layers, and, of course, the inverted succession of fossils, is not of primary or stratigraphic origin, but of secondary or tectonic origin, we should find (and we do) completely independent tectonic evidence (in addition to the fossil evidence) for a reversed position of a sequence of strata. Surely, we prefer simple structural relations when establishing a stratigraphic column in an area, but we do not finally depend on them.

In many instances, we can follow a certain sequence of strata from a less to a more intensely disturbed area, and observe, for example, how in this direction the dips increase to a vertical position, and somewhat further on have turned more than 90° from the original horizontal position so that they are then "overturned" and the sequence of layers has become in fact inverted or reversed. A gradual transition from a normal to an inverted position is in fact a phenomenon which is often encountered in folded areas. It has nothing to do with theory; it is just a matter of observation.

When in a mobile area we find with the help of fossils that a sequence of strata lies in reverse position, this conclusion if reliable implies that the strata are folded and that there must be a hinge zone along which the layers have been turned up. Such hinges, along which layers are sometimes turned over 180 degrees so that they are now in a perfect upside-down position, are perfectly visible, for example, in some deep valleys in the Swiss and Austrian Alps. Now, if our index fossils are reliable, the paleontological evidence, the succession of the fossils, must be in accordance with the tectonic-structural evidence for whatever, normal or reversed, position the strata are in. But if this is the case, and this is in fact what we find, then both evidences do mutually confirm each other. The reversed sequence in which the fossils are found locally therefore does not invalidate, but, on the contrary, fortifies their value as time markers, because we know from independent tectonic evidence that the layers there are in overturned position.

The same situation holds when, as a result of tectonic causes following differential movements in the earth's crust, rock masses are pushed up and over on top of neighboring areas; in this way also, older rocks will lie on top of younger strata. If such an abnormal succession is of tectonic origin, we should find the fault plane, the overthrust plane, exactly at the place where the older strata appear above the younger formations. Such a situation will usually be characterized by tectonic criteria related to the overriding phenomenon. At such an overthrust plane, we often find a tectonic breccia, consisting of broken and crushed rock fragments of usually heterogeneous material. In other instances, depending on overburden and fluid pressure at the overthrust plane, friction may have resulted in such high temperature that the anomalous contact indicated by our fossils is characterized by a 'burned' or a dynamometamorphically altered zone. And here again, this is exactly how we find it. Tectonic and paleontologic evidence point in the same direction. Instead of contradicting, they confirm each other, and here again we may speak of convergent evidence.

Top and Bottom Engraved in Individual Layers

To find an answer to the question of whether we are dealing with strata in normal or reversed position, a third criterion can usually be found. It is of stratigraphic-sedimentologic character, and involves sedimentary structures found in individual layers.

Let me give a few simple examples to demonstrate the principle. On a sandy bottom, running or waving water may cause characteristic ripples in the sand which we call ripplemarks. They are often found in a fossil state. Wave ripplemarks, for example, form sharp ridges and rounded troughs. When we find in a sequence of layered strata that these sharp ridges point downwards, we therefore know that this sequence lies in an overturned position. In case the external form is not clear, the internal lamination may provide decisive evidence.

Another example, seen by almost everybody at some time, is that when a puddle or a muddy ditch desiccates, a pattern of cracks appears in the drying mud, the so-called "mud-cracks". Such mud-cracks also have often been fossilized as a result of the filling of the wedge-shaped openings between the polygons with other material, e.g., sand. In this manner, again, the layer was marked for top and bottom during the process of sedimentation. The points of the wedges indicate the direction in which the older layers are to be found.

A great number of comparable stratigraphic-sedimentologic criteria, so-called top-and-bottom features, are known. Usually very small structures, they often give an unmistakable answer to the question whether the position of a layered sequence is normal or not, completely independent of tectonic or paleontologic evidence. In practice, the field geologist working in complicated areas is constantly concerned about the

question "normal or reversed position?" He therefore is very keen on finding such top-and-bottom features, the more so when fossil evidence is not immediately, not sufficiently, or not at all available.

It will be clear that when we add the stratigraphic-sedimentologic evidence of the sedimentary structures to the already convergent evidence of tectonics and paleontology, there remains no trace, not even a glimpse, of circular reasoning whatsoever. Quite the opposite is true; the reliability of the fossils for relative age determination of geological formations is not denied by local occurrences in reversed order, but on the contrary confirmed. For with the help of two other criteria, independent from each other and independent of those fossils, we can irrefutably demonstrate that the layers there indeed occur in overturned position.

The Question of Correlation

With the possibility of establishing the normal succession of strata in the earth's crust, we have in principle a factual basis for the establishment of the order of succession of the fossils they contain. In order to make clear now that the order of succession is the same all over the world, and that fossils therefore may be used as time-characteristic index-fossils I have to go into a little more detail about the local and regional successions of geological formations, the gaps they necessarily contain, and the question of regional and intercontinental correlation.

The actual situation is that the geological time-scale is based on a factual superposition of rocks yielding a factual superposition of paleontological criteria which has been proved to be the same all over the world.

When we look at a geological map of France, we can see that the relatively undisturbed sediments of the Paris Basin overlie more intensely folded sediments of Paleozoic age outcropping in various areas around the actual basin boundary. When we look now at the succession of rocks from Paris, then moving outward from the centre of the Paris Basin, to Charleroi in Belgium, we observe that the lowermost sediments of the Paris Basin, unconformably overlying the folded Paleozoic strata of the Ardennes Massiv, are Upper Cretaceous. Around the basin's edges, at the surface of this angular unconformity there is in this sequence a huge gap, because practically the whole Mesozoic and part of the Paleozoic are missing. But when we follow this contact, the outcrop of this important unconformity, in an East-South-Easterly direction we gradually encounter successively older formations appearing in the Paris Basin above the unconformity surface; these formations have been called: Lower Cretaceous, Jurassic, and then Triassic.

When we look at the geological map of the United States, we see that (in Tennessee, Alabama, and Georgia) the folded Paleozoic sediments of the Appalachians plunge down underneath essentially undisturbed sediments of the Atlantic and Gulf Coastal Province, the oldest of which are here Cretaceous, at least at the surface.

There is a striking similarity in the position of the Coastal Plain sediments as regards the folded Paleozoic rocks of the Appalachians on one side of the Atlantic and those of the Paris Basin with respect to the folded Paleozoic Rocks of the Ardennes on the other, particularly when we look at the Paris-Charleroi section.

That identity is not only structural; it is much more complex. There is a succession of Upper Mesozoic and Cenozoic strata which, notwithstanding all kinds of differences due to locally differing sedimentation conditions, can be compared and correlated with that in the Paris Basin, on the basis of the fossil faunal contents of the sediments. That is to say, when we compare the sequences of strata on both sides of the Atlantic Ocean, where the superposition is unquestionably known, there appear to be differences in the faunal content of successive layers; these differences allow for a descriptive stratigraphic subdivision, and they occur in the same order of succession. And when we look now at the underlying folded rocks and establish therein the stratigraphic superposition, we find, first of all, that the faunal content of these layers is totally different from the overlying strata, but very similar to that of the folded Paleozoic formations of the Ardennes. Furthermore that comparison of the sequence in the United States and in Europe *also* reveals faunal characteristics for a subdivision *in the same order* in America and Europe. All this has nothing to do with evolutionary theories. We simply find a factual superposition of faunal elements (in the strata) which occurs in the same order on both sides of the Atlantic. On the basis of such experience in comparing or correlating stratigraphic columns all over the world, we can then finally say that fossils may be used for indicating the place of the formation in the sequence. This experience of correlating the superposed strata all over the world is essential; every index fossil is constantly being checked on its guide value by new stratigraphic field work, by the many boreholes of the oil companies, etc., all over the world and every day.

The basis of our subdivision of geological time is found in the fact of a worldwide complex identity of the succession of sedimentary strata. The 'older' or 'younger' can without any doubt be established in both the locally and the regionally exposed strata. The 'as old as', the 'time correlation', on a regional to continental scale has its base in the identity in the complex succession of stratigraphic series in different places, a complex succession which practically eliminates any other interpretation than that of 'same age' (on a certain scale and with a certain degree of accuracy, of course).

We take the example of the Paris Basin/Ardennes and Gulf Coastal Plain Province/Appalachians again. It is clear that the unconformable superposition of unfolded Cretaceous and Tertiary sediments on folded Older and Younger Paleozoic sediments (which, both in relative detail, show comparable faunistic similarity on both sides of the Atlantic) reveals a complex identity structurally and stratigraphically to the effect that a geologist can give no other interpretation than: an older period (Paleozoic time) in which sedimentation

took place in the areas; then folding, mountain building and erosion at or towards the end of this time; finally, renewed sedimentation in at least part of these areas in Mesozoic and Cenozoic times.

We could go a little bit further now and ask about so-called Jurassic and Triassic sediments which appear under the Cretaceous of the Paris Basin. What about their equivalents in the Southeastern States of the United States? Do they really exist, and are they in a position comparable to those in Europe? The map shows that the oldest deposits of the Gulf Coastal province outcropping at the contact with the Appalachians are of Cretaceous age, which implies a gap here for Jurassic and Triassic. Is this implication correct? Yes, because for example away from this surficial contact, from Yucatan to Florida, the oil-well bore has struck older deposits underneath the Cretaceous, showing paleontological characteristics of Upper Jurassic age. Normally underlying sediments, possibly Lower Jurassic, Triassic or Permian, could not be identified as such because of lack of fossils. But when we go, for example, to the Southwestern part of the United States we find a normal superposition of dated Permian, Triassic, Jurassic and Cretaceous sediments covering very large areas in Utah, Colorado, Arizona and New Mexico. The same order of paleontologic criteria in the succession of strata—in Europe, in America, in Asia, Africa and Australia, all over the world—this is a fact which simply cannot be denied except by those who do not know or do not want to know. But the factual situation is there for everyone who wants to to go and see.

Parenthetically, I want to point out that therefore evolution (in the descriptive sense that flora and fauna on earth have been subject to change almost continuously in the course of geologic time) is also to be considered as a well observed fact, which is of course something quite different from a theory of evolution and from an evolutionistic philosophy.

Reworking: Mixing of Fossils of Different Age

But, the authors of *The Genesis Flood* might react by saying that we are still dishonest with our representation of the fossil succession as an observed fact, because in several instances mixed faunas are found, which would therefore represent a mixture of older and younger fossils. Then, they might say, we come along with a complicated interpretation of reworking or comparable phenomena, but that interpretation is only an interpretation, and the *fact* is that these fossils do occur together in the same bed. And we would have to answer that that is true, but truth and simplicity do not always go together.

When fossil-bearing sediments become subject to erosion, one must expect not only redeposition of the inorganic components but also those of organic origin. This general consideration already implies that a mixing of fossils of differing ages as a result of reworking processes must occur. But, reworking or redeposition in general results in characteristic features by which it can be determined as such.

In the Netherlands, we find silicified Cretaceous sea urchins as elements in Pliocene fluviatile gravels. Marine animal remains in fluviatile beds is of course already anomalous, but furthermore the silicified tests are rounded by their having been transported, and we know the place where they have been washed out of the sediments in which they were originally embedded.

A second example is that, in muds of the Wadden Sea, Cretaceous Foraminifera are found together with the recent foraminiferal assemblage. These Cretaceous elements, however, are found in the smallest fraction (smaller than 0.15 mm) of the washed residues. They are washed out of Cretaceous deposits of the Paris Basin exposed in the Channel, sorted by longshore current action, and only the finest material reaches the Dutch Wadden Seas. Here, although differing preservation already demonstrates the correct conclusion, the uniform size indicates sorting and proves the allochthonous character of these elements in the faunal assemblage.

We found a very interesting example of mixed faunas when working as stratigraphers for an oil company of the Royal Dutch Shell group in North Borneo. The washed residue of a shale sample appeared to contain a normal assemblage of beautifully preserved Paleocene (Lowermost Tertiary) Foraminifera, but also a few very poorly preserved *Miogypsinas,* larger Foraminifera of Miocene (Lowest part of Upper Tertiary) age. At first sight, the perfect preservation, absence of sorting, and normal assemblage of these Paleocene Foraminifera, mixed with some 30-40 million years younger *Miogypsinas* which were in part pyritized and very badly preserved, was astonishing. From the field geologist, we knew that big 'exotic' blocks of probably Paleocene age occurred scattered in the shale. We then looked at the part of the sample which had not been washed, and the solution of the problem was found. The sample consisted of a dark grey shaly matrix, in which a great number of angular fragments of a light coloured marl were disseminated. It was clear that the angular fragments were redeposited fragments of an older formation and that they appeared indeed to contain the Paleocene fauna. The autochtonous sediment—the dark shaly matrix—was apparently formed under more or less anaerobic conditions, as a result of which sulfuric acid was formed, which in turn attacked and in part pyritized the calcaeous shells of *Miogypsina* during or shortly after deposition. The Paleocene Foraminifera in the original sediment of the angular elements were perfectly protected against such chemical activity in the Miocene basin.

Stories like this may sound complicated, but in fact they are not. Again here, the way in which the resedimentation process was written down in the structural relationships of the younger sediment did not deny, but on the contrary again confirmed or corroborated the reliability of the fossils—in this case pelagic and larger Foraminifera—as index fossils.

Structural Uniformity and Actual Experience

Within the scope of this article it is impossible to deal with everything which the authors of *The Genesis Flood* have presented. There is one important and fundamental thing, however, concerning which I want to spend a few sentences—the practical meaning of the so-called uniformitarian and actualistic principles in geology.

As a first remark, I don't like -isms. A term ending in -ism usually means an overestimation of the aspect, modus, state of affairs or whatever is meant by the term. The question which has to be answered, however, is this: have those people who are considered to be the fathers of uniformitarianism or actualism seen

something fundamentally essential for our geological scientific knowledge, even if they may not have correctly defined, not fully understood, or over- or underestimated what they had seen?

As a historical geologist, who always has to do with *documents* of a geologic past in the earth's crust, I cannot pretend to speak even one reliable word about geological history except on the basis of what I called above "structural constancy". "Structural" is meant in a very large, generalized sense. The only way to distinguish differing processes in the documents is by means of the differing structures they may reveal. Sedimentary processes produce typical, characteristic structures, and tectonic processes produce other differing, but also characteristic structures in the rocks of the earth's crust. There are, of course, also many kinds or types of sedimentation processes, the results of which can be differentiated on the basis of the differing structural characteristics produced—such as lithologic and paleontologic criteria, texture and structure (in a restricted sense).

The reliability of the Word of God spoken in this world through His prophets and apostles is beyond the reach of scientific control, because the Bible is not a scientific book. As such, it is not vulnerable to the results of science. Therefore, Christian astronomers, geologists, and biologists can work without fear as long as they respect the limits of their own scientific field.

The general rule will be that the more detailed the interpretation, the more detailed also our structural analysis will have to be. The general starting point for an interpretation of the sedimentation processes in geologic history on a really, and the only possible, scientific basis will therefore be the assumption that a catastrophic sedimentation process would have to show characteristic structural relationships, and that, on the other hand, the normal, actual sedimentation processes necessarily result in different characteristic structural features. In other words, when our analysis of fossil sediments reveals in great detail the same structural relationship as that which is actually formed under present day condition, the only conclusion which can honestly be drawn is, "It is the same process!" Ascribing comparably structured sediments to catastropic processes would be something like declaring that fossil fish which we have found on the basis of fossil remains to look in detail like actual fish, were not really fish living in water but birds flying in the air!

The example may sound silly, but it clearly shows the basic role of structural *uniformity* even for the determination of fossil remains, and demonstrates also the link with actual life' *experience*. What could we say about the function of the organs of fossil fishes, or about the environment they lived in, if we did not know the living fish in its environment today?

Now, in view of the need for more detailed reliable interpretation of depositional environments of fossil sediments, one branch of geological sciences, called sedimentology, has grown very rapidly during the last decades. A major part of the work done by the sedimentologist was and still is a detailed analysis of actual sedimentation processes and their results in modern depositional environments. Of course, when we want to know what the characteristic features are of sediments found in a middle neritic marine environment (the zone of approximately 40-100 meters depth [20-50 fathoms] on the shelf), we shall first of all have to obtain samples of the modern sediments in this area, examine them in detail and study all kinds of physical, chemical, and biological conditions in the zone. In addition, we shall also have to study the bordering (inner neritic, and outer neritic) environments to be able to specify their characteristics also in a differential diagnosis.

Modern analyses of these sediments 'in formation' are done in very great detail, in both the physicochemical and biologic criteria, with the result that a very detailed classification of sediments as related to their depositional environment appears to be possible. But it also appears that this "key of the present" indeed fits into the sediments of the past, because most of them show, often in astonishing details, the same structural relationships. The identity is there. The uniformity is written down in the fossil sediments themselves. There is no way out unless one wants to declare, to pick up the above examples, that the fish is a bird. The identity may exist on a small scale (e.g., the number of Foraminifera per gram of sediment, and the percentages of different species or genera with respect to the total foraminiferal assemblage) but also on a large scale. To conclude I would like to give one example of the latter.

The authors of *The Genesis Flood* try to deny the evidence for deposits which required a very long time to form, such as coral reefs. Some of them at least are explained as being redeposited during the Flood (pp. 408,409).

Now there are different types of reefs and different organisms which can build reefs, in addition to corals. Reefs have played a very important role in the geological history of the earth's crust, and sedimentologic research is particularly active in investigating the depositional environments of reef limestones and those immediately related to the reefs.

Let's look at a barrier reef. It lies at a certain distance from a shore, and separates a lagoonal environment (between barrier-reef and shoreline) from the open marine environment. At the sea-side of the reef body, we distinguish a fore-reef area, on the landside a back-reef zone. The reef-body itself consists of a core of unlayered, massive limestone, built up by the sedentary reefbuilding organisms still in original life position; it is bordered by coarse, and farther away finer reef detritus, which, particularly the latter, are often very well bedded. Now, we do find barrier- and other reefbodies at many different levels in the stratigraphic column. But we do not find, say, the core of a barrier-reef body, as a strange element in other deposits. On the contrary, in Silurian reefs in Gotland, in Devonian and Lower Carboniferous reefs in Belgium, the Jurassic reefs in the Jura Mountains, and Cretaceous reefs in the Apennines, etc., etc., we can

recognize and locate, in addition to the reef bodies themselves, the associated depositional environments with their characteristic sediments and faunas: the lagoon, the fore- and the backreef zones, and the open marine environment.

On a small scale and on a large scale, there is no question whatsoever of some catastrophic mixing-up; on the contrary, everything is found exactly in the place where it should be, compared with actual sedimentation conditions in reef and associated environments. We find structural constancy in detail, even when we consider variation as a result of different reefbuilding organisms (such as calcaceous algae, stromatoporoids, bryozoans, corals, rudistids, or combinations).

These are the facts of stratigraphic and sedimentologic research, which are at the basis of the major results of the geological sciences. This basis makes it possible indeed to say that the broad lines of present-day historical geology, dealing with the formation of the earth's crust in geological times in the order of hundreds of millions of years, are correct, and are to be accepted as a well established fact.

Science and the Bible: Not the Fundamentalistic Way

It may seem as if I have written very little about fundamentalism so far. However, I was fighting against it all the time, but silently and indirectly until now.

The book of Whitcomb and Morris was written on the basis of what we usually call a fundamentalistic or biblicistic viewpoint. This standpoint implies the belief that the Bible teaches us principles, fundamentals or elements of human science in general and of historical-geological science in particular.

For the fundamentalist, therefore, the reliability of the Bible as the Word of God is related to *scientific* reliability. For him this is particularly true with respect to the first eleven chapters of Genesis. This conception, however, implies inevitably that science and God's Revelation in the first chapters of the Bible are placed on the same (scientific) level, on the basis of which scientifically obtained data about the history of the earth and man will have to fit into the 'Biblical scheme or framework'.

The 'question' of the reliability of the Holy Scriptures can thus be fought out on the scientific field, and, as a consequence, we then see theologians enter this field, as Professor Whitcomb now does, as Professor Aalders did in Holland a few decades ago, and as so many before them have done since the end of the Middle Ages.

But these 'scientific' battles for an infallible Word of God have been lost right from the start. In constant retreat, the theologians have had to surrender every position they had once taken in this struggle. That's what the history of the warfare between science and theology should have made conclusively clear. The tragedy of men who wanted to defend the reliability of the Word of God 'scientifically' should have taught us that this entire approach was wrong. It should have convinced us that this science is a very bad ally, because its word had only temporal and no eternal value.

The most tragic aspect of the fundamentalist conception seems to me that his standpoint requires *scientific* proof, so that he must somehow live in fear of the results of developing scientific work, because indeed this development could then also *disprove* the reliability of the Holy Scriptures. And this leads to the cardinal question whether in this way the fundamentalist's conception does not reveal an implicit faith in science, which is far more dangerous for Christian religion than is the scientific development itself.

A few years ago, I was speaking to a conference of Reformed ministers in the Netherlands about some fundamental facts of geology. In the discussion, one of them arose and declared that, if he were convinced that what I had told them was true, he would immediately abandon his ministry. But I ask myself what kind of a religion is Christianity when scientific geological facts can prove or disprove the reliability of God's Revelation to man? What then do we really believe in? In *our* own 'image', conceptions or ideas about an infallible Bible? In an interpretation of the first chapters of Genesis with the help of current natural scientific knowledge just as earlier theologians did with the help of a world picture, incidentally, usually already out of date in their own time?! Does the message of the Bible then really necessarily change with the changing world picture? It surely does as long as we continue trying to accommodate Genesis and geology.

Instead of giving human scientific work its proper place in the light of Scripture, fundamentalism indeed implies, as I indicated already in the beginning of this article, a colossal overestimation of natural science. Neither geology nor any other natural science can ever be a direct exegetical tool, as they have been used, and still are used in fundamentalistic conceptions.

However, the history of the natural sciences and the results of modern geology, for example, could play a far more modest role, the role of an indirect exegetical tool. Such would be not a tool to test, to prove or to disprove the reliability of Scriptures, but to test the reliability of our ideas and conceptions about the Bible, the inspiration, and the historicity of the first chapters of Genesis.

The reliability of the Word of God spoken in this world through His prophets and apostles is beyond the reach of scientific control, because the Bible is not a scientific book. As such, it is not vulnerable to the results of science. Therefore, Christian astronomers, geologists, and biologists can work without fear as long as they respect the limits of their own scientific field.

Our ideas and conceptions concerning the Bible may indeed appear to be vulnerable to the results of scientific development. This state of affairs seems to be difficult to accept, particularly for many evangelical Christians. It cannot be denied, however, that there is 'revelation' (be it of a different kind than that of the Bible) in the development of this created world, also in the results of human scientific and technical advances during the last centuries. It cannot be denied and should not be denied that, as a result of this development, our (scientific) world picture (Weltbild) has obtained huge dimensions, both in time and space and has become entirely different from that of the authors of the Bible. But, this is the world God has wanted us to live in, we and our children.

The fundamentalistic view, conservative in an erroneous sense, requires us to accept a so-called "biblical world picture" which should be normative

for scientific work. This is a poor predicament indeed for contemporary Christianity, because it tends to transform twentieth century Christians into aliens, standing, as it were, in Old Testament times. Since this is, of course, not possible, the fundamentalistic view tends to deprive them of their belief in a reliable Bible. It alienates us from the Words of Eternal Life, which we understand through *faith* and not through *science*, and which stand firm in this rapidly changing world.

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PALEONTOLOGIC EVIDENCE AND ORGANIC EVOLUTION

Dialogue *The existence and significance of paleontologic evidence, and arguments for or against the validity of organic evolution.*

THE POSITION OF JOHN N. MOORE

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Introduction and Definitions

Over 110 years after the publication of Charles Darwin's book, *The Origin of Species* on November 24, 1859, we hear and read, repeatedly, about evolution stated *as fact*, in unhesitating fashion, by leading evolutionists. Julian Huxley has said so in as many words on many occasions and in written form. In 1959, Huxley claimed even that the universe had evolved, the earth had evolved, life evolved, man evolved, and man's culture in sum total had evolved.

In 1966, the now deceased Hermann Muller was instrumental in gaining signatures of close to 200 prominent scientists in support of the idea that evolution is as well established as the rotundity of the earth. And Theodosius Dobzhansky has said that evolution is as well established as anything could be, according to all those who are in full possession of the data available.

Little room for credibility seems left for that minority of scientists (See Olson, 1960), who assert quite boldly that evolution is illogical and *not* at all *biological*. Nor is some imaginary credibility gap reduced much by someone challenging Gavin de Beer, who has maintained in print that the certainty of evolution is comparable to that of the system of Copernicus, or that of Newton. Yet, I will assert that evolution is *not at all comparable* to the systems of either Copernicus or Newton with regard to logical precision or probative strength. What can be the basis of such an allegation?

Actually many, many evolutionists *believe* that evolution *is* comparable to the Newtonian theory in logical precision and probative value, essentially because they *equate* evolution with natural selection. Evidently evolutionists labor under this impression because they feel as de Beer, i.e.,

> Only ignorance, neglect of truth, or prejudice could actuate those who in the present state of knowledge, without discovering new facts in the laboratory and in the field, seek to impugn the scientific evidence for evolution. (de Beer, 1958)

But a close, rigorous check of the de Beer article explicates the fact that he *has equated* literally the term "natural selection" with "evolution", and then subsequently proceeded to substitute for "natural selection", the term "evolution". And de Beer and many, many evolutionists make the *tacit assumption* that substantial experimental and field data that may be used to support the concept of natural selection are also useful as support for evolution.

Thus I find it necessary to raise questions of logical exegesis with regard to primary methodological issues associated with evolutionary theory and interpretations of several groups of physical data. It would be possible to offer extensive discourse around such topics as: a) use and abuse of *ad hoc* hypotheses, b) *ex post facto* explanations, c) the problem of definitions, d) methodological requirements of genuine scientific hypotheses, e) probability arguments involved in evolution theory, and f) the problem of untestable hypotheses.

Also I find it necessary to explicate the failure of many, many evolutionists to recognize overtly the *definite limitations* of scientific methodology. As time-binding organisms, human beings functioning as scientists are *still* limited in observational capacity beyond naked eye study to whatever extensions are possible through microscopes, telescopes, ultra-speed films, spectroscopes, and similar instrumentation. And direct physical data for the historical period of the past may be studied in archeology and similar work *only* some 3,000 years before the present. Thus *all* discussion about origin of the universe, the earth, life, man, and man's culture—*a la* the previously mentioned statement by Huxley—is *pure conjecture.*

As background to a discussion of physical evidence and evolution, an explication of the meaning of the word "science" or an answer to the question, "What is science?", is apropos. Of course the word "science" comes from the Latin for knowledge; and, according to a common dictionary definition, science is knowledge attained through study or practice. But this definition is obviously much too broad to be of much value. For a more coherent definition we find:

> Any body of doctrine or collection of truths is scientific to the extent that it yields the power to predict in relation to the subject matter of its choice. (Somerville, 1941)

And a decade later the following definition was offered:

> Science is an interconnected series of concepts and conceptual schemes that have developed as a result of experimentation and observation and are fruitful of further experimentation and observation. (Conant, 1951)

And thirdly the Oxford Dictionary contains this formal definition:

> A branch of study which is concerned either with a connected body of demonstrated truths or with observed facts systematically classified and more or less colligated by being brought under general laws, and which includes trustworthy methods for the discovery of new truth within its own domain.

Thus, from these three definitions scientific activity involves the search for facts that can be observed or demonstrated, and laws which have been demonstrated also, by means of *trustworthy* methods of discovery. Then at the core of scientific method or methods is *experimental repeatability* or reproducibility. Other synonyms for this core idea are *predictability* and/or control. As a leading paleontologist has pointed out:

> The important distinction between science and those other systematizations (i.e., the arts, philosophy, and theology) is that science is self-testing and self-correcting. The testing and correcting are done by means of observations that can be *repeated* with essentially the same results by normal persons operating by the same methods and with the same approach. (Emphasis added) (Simpson, 1962)

Therefore, the heart of scientific method is the problem-hypothesis-test process. And, necessarily, the scientific method involves *predictions.* And predictions, to be useful in scientific methodology must be subject to test empirically. But is this the case with regard to the theory of evolution? Are observations involved that are repeatable?

Thus, many scientists who have critically analyzed the theory of evolution have found that a General Theory of Evolution must be distinguished from a Special Theory of Evolution. (See Kerkut, 1960)

A proponent of the *General Theory of Evolution,* which is the "Amoeba to Man" thesis, would state that all living things in the world have arisen from a single source that came from an inorganic beginning. Thus, according to the General Theory of Evolution, the first living cell "evolved" into complex muticellular forms of life, these gave rise to all forms of invertebrates; in turn, invertebrates "evolved" into vertebrates; fish into amphibia, amphibia into reptiles, reptiles into birds and mammals, early mammals into primates, and finally primates "evolved" into man. Without question this is the basic meaning of the term "evolution" for most people.

However, a proponent of the *Special Theory of Evolution* would state that many living plants and animals *can be observed,* over the course of time, to undergo changes so that new varieties are formed.

Presentation of the General Theory of Evolution *as fact* has no basis in science. The General Theory of Evolution is totally without foundation in physical evidence as is shown presently.

But a final word of introduction is needed. I assert that evolutionists, who speak and write as "historical" geologists or biologists, do so as men who present their *imagined narratives* about the so-called geological past, and produce *imagined narratives* about supposed phylogenetic trees of living things. Geologists, especially, must be reminded constantly that they study only the present. Then they interpret and extrapolate about the past, and in so doing they leave empirical science.

Yet, such *imagined narratives* have been offered for a very long time in geology textbooks as "accounts" of past "history" of living things. Such imagined narratives have been presented so *persuasively,* for such a long time, that most geologists, paleontologists, and biologists have come to accept them *as fact,* as if the events imagined and the supposed changes in living

things had occurred actually. Thus, we find Huxley, Muller, Dobzhansky, and Simpson in the lead as spokesmen for the position that general evolution is fact.

The Real Situation

What is the real situation? Just what is the situation about general evolution *as fact*? The real situation is that discussion about general evolutionary thought or theory involves a paradigm case of the "interminable dispute" in scientific discourse. Discussion about general evolution is plainly a conceptual dispute, or a quarrel of *faiths*. There is no *experimentum crucis* possible. And there is no need for new physical evidence as de Beer would have his readers believe. There are no private facts for evolutionists; and no private facts for scientists who are not disciples of the Evolutionary Faith. Disagreements are *conceptual* in nature, and *not factual* in character. The same physical data of the geological record, animal breeding records, and plant breeding records are used by both evolutionists *and* other scientists.

Also, the real situation could be phrased in terms of "conflict questions", as was done in the doctoral thesis, "Methodological Issues in Evolutionary Theory", by Wing Meng Ho for his 1965 degree at Oxford University. Dr. Ho maintains that these conflict questions are no longer problems of *science*, but problems in *philosophy*. We do not need more physical evidence as per de Beer for conflict questions that center in such dichotomies as, 1) mechanism versus vitalism, 2) mechanistic versus organismic biology, 3) non-teleological versus teleological approaches, or 4) non-evolutionary versus evolutionary origin of matter and life.

Ho sees that empirical versus non-empirical questions must be faced, when conflict questions are formulated. And theories of general evolution involve conflict questions about origin that are quite non-empirical. Rather than collection of more facts, solution or dissolution of conflict questions on origins and general evolution require analysis and clarification of points at issue according to a particular viewpoint re *meanings, definitions* or *interpretations*. Resolution of conflict questions will not come by gaining new physical evidence, but by making decisions of intent to construe and apply certain key-terms in some definite manner. Such key-terms might be listed as,

1. cause, or causes
2. character
3. create
4. development
5. evolution
6. explanation
7. kind
8. life
9. mutation
10. origin
11. prediction
12. probability
13. purpose
14. species
15. succession
16. variation

But, in the main, evolutionists *seem* unaware of, or uninterested in, precision of definitions. This seems *especially true* when evolutionists *equate* "evolution" and "natural selection", or *equivocate* "evolution" and "variation". Or when evolutionary biochemists indiscriminately interchange "create" and "synthesize", or "creation" and "synthesis". Such neglect of detail seems contradictory to the spirit of empirical science.

When scientists criticize general evolutionary thought or the use of terms by evolutionists, when they raise objections to teaching general evolution *as fact*, as if it were or is observable, they are merely insisting on elementary scientific procedures. The very essence of suspended judgment, as an attitude of scientists, and further the self-correctiveness of scientific methodology (which is so often pointed to as a criterion to separate science from other disciplines of man, as per Simpson above), are *both* properly served when scientists ask pointed conflict questions above general evolutionary theory or thought.

Scientists, who criticize evolution, experience conflict when they ask questions such as, "If a machine is the result of a draftsman and engineer, and if the draftsman and engineer are the result of their genetic codes, then what is the organizing principle or pattern for these genetic codes?" If this question is pushed back far enough to involve the concept of beginning, or origin, then solution or dissolution of that conflict question will come only after certain key-terms are consistently employed by evolutionists.

In sum, then, with regard to the real situation, many scientists maintain that theories of general evolution are not suitable for the study of origin, whether concern is for the origin of the universe, the earth, life, man, or man's culture. It would seem that something as important to scientists as the origin of the universe should not be discussed in basic terms which are employed in a contradictory manner.

"Evidences" for General Evolution Examined

Therefore, it becomes necessary to examine the broad theory of general organic evolution, which entails development of an *imaginative narrative* about the "history" of living things, about their origin and changes in the past to the present. The thesis of general organic evolution has been well known ever since Charles Darwin made it acceptable to the intelligentsia of his time. Specialists and non-specialists are acquainted with the evolutionary thesis that all living things came from organisms of the past which came from some least complex beginning and in turn from an inorganic origin. Thus, change in living things from least complex to most complex is the "end" involved in general evolution. But the "means" involved whereby that "end" supposedly was and is accomplished was *imagined* by Darwin to be "natural selection", and evolutionists still hold this to be a *prime* mechanism of change.

Darwin used major chapters of his book to expound upon so-called "evidences" for general evolution and the same headings are useful today for reference to classified physical data as per the following: a) geological record (succession), b) morphological affinities, c) geographic distribution, d) embryological similarities, and e) rudimentary or vestigial organs. (Blood or protein analyses would be added by some today.)

At this point some scientists are quick to point out the practice of *ex post facto* explanations. No one has ever seen one type or form of an animal change into another type or form of an animal, and hence all use of physical evidence under the above headings partakes of the practice of formulating explanations *after the fact*. Darwin and all orthodox disciples of the Evolutionary Faith have diligently sought after physical evidence to substantiate the general evolutionary thesis already expressed simply as "Amoeba to Man", or as one high school textbook is sub-titled: "Molecules to Man". Yet all discussion of so-called "evidences" under the above

mentioned headings is done *after the fact*. Hence the crucial point still remains that the basic concepts always involve untestable hypotheses.

And in terms of their methodological approach, scientists are obligated to point out that the entire structure of general evolutionary thought rests upon the geological record–the supposed historical record of what actually happened.

Yet the whole discussion of supposed succession of horses, or any other type or form of living thing as based upon the geological record, partakes unavoidably of the logical fallacy of *post hoc ergo propter hoc* ("after this, therefore, because of it"). The fallacy involves the error of taking something as the cause for another thing merely because of being earlier in time. That is, merely because the remains of one kind of organism lie in a stratum under remains of another kind of organism, it does not necessarily follow that the "lower" is the cause (or ancestor) of the "upper".

Thus some scientists are attempting to construe and apply certain key-terms with regard to the geological record. Succession does *not* afford *sufficient* and *necessary* grounds for claiming one organism as the ancestor of another. (Succession in rock strata is not the same as clear genetic relationship established through interfertility tests, which many evolutionists hold as criteria for establishing the species concept.)

But most important of all is the fact that *all* of the physical "evidence" used by evolutionists under the above headings are made plausible and persuasive only because of *one basic assumption*. Underlying the geological record, morphological affinities, geographic distribution, embryological data, rudimentary organs, and blood or protein analyses is one basic assumption, i. e., *the degree of relationship of organisms depends upon the degree of similarity of organisms*. In short, if organisms look alike, then they are related, according to the degree of similarity. If organisms do not look alike then they are not related, or only distantly related, according to the degree of similarity. But, in no respect, as many scientists point out, are genetic relationships afforded the general evolutionary thinker by physical data grouped under the above headings. No genetic relationship is established through exercise of the *assumption* that the degree of relationship depends upon the degree of similarity.

And most conclusively, as far as methodological issues are concerned, only *circumstantial* evidence is involved throughout all the listings of classified physical evidences used to support evolution from "Amoeba to Man", or for that matter, from "Molecules to Man". Relationships expounded are purely *conjectural* because they *cannot be tested*. All these circumstantial evidences involve *extrapolations* quite beyond the realm of genuine scientific investigation, i. e., experimental analysis. All hypotheses of relationships of general evolutionary nature are *untestable;* and, therefore, are purely conjectural and speculative. It would appear, therefore, that these hypotheses are doomed forever to remain a part of the untestable dogma of the Evolutionary Faith.

At this point many scientists would open discussion of the validity of *circumstantial evidences* to the establishment of scientific truth. Being reminded that we *cannot equate* "natural selection" to "evolution", and we *cannot equivocate* "evolution" with "variation", critical scientists press hard on the fact that general evolutionary theorists, in using circumstantial evidences almost exclusively, are involved with an important weakness and seriously irremediable defect in their thinking. This is their heavy dependence on the *argument from analogy*. An analogy can be given:

> If (A) is known to have properties "P" and some additional property "R" and resembles (A′), in that (A′) is known to have properties "P", then (A′) is expected to have property "R".

Darwin depended on an analogy between *artificial* selection and *natural* selection, as he discussed his supposed mechanism for general evolution. He formulated the reasoning that the artificial selection of the breeder and fancier of domestic animals, about which he could observe and gain actual physical data, was *analogous* to his imagined natural selection of the better adapted organisms for survival. But the analogy breaks down.

In the first place, artificial (breeder) selection must be accomplished in accordance with certain desired or determined criteria. The plant breeder has distinct characteristics which he wants to retain, improve, or even remove, if possible, for his particular desire (criteria). The breeder works with plants to bring about distinct departures in characters according to this design. This also is true of the animal breeder or fancier.

In the second place, proponents of the doctrine of natural selection state that it occurs *without any set criteria*. There are no distinct characteristic changes planned or designed. Only the interaction of organism(s) (populations) and the environment are involved. Plants change according to wind pollination or as insect pollination occurs. Animals reproduce and control a territory and change according to interaction with the environment, *somehow*. There are *no* criteria. Furthermore, supposed changes are slight, minute, hardly noticeable variations of the genome. Actually most distinct departures (most mutants) are eliminated, and field and laboratory data are better interpreted that gene stability is the most proper conclusion from empirical data.

Artificial selection, therefore, is not analogous to natural selection, or *vice versa*. There is no resemblance between A and A′ because the properties associated with A are different from the properties associated with A. Thus, there is no adequate comparison of artificial selection and supposed natural selection and the analogy fails.

Genetics as "Evidence" for General Evolution

As a last defense for general evolution, many will demand, "Well, what about genetics? Aren't evolutionists on the correct path when they use data from genetics to try to support their thesis of 'amoeba to man' evolution? Is it not true that variations have been shown to be transmissible?" Yes. "Is it not true that changes of genetic material have been shown to be of a fixed nature?" Yes. "Is it not true that changes of genetic material are constantly arising?" Yes.

But many scientists are asking, "Is there *any* evidence of *empirical* nature that favorable variations have *accumulated* so as to effect overt general evolutionary changes?" Again, a conflict question has been reached, and the problem of defining the meaning of terms must be faced. "What is a viable mutation?" "What is a variation?" "What is an evolutionary change?"

Clearly, even evolutionists must admit that no new organs or organisms, re type or form, have come about by the shuffling and reshuffling of genes. It is true that

the researcher may conclude from his experimental data that changes in eye color, in eye shape, in eye pattern in fruit flies do occur, but the eyes *always* remain *Drosphilia* eyes, if that is the organism with which he deals in his research! Recombinations of genetic materials do *not* bring about new types or forms. Such changes are always within limits of known types or forms of organisms.

That inviolate *genetic* barriers exist between major groups of living things may be stated conclusively on the basis of available genetic evidence. Unbridgeable breeding gaps are known; no amount of reference to ploidy and or chromosomal rearrangements will truly erase the undeniable evidence that breeding gaps between major groups of living things do in point of fact actually exist.

Anyway any reference to different phenomena of ploidy and chromosomal rearrangements constitutes nothing more than *ad hoc*, untestable hypothesizing, as far as any attempt to explain any relationships between or among major groups of animals or major groups of plants is concerned. Absolutely no *genetic* connections are ever established between major groups of living things by means of any mechanisms involving ploidy and chromosomal rearrangements.

But there is another problem here. Are mutations, or more properly mutants, truly raw materials upon which "natural selection" operates, as is so commonly claimed by such as Theodosius Dobzhansky? He has admitted that mutants do not of themselves involve anything new (Dobzhansky, 1953). Mutations are sources only of differences of characteristic expressions of traits *already in existence*, and not a source of new traits. Mutations result only in changes *within* the existing genetic structure. Therefore the fundamental genotype remains unchanged as far as *traits* are concerned.

Thus the contention so often heard and read that mutations supply the raw materials for "natural selection" to bring about "amoeba to man" evolution involves a whole hierarchy of *ad hoc* hypotheses, which are void of testability. Once again the *untestable* hypothesis is encountered, which is so common in general evolutionary theory or thought.

Since the vast majority of mutations are lethal or cause impairment of physiology of the organism, since the gene mutation hypothesis suffers from the difficulties of the *pathological* nature of and the great rarity of mutational changes, it follows that mutations are *not useful* as supporting evidence for general evolution, that is, "molecules to man". And public attestations to the "failure" of the mutational theory are appearing in print more and more. As one scientist has written: "But who can tell us how point mutations and sundry tape doublings, crossings, and writhings made the oak and squirrel, the gull and the gall by summing up the changes in many a piece of enzymes?" (Morrison, 1971 and Davis, 1970; Haskins, 1971)

Any hypotheses about "suppressor" genes (Fisher, 1932), undetected viable mutations (East, 1936), or changes in the evironment favoring certain mutations (Dobzhansky, 1953) must be labelled *untestable*. And a similar generalization can be made of more recent attempts to "explain" change of one kind of organism into another kind of organism by way of mutations and other gene manipulations.

Thus an important methodological issue with regard to physical evidence from genetics is the fact that the favorite hypotheses of evolutionists fail to satisfy the *criterion of testability*, and because of this, they lie *outside* the realm of scientific investigation. In genetics, many scientists detect the repeated practice of *ad hoc* hypotheses, which are fully *untestable*, and detect heavy commitment by general evolutionists to extrapolation and interpretation of terms that are *vague* and *ambiguous*. "What is a viable mutation?" "What is a useful mutation?"

In considering for a moment that last question, a change of color in moths or alteration of food use by bacteria might be cited as results of "favorable" or "useful" gene mutations. Nevertheless such changes of moths or bacteria are only *within* a certain genus, and *not across* limits of genera. Therefore, any thought to consider any so-called "favorable" gene mutations as possible mechanisms for changes across limits of known kinds, which are the type of changes required if the general theory of evolution is to be given any empirically sound basis, partakes again of dependence upon *ad hoc*, untestable hypotheses.

In summation, with regard to physical evidence from genetics, the point that needs to be emphasized over and over again is that minor changes can and do occur in living organisms, but the changes are always within bounds of a certain type, form, or kind. And in passing, it should be noted that even in the fossil record, basic types, forms, and kinds are clearly recognizable even as we see them today in many, many examples.

Of course, this is in exact agreement with the pattern found in Genesis 1, that is, "after their kind", "after his kind". This can be extended by the statement that all the known physical evidences can be fitted into the Genesis account in great consistency with all the better scholarship; and this can be done better by far than attempts to fit the physical evidence into imagined, speculative narratives of evolutionary theorists.

On the basis of the most rigorous scholarship, the conclusion is inescapable that *no* transitional forms of true *genetic* relationship or connection can be established from breeding records, which constitute the only truly repeatable, demonstrable physical evidence (hence really scientific). There is truly an irrefutable case that can be made for "fixity of kinds".

Conclusion

Because of failure to follow fundamental scientific procedures, *especially* with regard to origins, because of the extensive commitment of general evolutionists to sheer circumstantial evidences, because of the failure of mutational hypotheses to provide anything pertaining to truly *new* physical traits, it is clear that theories of general evolution are not suitable for the study of origins, whether concern centers on origin of the universe, the earth, life, man, or man's culture. And equally important, theories of general evolution cannot be presented *as fact* without implication in fraud and/or *hoax*.

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Cuffey's Critique of Moore's Position

The critical role of paleontologic evidence in demonstrating organic evolution to the satisfaction of the scientific community seems largely overlooked by writers of Moore's persuasion. Consequently, presenting such evidence here in non-technical fashion seems to me to be the most useful contribution which these papers can make toward resolving the evolution controversy.

Moreover, the arguments used against this paleontologic evidence by anti-evolutionists like Moore are woefully lacking, because they rest upon misunderstanding or oversimplification of actual paleontologic procedures. Four brief comments suffice to elaborate this point.

First, as an example, Moore's suggestion that the stratigraphic succession of fossils is logically fallacious is based upon a grossly and erroneously oversimplified view of the nature of the fossil record. As explained previously in my position paper, it is important not only that one organism's remains lie below those of another. It is also essential, for demonstration of evolutionary relationship between the two, that the intervening strata contain other fossils which grade continuously in both morphology and chronologic-stratigraphic position from the lower to the upper form.

Similarly, as a second example, the curious notion that studying past events involves only speculation and untestable hypotheses reflects serious ignorance. Actual paleontologic practice is in fact dominated by observational investigation of the fossil materials which would have been produced under various possible circumstances, in an attempt to determine how nature most probably did behave in the past.

Third, as previously indicated, the paleontologic record provides an immense and overwhelming quantity of evidence supporting evolutionary concepts. In general, retreat into oversimplified philosophical arguments against such a massive body of verifiable observational evidence suggests strongly an inability to convincingly counter the clear implications of that evidence.

Fourth, Moore states that disagreements concerning evolution are "quarrels of faiths". In contrast, as indicated earlier, I believe that such disagreements are readily resolvable by scientific data. I sincerely hope that those of his persuasion will reject one possible implication of his statement—namely, that no matter what relevant evidence is newly presented to them, they will not consider the implications of that evidence!

Retaining open minds about controversial concepts is necessary, until sufficient evidence accumulates. However, enough scientific evidence is already at hand to remove any reasonable doubt about the validity of the concept of organic evolution.

Other points raised by Moore are adequately covered in my position paper, and therefore need not be repeated here.

Moore's Rebuttal

In rebuttal to Cuffey's critique, I assert that I am quite aware of "the critical role of paleontologic evidence" with regard to supposed organic evolution. It is my concern about *misuses* of such information that prompts me to point out *again* that no demonstration *empirically* of general evolution has been accomplished. To allude to the "satisfaction of the scientific community" seems to me to be no more than an appeal to the fallacious idea that truth is a matter of voting.

The "scientific community" was satisfied with the Copernican formulations; and yet, Kepler wrought great and significant changes. The scientific majority was satisfied with Newtonian physics; and yet, Einstein wrought great and significant changes. Contemporary scientists of Charles Darwin were at one moment satisfied with their interpretations of Genesis 1; and yet, Darwin wrought great and significant changes.

It is just because of my understanding and appreciation of the complexity of actual paleontological procedures that I make bold to *tell it like it is*, and urge fellow colleagues in the scientific community today to realize, that now is the time for all scientists to reconsider general evolution. A period of over 110 years, since Darwin's book appeared, is time enough to insist that evolutionists either put up *hard physical evidence* for general evolution, or else yield in their arrogant dogmatism in writing and teaching about general evolution *as fact*. To challenge scientists in astronomy, biochemistry, botany, embryology, geology, paleontology, and zoology to provide *hard physical evidence* is done in the spirit of self-correctiveness of scientific endeavor mentioned in the Simpson quote in the Introduction of my position paper.

And Cuffey's use again of such words as "demonstration", "observational", and "implications" in his critique must be challenged. He did not write of, and he cannot provide, any *empirical* demonstration of genetic lineage between or across limits of kinds of organism. He joins his reference to "observational" with "possible" and "probable" and thus provides further basis for my case that he *does deal inescapably* in "speculation and untestable hypotheses". And when he asks that critics of evolution consider the implications of physical evidence, I offer that I have done just that per my position paper, and I repeat that the *real situation* that prevails is *total absence* of any physical evidence upon which to base the General Theory of Evolution. Any discussion of change of species or genetic variation *within* limits of kinds of organisms must never be confused with general evolution.

To speak of "validity", as Cuffey does in his next to closing statement of his critique, leads directly to the whole thrust of my criticisms of any presentation of general evolution *as fact*.

There is immense "reasonable doubt" about the

validity of *general evolution*. There is immense "reasonable doubt" that general evolution has ever occurred. *All* of the physical data from comparative anatomy, comparative embryology, rudimentary (vestigial) organs, blood and protein analyses, Mendelian and population genetics, *and* the fossil record may be fitted more validly into the creation account of Genesis 1, than into any speculative, imaginative narrative of men about general evolution.

I hope sincerely that those of Cuffey's persuasion will reject one possible implication of his statement before concluding his position paper, that Christians "will need to integrate evolutionary process into their views as being the proximate means which God uses to create various forms of life"—namely, the implication that the ways of men, the ideas of men, the traditions of the world must be given credence over the ways of Christ, who said, "male and female created he them". If Christians accept the ideas of men about general evolution, then they may be consciously or unconsciously beguiled (Col. 2:8 and Eph. 4:14) to accept a human substitute about origins for the Word of God, which is the one and only source of *unchanging* answers for people of all generations about origins of the universe, the earth, life, man, and man's culture.

Today, Christians can declare confidently that "fixity of kinds" is *the* scientifically documented prediction from the creation model, that is, supported by *all* physical evidence. And "fixity of kinds" might well be understood as the modern day equivalent of the Biblical "after his kind" or "after their kind".

THE POSITION OF ROGER J. CUFFEY

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Introduction

Practicing paleontologists today, regardless of personal philosophical outlook, unanimously agree that the varied organisms inhabiting the earth originated by a process of gradual, continuous development or evolution over long periods of prehistoric time. Because the case for organic evolution had been adequately demonstrated in the late 1800's (principally by paleontologic evidence), scientists in this century turned their attention to many other important subjects. Consequently, most have been surprised by (Lewontin, 1971) and also ill-prepared to cope with the recent reappearance of anti-evolutionary ideas (such as Morris, 1963; Moore, 1970a, 1970b, 1971a, 1971b; Moore & Slusher, 1971). Therefore, presenting the paleontologic evidence relevant to the concept of evolution is most timely, particularly for an audience like that of the *Journal ASA*.

The participants in the current controversy about evolution seemingly agree that fossils (the study of which comprises the science of paleontology) are the remains (or direct traces) of formerly living organisms, preserved in the earth's crust since prehistoric times. This conclusion is incontrovertibly supported by the complete spectrum observable within the earth's crust between recently dead organisms and highly altered fossils.

In addition to the morphology of fossils, a paleontologist studies also various aspects of their distribution within the earth's crust. As Van de Fliert (1969) has ably discussed, the rock layers comprising that crust reveal a chronological framework (usually stated succinctly as the standard geological time scale) for the earth's history. This basic framework, founded upon repeatable observations of the succession of rock strata, is quite independent of any concept of organic evolution (Van de Fliert, 1969, p. 75, 77); in fact, the standard time scale historically was worked out half a century before evolution was proposed and demonstrated.

Fossil Sequences

As a consequence, we can examine the fossils entombed in chronologically successive rock layers, and thereby learn what organisms inhabited this planet during successive intervals of past geologic time. When we do this, we find that the fossils naturally form sequences showing gradual and continuous morphologic changes from earlier forms to later forms of life, sequences which make evolutionary interpretations ultimately inescapable.

As working paleontologists interested in the history of particular organisms, we locate for detailed study a relatively thick succession of fossil-bearing rock layers whose observable physical features indicate continuous and uninterrupted deposition over a comparatively long time interval. We next examine those layers for

the fossils in which we are interested. We initially find a few fossils, scattered widely among the different layers. Studying these specimens usually shows noticeable morphological differences between ones from various geologic ages, differences which we recognize formally in progress reports by referring the specimens to different species, genera, etc., depending upon the magnitude of those differences. Continued field collecting from the rock strata intervening between any two successive forms thus described frequently produces a series of fossils which begin with the earlier form, change in morphology gradually and continuously as we proceed upward, and end up with the later form. Because these new fossils demonstrate a morphological and parallel chronological transition from the earlier form to the later form, they are termed "transitional fossils".

Examples of Transitional Fossils

If we read the paleontologic literature (especially if with the background of professional paleontologic training and experience; Cuffey, 1970, p. 93), we find that the fossil record contains many examples of such transitional fossils. These connect both low-rank taxa (like different species) and high-rank taxa (like different classes), in spite of the record's imperfections and in spite of the relatively small total number of practicing paleontologists. Because of the critical role which transitional fossils played in convincing scientists of the occurrence of organic evolution, paleontologists have been appalled that many otherwise well-informed persons have repeated the grossly misinformed assertion that transitional fossils do not exist. Consequently, after a relatively brief and non-exhaustive search of the literature immediately available to me, I compiled the examples of transitional fossils presented here. At least enough of these can be readily examined by anyone seriously interested in this topic that he can be convinced of their implications, I believe; collectively, they (and the many other similar ones which more extended search would find) comprise a massive body of evidence which cannot be ignored or explained away.

Although the broad patterns and many details in the history of life are well known, many other details remain to be learned. Because of the unevenness of our knowledge, therefore, we can conveniently distinguish several different types of transitional-fossil situations. Let us consider these now, starting with that situation where our knowledge is most complete, and proceeding through situations in which knowledge is progressively less complete.

First, some groups have been so thoroughly studied that we know sequences of transitional fossils which grade continuously from one species to another without break (Table 1), sometimes linking several successive species which cross from one higher taxon into another (Table 2). We can say that situations of this kind display *transitional individuals*. Among the many available examples of transitional individuals, some particularly convincing examples can be noted. These involve:

corals (Carruthers, 1910, p. 529, 538; Easton, 1960, p. 175; Moore, Lalicker, & Fischer, 1952, p. 140; Weller, 1969, p. 123),
gastropods (Fisher, Rodda, & Dietrich, 1964),
pelecypods (Kauffman, 1967; Kauffman, 1969, p. N198-200; Kauffman, 1970, p. 633),

Table 1. *Examples of transitional individuals grading continuously between successive species within the same higher taxon (genus).*

Algae: Gartner, 1971.
Angiosperms: Chandler, 1923, p. 124, 132-133; Chaney, 1949, p. 197-198; Stebbins, 1949, p. 230-231.
Foraminiferans: Barnard, 1963, p. 82, 90; Rauzer-Chernousova, 1963, p. 48.
Corals: Carruthers, 1910, p. 529, 538; Cocke, 1970, p. 13; Easton, 1960, p. 175; Moore, Lalicker, & Fischer, 1952, p. 140; Ross & Ross, 1962, p. 1182-1184; Weller, 1969, p. 123.
Bryozoans: Cuffey, 1967, p. 38-39; Cuffey, 1971a, p. 158; Cuffey, 1971b, p. 38; Elias, 1937, p. 311, 317.
Brachiopods: Ziegler, 1966, p. 532.
Gastropods: Fisher, Rodda, & Dietrich, 1964; Lull, 1940, p. 19; Sohl, 1967, p. B12-13, B15-16; Thomson, 1925, p. 96.
Pelecypods: Charles, 1949; Charles & Maubeuge, 1952, 1953a, 1953b; Heaslip, 1968, p. 58, 69, 77-79; Imlay, 1959; Kauffman, 1965, p. 8-21; Kauffman, 1967; Kauffman, 1969, p. N198-200; Kauffman, 1970, p. 633; Kay & Colbert, 1965, p. 325; Lerman, 1965, p. 416, 431-432; MacNeil, 1965, p. G35-36, G42; Raup & Stanley, 1971, p. 191, 257; Stenzel, 1971, p. N1077; Waller, 1969, p. 26.
Ammonoids: Cobban, 1958, p. 114; Cobban, 1962a, 1962b; Cobban, 1969, p. 6; Cobban & Reeside, 1952, p. 1020-1022; Easton, 1960, p. 456.
Trilobites: Brouwer, 1967, p. 152-155; Kaufmann, 1933, 1935; Raup & Stanley, 1971, p. 292; Simpson, 1953, p. 250.
Echinoids: Beerbower, 1968, p. 136, 138; Durham, 1971, p. 1126-1127; Hall, 1962; Kermack, 1954; Nichols, 1959a, 1959b; Olson, 1965, p. 98; Rowe, 1899.
Conodonts: Clark, 1968, p. 21-23; Scott & Collinson, 1959, p. 562.
Mammals: Osborn, 1929, p. 20-21; Simpson, 1953, p. 387-388; Teilhard de Chardin, 1950; Trevisan, 1949; Watson, 1949, p. 47; Wood, 1949, p. 188-189.

Table 2. *Examples of transitional individuals grading continuously between successive species, and crossing from one higher taxon into another.*

Ginkgophytes: Andrews, 1961, p. 337-339; Brown, 1943, p. 863; Franz, 1943, p. 323; Scagel *et al*, 1965, p. 484; Seward, 1938; Weller, 1969, p. 66.
Angiosperms: Chaney, 1949, p. 193-199; Elias, 1942, p. 70-71, 88-89, 109-122; Stebbins, 1949, p. 230.
Foraminiferans: Banner & Blow, 1959, p. 21; Barnard, 1963, p. 86, 88-89; Gimbrede, 1962, p. 1121-1123; Jones, 1956, p. 274; Papp, 1963, p. 352-353; Woodland, 1958, p. 803-808; Zeller, 1950, p. 19.
Brachiopods: Boucot & Ehlers, 1963, p. 48-51.
Pelecypods: Newell, 1942, p. 21, 59.
Ammonoids: Arkell, Kummel, & Wright, 1957, p. L113-119; Brinkmann, 1929, 1937; Brouwer, 1967, p. 156-158; Cobban, 1951, p. 5-11; Cobban, 1964, p. 110-14; Easton, 1960, p. 455; Erben, 1966; Krumbein & Sloss, 1963, p. 369; Olson, 1965, p. 105-107; Raup & Stanley, 1971, p. 264, 306-307; Spath, 1938; Wenger, 1957.
Conodonts: Rexroad, 1958, p. 1158.
Mammals: Hanson, 1961, p. 50-51; Scott, 1937, p. 417; Simpson, 1951, p. 114-121, 148, 217-228, 232, 236, 257, 265, 282, pls. 20, 31; Wood, 1949, p. 186.
Hominids: Coon, 1962; Howells, 1967; Kummel, 1970, p. 578-583; Le Gros Clark, 1964; Uzzell & Pilbeam, 1971, p. 615.

echinoids (Beerbower, 1968, p. 136, 138; Kermack, 1954; Nichols, 1959a, 1959b; Olson, 1965, p. 98; Rowe, 1899).

Second, other fossil groups have been well enough studied that we know sequences of transitional fossils comprising a series of chronologically successive species grading from an early form to a later form (Table 3), again sometimes crossing boundaries separating different higher taxa (Table 4). This type of situation can be termed *successive species*. Published descriptions of successive species lack explicit discussion of individuals transitional between the species, although frequently such exist in the author's collection but are not discussed because they are not directly pertinent to his purposes. Again, some especially persuasive examples of successive species can be seen, among:

foraminiferans (Wilde, 1971, p. 376),
brachiopods (Greiner, 1957; Raup & Stanley, 1971, p. 124),
pelecypods (Easton, 1960, p. 348; Kay & Colbert, 1965, p. 327; Moore, Lalicker, & Fischer, 1952, p. 447; Newell, 1942, p. 21, 42, 47-48, 51-52, 60, 63, 65; Olson, 1965, p. 97; Stenzel, 1949; Stenzel, 1971, p. N1079-1080; Weller, 1969, p. 209),
ammonoids (Cobban, 1961, p. 740-741).

In many fossil groups, our understanding is relatively less complete, thus giving rise to a third type of situation which we can label *successive higher taxa*. Here, we may not have complete series of transitional individuals or successive species, but the genera (or other higher taxa) represented in our collections form a continuous series grading from an earlier to a later form, sometimes crossing from one higher-rank taxon into another (Table 5). Because genera are relatively restricted in scope, many series of successive genera have been published. However, families and higher-rank higher taxa are so broad in concept that they are not usually used to construct transitional-fossil sequences, althougb occasionally they are (Bulman, 1970, p. V103-104; Easton, 1960, p. 436; Flower & Kummel, 1950, p. 607).

Table 3. *Examples of successive species within the same higher taxon (genus).*

Angiosperms: Chandler, 1923; Chaney, 1949, p. 197-199; Elias, 1942; Stebbins, 1949, p. 230-231.
Foraminiferans: Barnard, 1963, p. 82; Bronnimann, 1950, p. 406; Cita-Sironi, 1963, p. 119-121; Hottinger, 1963, p. 306-307; Schaub, 1963, p. 288-290, 292-294; Wilde, 1971, p. 376.
Brachiopods: Berry & Boucot, 1970, p. 30-31; Dunbar & Waage, 1969, p. 113; Greiner, 1957; Raup & Stanley, 1971, p. 124.
Gastropods: Franz, 1932; Franz, 1943, p. 272; Sohl, 1960, p. 100.
Pelecypods: Dechaseaux, 1934; Easton, 1960, p. 348; Heaslip, 1968, p. 74-77, 79-81; Kay & Colbert, 1965, p. 327; Lerman, 1965, p. 416; Moore, Lalicker, & Fischer, 1952, p. 447; Newell, 1937, p. 40, 80; Newell, 1942, p. 21, 42, 47-48, 51-52, 60, 63, 65; Olson, 1965, p. 97; Schafle, 1929, p. 79; Stenzel, 1949; Stenzel, 1971, p. N1056-1057, N1077, N1079-1080; Weller, 1969, p. 209; Zeuner, 1933, p. 317.
Trilobites: Grant, 1962, p. 983-998.
Crustaceans: Guber, 1971, p. 15-16; Sohn, 1962, p. 1207; Swartz, 1945; Weller, 1969, p. 267.
Carpoids: Barrande, 1887; Weller, 1969, p. 297.
Blastoids: Beaver, 1967, p. S303-305.
Graptolites: Berry, 1960, p. 9.
Fishes: Boreske, 1972, p. 3-4.
Amphibians: Olson, 1965, p. 45-48.
Mammals: Lull, 1940, p. 189; McGrew, 1937, p. 448; Tedford, 1970, p. 671, 694.

Table 4. *Examples of successive species crossing from one higher taxon into another.*

Ginkgophytes: Andrews, 1961, p. 337-339; Brown, 1943, p. 863; Franz, 1943, p. 323; Scagel *et al*, 1965, p. 484; Seward, 1938; Weller, 1969, p. 66.
Foraminiferans: Berggren, 1962, p. 109, 116-126.
Bryozoans: Lang, 1921-1922; Easton, 1960, p. 268.
Gastropods: Fisher, Rodda, & Dietrich, 1964.
Pelecypods: Stenzel, 1971, p. N1057, 1078.
Nautiloids: Easton, 1960, p. 425; Flower, 1941, p. 526; Moore, Lalicker, & Fischer, 1952, p. 351.
Ammonoids: Arkell, Kummel, & Wright, 1957, p. L116; Cobban, 1961, p. 740-741; Easton, 1960, p. 446; House, 1970, p. 666-674; Miller, Furnish, & Schindewolf, 1957, p. L22; Wright & Wright, 1949.
Crustaceans: Glaessner, 1960, p. 40-41; Glaessner, 1969, p. R410-411.
Crinoids: Moore, Lalicker, & Fischer, 1952, p. 629.
Echinoids: Jackson, 1912, p. 231; Weller, 1969, p. 355.
Reptiles: Lull, 1940, p. 296; Olson, 1965, p. 99-101.
Reptile–Mammal Transition: Olson, 1965, p. 202.
Mammals: Kummel, 1970, p. 514; Lull, 1940, p. 524; Matthew, 1910; Nelson & Semken, 1970, p. 3734; Osborn, 1929, p. 35-37, 724, 761, 773, 784, 791, 801, pl. 48; Patterson, 1949, p. 243-244, 246, 263, 268; Scott, 1937, p. 429; Simpson, 1951, p. 148, 245; Wood, 1949, p. 188-189.

Finally, in some fossil groups, our knowledge is quite fragmentary and sparse. We then may know of particular fossils which are strikingly intermediate between two relatively high-rank higher taxa, but which are not yet connected to either by a more continuous series of successive species or transitional individuals. We can refer to these as *isolated intermediates*, a fourth type of situation involving transitional fossils, a type which represents our least-complete state of knowledge.

Isolated intermediates include some of the most famous and spectacular transitional fossils known, such as *Archaeopteryx* (Colbert, 1969, p. 186-189; Romer, 1966, p. 166-167). This form is almost exactly intermediate between the classes Reptilia and Aves (Cuffey, 1971a, p. 159; Cuffey, 1972, p. 36), so much so that "the question of whether *Archaeopteryx* is a bird or a reptile is unimportant. Both viewpoints can be defended with equal justification" (Brouwer, 1967, p. 161). The fossil onychophorans (Moore, 1959, p. O19; Olson, 1965, p. 190) and the fossil monoplacophorans (Knight & Yochelson, 1960, p. I77-83; Raup & Stanley, 1971, p. 308-309) have been regarded as annelid-arthropod and annelid-mollusk inter-phylum intermediates, respectively. Moreover, although invertebrate phylum origins tend to be obscure for several reasons (Olson, 1965, p. 209-211), recently discovered, Late Precambrian, soft-bodied invertebrate fossils may well alter that situation, particularly after certain peculiar forms are studied and compared with Early Cambrian forms (Kay & Colbert, 1965, p. 99, 103; Weller, 1969, p. 247).

Mention of this last prompts me to point out parenthetically that the appearance of shelled invertebrates at the beginning of the Cambrian has been widely misunderstood. The assertion is frequently made that all the major types of animals appeared suddenly and in abundance then. In actual fact, collecting in

successive strata representing continuous sedimentation from Late Precambrian into Early Cambrian time reveals a progressive increase upward in abundance of individuals. Moreover, the various higher taxa—particularly the various classes and orders reflecting adaptation to different modes of life—appear at different times spread over the long interval between the Early Cambrian and the Middle Ordovician.

Finally, because of widespread interest in questions of man's origins, it is well worth emphasizing that a rather complete series of transitional fossils links modern man continuously and gradationally back to mid-Cenozoic, generalized pongids (see references in Table 2).

> In spite of statements to the contrary . . . , the fossil record of the Hominoidea, the superfamily containing man and the apes, is quite well known, and it is therefore possible to outline a tentative evolutionary scheme for this group (Uzzell & Pilbeam, 1971, p. 615).

Potential Complications of the Paleontologic Literature

Non-paleontologist readers examining examples of transitional fossils mentioned above should be aware of several common occurrences within the professional paleontologic literature which could conceivably be confusing.

Historically, continued paleontologic research on any particular fossil group tends to move our understanding of its fossil record from the least-complete to the most-complete type of transitional-fossil situation. For example, early paleontologists recognized that the goniatite ammonoids gave rise to the ceratite ammonoids (successive higher taxa, in this case superorders or infraclasses; Easton, 1960, p. 436); later work indicated the successive species by which this transition was accomplished (Easton, 1960, p. 446; Miller, Furnish, & Schindewolf, 1957, p. L22). Other examples can also be cited (Simpson, 1953, p. 361-364; Cuffey, 1967, p. 38-39). Also, our ideas about particular lineages may sometimes change as more specimens are brought to light (Stenzel, 1971, p. N1068-1070, 1077).

Frequently, secondary references portray evolutionary lineages much more vividly than does the original paper reporting them. For instance, contrast the original presentation of one coral sequence (Carruthers, 1910, p. 529, 538) with several later presentations (Easton, 1960, p. 175; Moore, Lalicker, & Fischer, 1952, p. 140; Weller, 1969, p. 123).

Sequences of transitional individuals or successive species are often, especially for teaching purposes, presented instead as more generalized sequences of successive genera. One ammonite lineage including transitional individuals between families (Spath, 1938; Arkell, Kummel, and Wright, 1957, p. L113-116) appears elsewhere as merely successive genera (Olson, 1965, p. 105-107). The various successive species of the horse lineages (Simpson, 1951, p. 114-121, 217-228, 282) are often summarized as successive genera (Hanson, 1961, p. 50-51; Scott, 1937, p. 417).

Similarly, for instructional purposes, some authors illustrate a series of fossils which show a progression in morphology, but which are not chronogically successive. These therefore are not evolutionary sequences, even though they resemble such. Two examples of such morphological series involve foraminiferans (Pokorny, 1963, p. 312) and nautiloids (Easton, 1960, p. 426).

In many instances, transitional individuals exist but are not reported explicitly as evolutionary lineages, for several reasons. Fully documenting such complete sequences is rather expensive in both research effort and publication cost; thus, many remain unpublished (Berry & Boucot, 1970, p. 30-31). Moreover, the practicing paleontologist sees little need to repeatedly reprove well-established concepts, especially when his primary concern is with other matters such as biostratigraphic dating (Berry, 1960, p. 9).

Effect of Transitional Fossils on Taxonomic Practises

Still further, because the Linnean system of taxonomic nomenclature has been very useful historically, we tend to refer transitional individuals to that species which they resemble most, rather than calling attention nomenclaturally to their intermediate status (Bird, 1971; Crusafont-Pairo & Reguant, 1970). As a result, a casual reader might conclude erroneously that we see no evolutionary variations within species. However, the true situation is that paleontologists frequently ignore such variation because it is not pertinent to their immediate goals (Williams, 1953, p. 29), but that such variation is present as transitional individuals within the species (Anderson, 1971; Cuffey, 1967, p. 41, 85-86; Klapper & Ziegler, 1967; Scott & Collinson, 1959; Williams, 1951, p. 87).

Similarly, we also tend to refer transitional fossils to that higher taxon which they most resemble or to which their final representatives belong. Consequently, the fact that we are dealing with continuously gradational sequences may be obscured by our conventional practise of superimposing artificially discontinous, higher-rank taxonomic boundaries across such lineages (Olson, 1965, p. 100-101, 202-203; Van Morkhoven, 1962, p. 105, 153; Williams, 1953, p. 29; Cuffey, 1967, p. 38-39). As a result, for example, in the middle of sequences of transitional fossils bridging the conceptual gaps between the various vertebrate classes, we find forms which sit squarely on the dividing line between these high-rank taxa and which can be referred to either of two. In addition to *Archaeopteryx* between reptiles and birds (discussed previously), we can also note *Diarthrognathus* between reptiles and mammals, the seymouriamorphs between amphibians and reptiles, and *Elpistostege* between fishes and amphibians (see references in Table 5).

Higher taxa—from genera on up through phyla—are useful concepts in handling data concerning organisms (in fact, they constitute what the layman terms "major kinds" of organisms); however, they are artificial mental constructs rather than "basic facts of nature" (Brouwer, 1967, p. 161; Olson, 1965, p. 100-101, 201-203). Moreover, although there are reasons why transitional sequences between higher taxa are not as frequent as we would like (Brouwer, 1967, p. 160-169; Olson, 1965, p. 118, 184-211; Simpson, 1953, p. 366-376; Simpson, 1960, p. 159-161), nevertheless we can cite some particularly impressive transitional fossils between higher taxa of various ranks. In addition to those mentioned previously as inter-phylum and inter-class transitions, others involve higher taxa of class-group rank (Erben, 1966; Raup & Stanley, 1971, p. 306-307), orders (Easton, 1960, p. 446; Miller,

Table 5. *Examples of successive higher taxa (genera).*

Coniferophytes: Florin, 1951; Scagel *et al*, 1965, p. 491-492, 520-522, 596-597.
Foraminiferans: Dunbar, 1963, p. 42; Pokorny, 1963, p. 155, 192.
Corals: Wells, 1956, p. F364.
Brachiopods: Dunbar & Rodgers, 1957, p. 280; Shrock & Twenhofel, 1953, p. 346.
Nautiloids: Teichert, 1964a, p. K200-201; Teichert, 1964b, p. K325.
Ammonoids: Miller, Furnish, & Schindewolf, 1957, p. L23.
Coleoids: Easton, 1960, p. 476; Weller, 1969, p. 233.
Blastoids: Fay, 1967, p. S394-395; Tappan, 1971, p. 1087.
Crinoids: Moore, Lalicker, & Fischer, 1952, p. 631.
Echinoids: Kier, 1965; Tappan, 1971, p. 1088.
Graptolites: Moore, Lalicker, & Fischer, 1952, p. 726.
Fish-Tetrapod (Crossopterygian-Amphibian) Transition: Colbert, 1969, p. 71-78; Romer, 1966, p. 72-74, 86-88, 90; Romer, 1968, p. 71-72.
Amphibian-Reptile Transition: Colbert, 1969, p. 111-114; Romer, 1966, p. 94-96, 102-103; Romer, 1968, p. 86-87, 96.
Reptiles: Colbert, 1948, p. 153; Colbert, 1965, p. 170-171; Romer, 1968, p. 131, 137, 138.
Reptile-Mammal Transition: Beerbower, 1968, p. 477-480; Colbert, 1969, p. 130-144, 250, 254; Cuffey, 1971a, p. 159; Olson, 1965, p. 40-44, 193-209; Olson, 1971, p. 671-731; Romer, 1966, p. 173-174, 178, 186; Romer, 1968, p. 159, 163-164.
Mammals: Colbert, 1969, p. 368-369, 454, 457; Dunbar and Waage, 1969, p. 464; Lull, 1908, p. 180; Lull, 1940, p. 569, 615; McGrew, 1937, p. 448; Osborn, 1929, p. 759, 831; Scott, 1937, p. 335, 476; Stirton, 1959, p. 48; Thomson, 1925, p. 60.

Furnish, & Schindewolf, 1957, p. L22; Teichert, 1964, p. K325), families (Arkell, Kummel, & Wright, 1957, p. L117-119; Brinkmann, 1937; Easton, 1960, p. 425; Flower, 1941, p. 526; Moore, Lalicker, & Fischer, 1952, p. 351), and genera (Arkell, Kummel, & Wright, 1957, p. L116-118; Brinkmann, 1929; Brouwer, 1967, p. 158; Gimbrede, 1962; Newell, 1942, p. 21, 59; Raup & Stanley, 1971, p. 264).

Evolutionary Implications of Transitional Fossils

Let us consider the implications of an observable sequence of transitional fossils, such as those examples cited above, linking an earlier form (A, in Figure 1) with a later form (I). At a preliminary stage of knowledge, when only the relatively distinct forms A and I are known, it could be thought (as was actually done in the early 1800's) that the earlier form (A) had been instantly created, lived for a time, was then eliminated by some catastrophic environmental event, and after extinction was replaced by special creation of the somewhat similar later form (I). As our knowledge of the paleontologic record begins to increase, we find a third form (such as E, in Figure 1) which is morphologically and chronologically intermediate between A and I. The gap between A and I is thus partly filled and replaced by two narrower gaps, and we must invoke an additional special creation and catastrophic extinction to explain the observed record. Continued collecting uncovers more morphologically and chronologically intermediate specimens (say C and G, and later also B, D, F, and H, in Figure 1); at each step, the new gaps we produce by partly filling existing ones are progressively smaller, and we must invoke ever more instantaneous creations and catastrophic extinctions. It is evident that, when we have accumulated a very large series of transitional fossils grading continuously from A to I (as we often now have in the course of population-oriented paleontologic studies), we must envision a very large number of creations and catastrophes—approaching, in fact, the probable number of reproductive generations involved in the sequence, allowing for the vagaries of the processes of fossilization and study. Invoking progressively more special creations until each generation is interpreted as the result of special creation becomes clearly implausible. Instead, noting that many fossils preserve ordinary reproductive structures, and also that the differences between successive fossil assemblages are of magnitude comparable to those observable between consecutive ancestor-descendent populations in nature today, we are forced to conclude that the entire series represents a chain of reproductive generations, descending one from the other by the usual natural reproductive processes, uninterrupted by any special creative acts from without.

As emphasized above, transitional fossils are known between groups of organisms classified at both low and high taxonomic ranks; i.e., between both low- and high-rank taxa.

Low-rank taxa—the many species known to us—have a real existence in nature, in that they consist of populations or morphologically similar, actually or potentially interbreeding individuals which live during a continuous segment of geologic time. Transitional fossils between morphologically distinct, chronologically successive species require us thus to conclude that a new species results from the operation of natural reproductive processes upon successive generations of a population without the intervention of special creative acts; i.e., through what the scientist terms "evolutionary processes".

On the other hand, higher taxa—those above species-rank, from genera up through phyla—do not have a real existence in nature in quite the same sense that species do. Instead, higher taxa of various ranks are simply the scientist's mental abstractions by which the many species comprising the organic world are grouped according to the various degrees of over-all morphologic similarity displayed. Species which are very similar may be grouped within one genus, while species

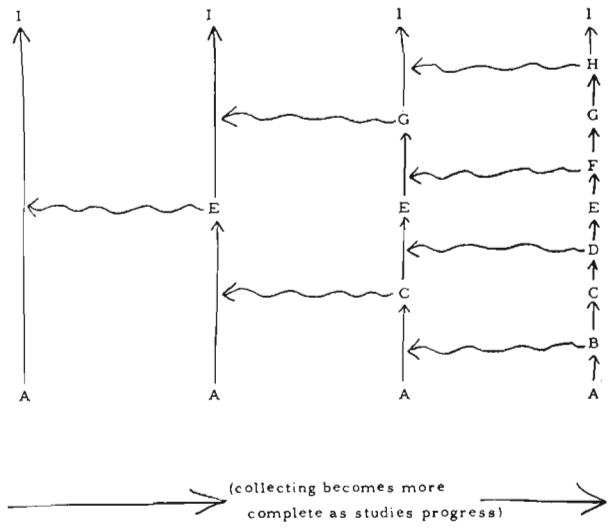

Figure 1. The implications of an observable sequence of transitional fossils, linking an earlier form (A) to a later form (I).

which have only a little in common may be grouped together only in the same class or phylum. Since higher taxa are no more than aggregations of species, transitional fossils between higher taxa indicate simply that, in time, the same natural ancestor-descendent process producing new species eventually produces a chain of successive and progressively more different species, whose final member will be drastically different in morphology from its initial member and will therefore be classified by taxonomists in a different high-rank taxon. Consequently, the practice has developed among modern taxonomists that higher-rank classifications, which are based initially upon observable degrees of morphologic similarity among species, also should reflect evolutionary ancestor-descendent relationships among those species as much as possible. Moreover, it also is apparent that the amount of morphologic change producable by evolutionary processes is essentially unlimited, given the context of vast eons of geologic time.

As a still broader implication of these considerations, we can define "evolution" as the gradual and permanent change in the form and function of adult living organisms, of successive generations, over a long period of geologic time. Paleontologic evidence (discussed here) has played the critical role in developing this concept, but numerous other lines of evidence also suggest it. The interested reader can explore these in other excellent sources (especially Lull, 1940; Olson, 1965; Simpson, 1953), where he also can learn that the process termed "natural selection"—far from being carelessly equated to evolution as some anti-evolutionists assert—is an important part of the *method* by which evolution is accomplished. Moreover, the range in taxonomic ranks over which transitional fossils are observed (as described above) shows that what some anti-evolutionists label "general" and "special" evolution are merely extreme end-members in the scale of a single natural phenomenon, evolution, and thus usually do not warrant separate consideration.

As defined above, evolution is a scientific (rather than, say, philosophical) concept, and so comments about the nature of science are relevant here.

Using actual practice as the basis for definition, we can define "science" simply as the attempt to understand natural phenomena more completely by means of repeatable or verifiable observations of natural phenomena. (This is broader than the rigid, prediction- or experiment-oriented definitions developed by some philosophers not actively engaged in scientific work.) Also, unlike mathematics or logic, science does not deal in formally rigorous certainties, but instead strives for conclusions which are at best highly probable. Failure to understand this has made extensive, philosophically-based discussions—by anti-evolutionists, among others—irrelevant. Moreover, while the search for ultimate or first causes moves into the realm of metaphysics, discussion of possible proximate or intermediate causes which might be implied by observational evidence clearly falls well within the scope of science.

Still further, we need to realize that there is no fundamental difference between what has been termed "historical science" and "empirical science". The scholar can be relatively certain of only what he is experiencing at the present moment, not of what the objects he is examining imply to him about the past. This is as true for the chemist reading his notebook describing yesterday's experiments and for the historian examining ancient Egyptian records, as it is for the paleontologist viewing the fossils and rock strata which form the pages of a natural textbook. None of these three can be rigorously certain that their world was not instantaneously created minutes ago with all its evidences of apparently longer history (Olson, 1965, p. 49); however, for each, his scholarly interpretations about events before the present moment are much more probable than would be purely conjectural imaginings.

Paleontologists studying sequences of transitional fossils are clearly operating in a scientific manner, because their data can be regenerated by anyone willing to examine the earth's crust independently. As more and more such sequences come to light, considering the processes which formed them becomes essential if we are to understand nature more thoroughly (i.e., still within the scope of science). As discussed above, interpreting these sequences as proximately due to evolutionary processes becomes ever more probable (in fact, overwhelmingly so, agree all who have been directly involved with the evidence), while a *fiat*-creationist interpretation becomes ever less likely. Because of the long time spans involved, we will never be rigorously certain that our view is a wholly accurate reflection of natural reality, but the many transitional fossils known render evolution already so highly probable that presentation of it as scientific fact is quite justified. Finally, as is generally true in the development of science, once a concept has been well documented, it can in turn provide a basis for further work; the concept of evolution has done just this most fruitfully for many areas within the earth and life sciences over the past years.

A few remarks are also appropriate about the theological implications of evolution as demonstrated by sequences of transitional fossils. As the reader may have noted, theological considerations do not enter at all into our demonstration of evolution as a very highly probable scientific conclusion. Consequently, like other scientific conclusions, this one cannot be viewed as inherently either pro- or anti-Christian. However, of course, Christians—especially theologians—will need to integrate evolutionary process into their views as being the proximate means which God uses to create various forms of life, just as He uses other scientifically demonstrable processes to maintain the natural universe.

Conclusion

In summary, the paleontologic record displays numerous sequences of transitional fossils, oriented appropriately within the independently derivable geochronologic time framework, and morphologically and chronologically connecting earlier species with later species (often so different that the end-members are classified in different high-rank taxa). These sequences quite overwhelmingly support an evolutionary, rather than a *fiat*-creationist, view of the history of life. Consequently, after carefully considering the implications of the fossil record, we must conclude that that record represents the remains of gradually and continuously evolving, ancestor-descendent lineages, uninterrupted by special creative acts, and producing successive different species which eventually become so divergent from the initial form that they constitute new major kinds of organisms.

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Moore's Critique of Cuffey's Position

Several comments must be made in critique of Cuffey's position paper. Within his very first sentence he contributes to confusion of terminology by presenting the alternative: "development or evolution". This suggestion that development, during the life time of an organism, is interchangeable with supposed evolutionary alteration of one kind of organism into another kind of organism is the very confusion that Louis Agassiz and many others in succeeding decades have urged evolutionists to avoid. Development of an individual organism and general evolution are *not* alternative concepts.

And apparently Cuffey has contented himself with consideration of physical evidence from the geological record only; consequently, he has ignored completely the full range of data utilized initially by Charles Darwin as he developed his persuasively expressed case for imagined changes of species over time. (I assume that Cuffey realizes the cogency of my explication of the sheerly circumstantial nature of physical evidence from those areas covered by Darwin.)

Anyway because Cuffey has chosen to concentrate only on the fossil or paleontological evidence, and has given his greatest attention to so-called "transitional fossils", he has limited my task of criticism.

However, before turning to careful examination of his proffered evidence for so-called "transitional fossils", a significant lack of understanding of scientific methodology on Cuffey's part must be made explicit. He fails to comprehend evidently that all empirical work of geologists is confined to what they are able to study in their lifetime. That is, most of the actual empirical work of geologists involves detection of types of rocks, classification of rock types on or near the earth's surface, and examination of material included in rocks (especially sedimentary rocks), which commonly involves study of inclusions (fossils) *interpreted* as parts of and /or impressions of previous living organisms.

Thus his early use of the term "demonstrated" in his second sentence, and again several times in the Introduction plus many other times in his position paper, is ample indication that he does not understand that geologists cannot *demonstrate empirically* anything regarding organic evolution which is supposed to have occurred over time. Geologists can only *interpret* what they find as empirical scientists, as far as the unrepeatable past is concerned, and this fact would seem to be clearly evident from Cuffey's own words before his last introductory paragraph, i. e., "make evolutionary interprepretations ultimately inescapable". Of course his evolutionary *interpretations* are *not* ultimately inescapable.

Hence, in his zeal to present his case for "transitional fossils", as forcefully as he feels he can, Cuffey fails to realize that all conclusions that he offers about "sequences" or "succession" or "series" are plainly *reconstructions* and *extrapolations* of what geologists want to interpret about material found in rocks, *after* they have first accepted evolutionary thinking as a frame of reference. In writing to numerous other geologists about these concepts, I find that they rather reluctantly admit this point; they come to realize belatedly that the fossil record in no way is sufficient and necessary to establish genetic connections between different kinds of organisms. Absolutely no known genetic lineage is established from any paleontological study, no matter how lengthy the study of the rocks or of the literature about the rocks.

This brings us face to face with another significant shortcoming of the position taken by Cuffey. He does not define "evolution" in his introductory remarks and, when he finally gives attention to such an important point midway in the section before his conclusion, he leaves his readers in utter confusion. Cuffey then defines "evolution" in reference to changes in adult forms through successive generations. Clearly ambiguous, he does not tell his readers that he is only addressing his entire line of discourse *basically* to changes within limits of a kind of organism where generation after generation of the same kind of organism could be extrapolated from the fossil data.

He evidently tries to avoid this restriction on his presentation by referring to "general" and "special" evolution as extremes "in the scale of a single natural phenomenon, evolution, . . ." . But neither he nor any other geologist can show *empirically* that the fossils they find are part of any "natural phenomenon", as far as illustrating any genetic lineage of one kind of organism with another kind of organism.

His attention to supposed "transitional fossils" is where Cuffey becomes involved in a blatant ambiguity. He clearly illustrates this fact in his use of Tables 1 through 5.

All the physical data cited per references included in Table 1 relate solely to supposed changes of "species within the same higher taxon (genus)". So in what way can Cuffey think that these data are at all relevant to the question of explaining change of one kind of organism into another kind of organism? And the same question can be asked with respect to Table 3 wherein he has cited referential materials again of "species within the same higher taxon (genus)".

It may be true that paleontologists have interpreted some fossil evidence to involve changes of species *within* those kinds of organisms he lists, i.e., angiosperms, foraminiferans, brachiopods, gastropods, pelecypods trilobites, and mammals, as far as groups common to both Tables 1 and 3 are concerned. Nevertheless, paleontologists evidently had no difficulty in recognizing these kinds of organisms as *kinds*, and had no basic difficulty in separating the species of one kind of organism from species of another kind of organism.

Thus Table 1 and Table 3 are totally irrelevant to any discussion of supposed changes of one kind of organism into another kind of organism, which is precisely the fundamental meaning of organic evolution, as I have made pointedly specific by affording clear and unambiguous definitions of "general evolution" versus "special evolution". The evident confusion of the terms with which Cuffey seems to be satisfied is quite clear in his fourth section when he refers to "evolutionary variations within species". To juxtapose "evolutionary" and "variation" in this manner partakes explicitly of confusion between supposed changes *across* limits of kinds of organisms (general evolution) and those changes *within* limits of kinds of organisms (genetic variation, or microevolution, if that is what Cuffey means), which can be successfully studied in proper empirical fashion by geneticists.

But to return to Table 2, and then give attention to Tables 4 and 5, which Cuffey refers to at some length in his section on "examples" of so-called "transitional fossils". I again write "so-called" because his referential citations, when checked out carefully, do not afford any evidence of change of one kind of organism into another kind of organism, which is exactly the degree of change to which Cuffey and any paleontologist must address himself, if purporting to supply physical "evidence" for organic evolution, and not just limited changes *within* boundaries of kind. Space limitations prevent complete, item by item analysis, but I will give attention to several representative groups included in these tables.

For instance, in Table 2, Cuffey cites five sources of information about hominid species gradation supposedly "crossing from one higher taxon into another". Accepting the clear fact that a "taxon" is essentially whatever a group of specialists say it is, then I must point out that proposals about hominid relationships by Coon, Howells, Kummel, Le Gros Clark, or Uzzell and Pilbeam are sheerly conjectural and speculative because their work is totally devoid of establishment of any direct genetic lineage. These men have concentrated on *reasoned extrapolations* from the fossil data, and have offered their speculations about supposed hominid

changes *after* they have first accepted the thesis of general evolution as I have defined it. And the same comment holds for the speculations of E. C. Olson with respect to supposed reptile to mammal transition included in Table 4.

But most attention should be given to Table 5 because of referential citations pertaining to three supposed vertebrate transitions: a) fish-tetrapod (Crossopterygian-amphibian), b) amphibian-reptile, and c) reptile-mammal (also included in Table 4). (Discussion of supposed vertebrate transitions are always favored by evolutionists.) Here Cuffey, like most other paleontologists, claims that amphibians have "evolved" from fish. However, no one has ever found a single transitional form showing part fins and part feet, though these changes would have involved conceivably a vast multitude of transitional forms.

A certain fish, known as a crossopterygian, is supposed to have "envolved" into a labyrinthodont. Noteworthy is the fact that paleontologists reconstruct the crossopterygian as a fish, equipped with fins, which certainly did not resemble a four-footed animal. The labyrinthodont, on the other hand, had four feet and legs according to paleontological reconstruction, and was obviously an amphibian. No one would confuse it with a fish.

But no one has ever found a single transitional form between them! The *only reasonable scientific conclusion* seems to be that these transitional forms are not found because they never existed.

Paleontologists have supposed that a reptile "evolved" into a bird. Such transition should be traced easily in the fossil record, since forelimbs of the reptile must have changed slowly and gradually into wings of the bird, and reptilian scales must have changed slowly also into feathers. However, no one has ever found a single fossil either with half-way forelimbs and half-way wings, or with half-way scales and half-way feathers. Nor has any other stage between reptile and bird ever been found.

Of course, Cuffey refers to *Archeopteryx* as one of the "most famous and spectacular transitional fossils known", as is so customary with most paleontologists. However, other evolutionists deny this claim. It is noteworthy that *Archeopteryx* had claw-like appendages on the leading edge of its wings; and, a species of birds living today, the Hoactzin of South America, has such claw-like appendages. Also *Archeopteryx* had teeth, but other extinct birds, unquestionably 100% birds, had teeth. And though *Archeopteryx*, unlike all other birds, had vertebrae extending out along the tail, nevertheless *Archeopteryx* had 100% wings and 100% feathers. Thus it is safe to conclude that *Archeopteryx* was a bird.

Archeopteryx was no more a transitional form between reptile and bird than the bat is between mammal and bird. An authority on birds has stated: "The origin of birds is largely a matter of *deduction*. There is *no fossil* of the stages through which the remarkable change from reptile to bird was achieved." (Marshall, A.J., Editor. 1960. Biology and comparative physiology of birds. New York: Academic Press, p. 1) (Emphases added) Now this evolutionist did not say that there are only a few fossils at this supposed transitional stage, but he said there are *no* fossils.

And speaking of bats, I would call attention to the cover photograph of *Science*, December 9, 1966, showing a reconstruction of the bones of what is claimed to be the oldest known bat, and also call attention to comment in the related article that *no fossil related to a bat had ever been found* in the same rocks, or any older rocks than the claimed age of 50 million years for the bat bones. Pictured there was the oldest known bat and it was recognized clearly as 100% bat, the only mammal that flies, which supposedly "evolved" the power of flight over vast lengths of time. Yet no one has ever been able to find a single fossil to document this claim.

With reference to supposed transitional forms, the ability to fly supposedly has "evolved" separately in four different kinds of animals—the insects, flying reptiles (pterosaurs), birds, and bats. If general evolution has really happened, surely we must be able to find some physical evidence in the fossil record, in at least one or two of these cases. But *no* evidence can be found for the imagined evolutionary origin of the ability to fly.

Paleontologist Olson has admitted that as far as flight is concerned there are some very big gaps in the record (The evolution of life, 1966. New York: The New American Library, p. 180). He holds that there is almost no information about the history of the origin of flight in insects. He stated that there is absolutely no sign of intermediate stages for the pterosaurs, or flying reptiles. And referring to the alleged reptile-like features of *Archeopteryx*, he had to admit that *Archeopteryx* was definitely a bird with no evidence of presumed evolutionary ancestors. Finally he stated that the first evidence of flight in mammals is in *fully developed bats*. Therefore, the fossil record is *devoid* of any physical evidence for any imagined evolutionary origin of flight. There are *no* transitional forms! (See also Gish, Duane T. 1972. Evolution: the fossils say *no!* San Diego: Institute for Creation Research, 2716 Madison Avenue.)

A further indication of Cuffey's inclination toward lack of precision in definition of terms he uses, beyond his perpetrated confusion re the term "evolution", is found after his definition of "science" in his words, "there is no fundamental difference between what has been termed 'historical science' and 'empirical science' ". This is completely false. He is confused when he compares the chemist, who actually wrote the notebook he later reads, and the work of the paleontologist, who never has seen the rocks formed or the fossils made that he purports to interpret as bases for general evolution.

Even examination of ancient Egyptian records ranks in a separate category from the "paleontologist viewing the fossils and rock strata", because the former are the products of human effort wherein some Egyptian reported what was actually seen or known on a first-person basis. The paleontologist has *no* such first-person experience with rocks or fossils. Contrary to assertions by Cuffey, "interpretations about events before the present moment", i.e., formation of rock strata and fossilization of organisms, are *nothing more than* "purely conjectural imaginings", to use his own words.

Evidently Cuffey has been weaving *imagined narratives* about fossils and rock strata for so long, as have most paleontologists ever since Charles Lyell, a lawyer, made the practice acceptable to the intelligentsia, that Cuffey and his colleagues have not come to realize, in any explicit manner, the fact that the whole field of

"historical" geology involves a maze of imaginative, speculative narratives as extensive *extrapolations* into the past. Indisputably, paleontologists are *limited only* to observational work with rocks, strata, impressions, and inclusions, and such observational work is the extent of their actual *empirical* scientific work. They *cannot repeat* events involving such objects. They *cannot be scientific* by trustworthy, testable, repeatable methods beyond straight forward observation of rocks, strata, impressions, and inclusions. Therefore, *all* their thoughts about supposed transitional forms, and about imagined past events, are of no value other than as imagined formulations based on *circumstantially* arranged objects.

When evolutionists, and others probably including Cuffey, refer to such forms as *Peripatus* and *Neopilina* as possible transitional forms, or to *Jamoytius, Archeopteryx, Seymouria,* and *Tupaia,* as intermediate or linking forms, they merely count on circumstantial similarities which are proposed by the paleontologists *in their opinion* as evidence to support general evolution. But opinion and speculative, circumstantial interpretations are exactly what the empirical scientist seeks to *avoid* in *preference* to conclusive genetic evidence.

The only true transitional form that could be accepted, it seems to me, is that form demonstrated empirically, conclusively as genetically connected to two major kinds of organisms. Such conclusive evidence would be obtainable only through cross breeding experiments subject to repeatable observations.

Hence, nothing is gained, from all of Cuffey's careful compilation of referential citations, that counts as physical evidence for imagined general evolutionary changes of the degree that might have involved changes from one type, form, or kind of organism into another type, form, or kind of organism. He has provided *only* data regarding changes supposedly within kinds which are essentially to be considered as no more than genetic variational changes. Basically, *all* of his referential citations relate to physical evidence that can be utilized better to support the concept of "fixity of kinds". He has failed to provide any true transitional forms between or across kinds of organisms.

C. Age Problems

Introduction

During the 19th century it became increasingly evident that the earth was of much greater age than previously thought. Instead of a history measured in thousands of years, it was seen that units of millions or even billions of years were more appropriate. Initially, the ages assigned were merely relative. With the advent of radioactive dating methods in this century, absolute ages were determined.

Some "Creationists" currently insist that proper interpretation of the biblical record requires a "young earth" (recent creation). This viewpoint forces them to discount or reinterpret any scientific evidence for an ancient earth. Their arguments have so focussed on the alleged unreliability of the radioactive dating method that it is discredited in the eyes of many Christian laymen.

The two articles that follow stress evidence for an ancient earth based on non-radioactive determinations. It is important to note that these are independent of each other, but all point to a much greater age of the earth than "recent creationists" are willing to admit. The cumulative force of such independent age determinations should be evident.

Prof. Wonderly was formerly Head of the Biology Department at Grace College, Winona Lake, Indiana. He briefly reviews eighteen different geological phenomena which indicate a great age for the earth. Extensive references will allow interested readers to consult original articles describing these phenomena in detail.

Dr. Phillips has had training in both theology and astrophysics. His article draws from the latter field to show that the rate of accumulation of meteoritic dust on the earth is inconsistent with a "young earth." Recent lunar measurements are cited as further confirmation of this argument.

Non-Radiometric Data Relevant to the Question of Age

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Within the past twenty years several useful types of age-indicating data have become available. An abundance of objective research reports on these subjects can now be easily found in scientific journals and other publications. It is time for creationists to begin to make far more use of such reports than we have in the past. We have often failed to realize that these are very helpful in making estimates of the earth's age. The record of God's work in nature is far more complete, informative, and worthy of consideration than we have usually thought.

It is our purpose here to list some of the specific types of data available, giving a few selected bibliographic references for each type. These sources have been carefully chosen with a view to their being sufficient to serve as at least a "starter" for anyone wishing to pursue a given subject. Most of the sources themselves also have good bibliographies, which will readily enable any interested person to locate numerous additional articles on the subject. An effort has been made to choose those articles and monographs which consist primarily of the objective results of research rather than of theory. However, in the references in which evolutionary theory may appear, the presence of some theoretical material need not obscure the facts which were obtained in the research. The reader should keep in mind that long periods of time do not necessarily imply evolutionary development, and that all of the types of data which are listed below appear to be in keeping with the historical account of creation that we find in Genesis 1 and 2.

Most of the bibliographic entries are available at the geology library of practically any large university. Other materials can be obtained from the geological societies of major oil producing states, and by means of interlibrary loan. The addresses of most of the geological societies are found in a special Directory section near the back of each issue of the *American Association of Petroleum Geologists Bulletin*. Many of the sources can be used and understood without an extensive background in geology. This paper is basically a *listing* of types of data, rather than a composite monograph. There is a separate bibliography for each section. The reader will thus be able to consider any one subject separately, and locate the bibliographic references for that subject easily.

Carbonate Deposits

Drilling records from the sedimentary carbonate deposits of the Great Bahama Bank, off the coast of Florida. This is a multilayered deposit of various forms of limestone and dolomite somewhat in excess of 14,500 feet in thickness. In the deeper parts, dolomites alternate with limestones, with evidence of erosion between four major cycles of deposition. Identifiable fossils were found to a depth of at least 10,600 ft. Alternations between limestone and dolomites in this and similar formations indicate at least a corresponding number of changes of environment during deposition and during the process of dolomite formation. (See below on dolomite formation and on limestone formation.) Also, the unconformities, at the levels where erosion is revealed, must represent significant amounts of time.[1]

Ooids

The distribution and rates of formation of the small, spheroidal bodies known as ooids, oolites, or ooliths. (The term oolite is more properly used of rocks containing the individual ooids.) Most ooids are concentrically laminated, around a core of extraneous material such as a grain of sand, a small shell fragment, or a recrystallized fecal pellet. This process of adding concrete layers (which can be readily observed with a microscope) is accomplished by a slow accretion of mineral which is extracted from the sea water on the beach where the ooids are being formed. The present-day formation of carbonate ooids is observable on numerous shores where shallow water carbonate deposition is taking place. Oolitic limestone, with ooids of various types, appears at numerous levels in the Great Bahama Bank and in many other carbonate deposits.[2]

Sediments

The similarities between the order of deposition of

present-day marine sediments, and the order found in deep subsurface sedimentary deposits in oil fields. These similiarities are now being used by oil research geologists for understanding and predicting the arrangement of older deposits deep in the earth. This research also deals with paleoecological topics, such as the faunal associations and ecological succession found in ancient strata, and compares them to modern faunal associations observed in shallow-water depositional environments. Even though we cannot accept all the tenets of uniformitarianism, the close similarities between modern marine carbonate deposition and these ancient deposits demand that we recognize slow, natural deposition as accounting for many thick carbonate deposits in the oil fields.[3]

Oceanic Sedimentation

The thickness and arrangement of the layers of carbonate and siliceous skeletal remains found on the ocean floor, formed by the accumulation of the shells of Foraminifera, Radiolaria, and other planktonic organisms. A comparision of the thicknesses of such deposits with current rates of deposition of these skeletons in parts of the ocean floor where there is no evidence of rapid deposition or recent disturbance is meaningful. Of special significance are the pelagic sediments found in isolated parts of the ocean, such as on the tops of certain seamounts and abyssal hills, which are far enough from land masses that the rate of deposition is not appreciably affected by currents bringing sediments from those land masses.[4]

Plant and Invertebrate Skeletons

Present-day burial and fossilization of calcareous plant and invertebrate animal skeletons in marine coastal environments, on the sea floor, and in the subsurface of modern reefs. It has sometimes been said that processes of fossilization are not occurring today, but recent studies of marine coastal environments have revealed numerous cases of the current formation of fossils.[5]

Dolomite Formation

The rate of dolomite formation in modern marine environments, combined with a study of ancient formations which exhibit alternating dolomite (dolostone) and calcium carbonate (limestone) strata. In recent years the process of natural dolomite production has been observed and studied in several marine environments which have the proper conditions for the necessary magnesium ions to be extracted from the sea water and deposited. There are many lines of very strong evidence indicating that practically all dolomites—both ancient and modern—are formed by a process of replacement of calcium carbonate particles in lime sediment or limerock. In order for dolomitization of such sediment or rock to occur there must be a ratio of Mg and Ca ions in the water which will favor the formation of dolomite, and there must be an extensive circulation of the water over the sediment or through pores in the rock. Because dolomization proceeds by ion exchange it is of necessity a slow process, and can not occur to any appreciable degree without extensive circulation of water.[6]

Deposits of Evaporites

Multilayered deposits of the (water soluble) evaporites anhydrite and salt, which often not only alternate with each other, but also alternate with (relatively insoluble) calcium carbonate layers. The Castile Formation of west Texas and southeastern New Mexico is one such deposit, the thickness being in excess of 2,000 feet in some places, including approximately 200,000 calcium carbonate-anhydrite "couplet" layers. The nature of these thin layers of anhydrite and of calcium carbonate definitely shows that they were deposited by precipitation. It should be remembered that these two substances do not precipitate at the same degree of concentration of the sea water. Calcium carbonate begins to precipitate when the sea water has been evaporated to about half the original volume, but the precipitation of anhydrite does not begin until a volume of about 19% has been reached.

Thus it is evident that a major change in the concentration of the sea water took place 200,000 times, with the concentration coming back each time to at least very near the same value. Furthermore, each of the precipitation events had to be accompanied by quiet water, for allowing the mineral to settle to the bottom to form the thin, uniform layer that it did. (The areal extent of these layers is many miles, with almost uniform thickness of any given layer maintained over at least a distance of 18 miles.) These are processes which required very considerable amounts of time.

Another very significant evaporite formation which shows conclusive evidence that it was formed slowly is that found in the Mediterranean Sea. Beneath the Sea floor in several areas core drillings have revealed repeating layers of fossil-bearing oceanic sediments interbedded with evaporite layers, showing that the Mediterranean dried up numerous times. Also, in the Balearic abyssal plain, west of Corsica and Sardinia, a "bulls-eye pattern" of evaporite deposition was found. In this deposit, layers of $CaCo_3$, $CaSO_4$, and NaCl were found *in the normal order* of precipitation when evaporation of sea water occurs. There is good evidence that this evaporite deposit is a few thousand feet in thickness.[7]

Deposits of Sandstone and Shale

Multilayered deposits of sandstone and shale. An example is found in the Haymond Formation in the Marathon region of Texas. There are approximately 15,000 thin sandstone layers alternating with approximately the same number of contrasting shale layers in this formation. The study of such a deposit requires that we carefully consider the length of time required for the clay particles, which formed each layer of shale, to settle out of suspension. The clay particles which form uniform layers such as this are extremely small, thus settling slowly, and only when a minimum of turbulence exists.[8]

Modern Coral Reefs

The thicknesses of modern coral reefs, as related to the growth rates of reef-forming organisms. The thickest deposit of this kind measured to date is that of the Eniwetok atoll, where the test drill penetrated 4,610 ft. of coral deposit in order to reach the volcanic seamount on which the reef was built. A study of such

deposits in the light of present-day coral growth rates cannot produce an exact chronology of the past, but will nevertheless be very meaningful. This is because of our recognition of the stability of God's natural laws, including the laws of nutrition, respiration, and secretion in living organisms. According to detailed and extensive studies by A. G. Mayor (1924) on the growth rates of various genera of corals in the Samoan Islands (in a tropical area where conditions are most favorable for rapid growth), the fastest rate of upward growth of the reef surfaces was only about 8 mm per year.[9]

The record of God's work in nature is far more complete, informative and worthy of consideration than we have usually thought.

Ancient Coral Reefs

Ancient coral reefs, such as the atolls found in the oil fields of Canada, together with the extensive deposits of evaporites and other minerals which frequently cover them. This is a geographic area where the process of comparing modern reefs and other modern carbonate deposits with the ancient has yielded spectacular results in predicting the best drilling sites (cf. reference 3). Some of the atoll reefs in the Rainbow Lake area of Alberta, Canada, are 800 ft. in thickness at the rim, and are strikingly similar to the crescent-atolls of the present-day Great Barrier Reef of Australia. The Rainbow Lake reefs contain abundant massive growths of colonial corals *in situ*, as well as crinoids, stromatoporoids, brachiopods, and gastropods. Thus, these were genuine, wave-resistant reefs which grew in ancient times, when most of central North America was covered by relatively shallow ocean waters. The multiple layers of evaporites and other thick mineral deposits which cover these reefs give witness of the long periods of time since that geological period (the Devonian).[10]

Coral Growth Bands

The growth bands exhibited by ancient and modern corals and mollusks, which appear to be an accurate indicator of the daily growth rates of these organisms, as well as of the number of days in the year at the time when the animal was living. It has been known since the beginning of this century that the corallites of some kinds of modern corals possess annual growth bands. Now, within the last decade, it has been learned that these corals possess two lesser orders of growth bands or ridges between the annual rings, the one marking the growth increments of synodical, lunar months, the other the increments of daily growth. When certain fossil corals from the deeper strata, e.g., from Devonian rocks of New York and Ontario, are examined, they are found to show growth bands very similar to those of modern corals, except that the number is approximately 400 instead of 365, apparently indicating that these corals lived at a time far enough back that there were 400 days in the year, and consequently slightly less than 22 hours in the day. (The calculations of astronomers have shown clearly that the rate of rotation of the earth is decreasing, but that the period of the earth's revolution around the sun has been essentially constant. Thus, in earlier times, though the absolute length of the year was the same as now, the earth's rotation was more rapid, making the days shorter, and also affecting the number of lunar—and tidal—months in a year.) The growth rings on the Devonian corals thus show that they lived and grew at a very early date; and the size of the rings shows that the growth rates of these corals were not very different from the growth rates of modern corals. The growth bands which have been observed on certain ancient bivalve mollusk shells are in essential agreement with the findings in corals.[11]

Organic Banks

Various types of ancient carbonate organic banks, and cyclic deposits which include layers of definite, identifiable fossils. The larger of these banks are usually spoken of as reefs in geologic literature. Examples are the famous "Horseshoe atoll" (or Scurry reef) of west Texas, the numerous Silurian reefs of Indiana, and the Capitan reef of west Texas and New Mexico. Organic banks which are moundlike in shape and enclosed in rock of a contrasting type, are usually called bioherms, though the terms reef and bioherm are often applicable to the same structure.

Some of these organic banks are very large, lie at great depths, and are components of extensive, local stratigraphic columns. For example, the Capitan reef is 350 miles long, and 2,000 ft. thick in places; and the eastern half of it lies in a large oil field, at a depth of some thousands of feet. Numerous alternating layers (cyclic deposits) of evaporites make up an extensive part of the formations which cover it. This reef has numerous bryozoan colonies and other fossils still in growth position (*in situ*). Beneath the Capitan reef there are, in some localities, more than 15,000 feet of sedimentary rock. This rock consists of numerous distinct layers of limestone, dolomite, sandstone, shale, etc., alternating with each other. Most of these deep layers underlying the reef possess identifiable fossils.

Often an ancient organic bank will be associated with, or a part of, a group of repeating depositional units called cyclothems. A cyclothem is a series of sedimentary layers which repeats itself in the stratigraphic record in a particular locality. Each cyclothem represents the depositional results of a series of changing environments in the ancient locality involved. The fact that several very similar cyclothems sometimes exist in a local stratigraphic column, and that evaporite layers and other environmental indicators frequently make up a part of each cyclothem, is conclusive evidence that these are naturally formed series representing rather large units of time. It is also significant that cyclothems contain sub-cycles.

Calcareous algal, limestone banks and mounds are often found lying deep in the strata of oil fields. These are of course a type of organic bank, having been produced by calcium-secreting algae which are similar to the many species of calcareous algae which we have today. The fossilized remains of the algae in these banks give every evidence of being *in situ*, and of having accumulated in a manner similar to the formation of algal deposits in modern tropical marine environments.

Recent extensive research has shed much light on the true nature of limestones such as those found in the organic banks. The study of the various types of organic banks, together with a comparison of the carbonate depositional processes in modern marine environments, has shown that a very high percentage of the limestone deposits of the earth was formed by the gradual accumulations of calcareous animals and plants rather than by inorganic processes. Even though diagenetic change obliterates many of the skeletons of these organisms, sufficient parts usually remain (with some of the substrate material on which they were growing) so that we can be sure, in at least many cases, that they were preserved either at or near the place where they grew. Since most limerocks have large amounts of microscopically identifiable particles, it has been observed that the layers of major limestone deposits are usually composed of normal assemblages of grains and other characteristic particles. These are frequently very similar to the assemblages found in modern carbonate rock-forming environments such as those of the Caribbean area and other parts of the world.

Often the fossils found so abundantly in a given bed of limestone make up a typical marine faunal and floral community, and a significant percentage of the delicately articulated skeletons will be intact, showing that they were not transported any long distance. Also, the lack of signs of abrasion of certain carbonate grains, such as fecal pellets, in the rock, and the lack of size sorting of the various types of grains are further evidence that the limestone was formed *in situ* without extensive transport of the materials of which it is composed. One of the most spectacular examples of evidence for the *in situ* formation of limestones, as a result of the growth of organisms, is the rounded, laminated masses of limestone which are called stromatolites. Extensive study of very similar structures being formed today in some carbonate depositional environments has made possible a detailed analysis of the ancient stromatolites. (Each stromatolite is formed by a large mass of algae growing in the water, and collecting layers of carbonate grains on its gelatinous surface as the water sweeps over it.)

The presence of layers of shale between the layers of limestone in many formations has usually aided in the preservation of the skeletal material, and in the identification of the environments in which the limestone layers were accumulated.[12]

Stratigraphic Columns

Well logs and drilling cores from oil fields, which provide us with the structure and composition of entire, *local* stratigraphic columns. In the past we have too often neglected to study the deeper parts of the local stratigraphic columns in areas where we have focused attention upon a single geologic formation. There are now available very complete records of the local columns in many geographic areas in the literature of petroleum geology. For example, Hughes (1954) gives the 16,705 ft. column of the Richardson and Bass No. 1 Harrison-Federal well, in the Delaware Basin of southeast New Mexico, as a 167 inch printed column. By devoting one inch to each 100 feet of well core he was able to show the lithology of the entire well in considerable detail. Also included are the generic names of some of the fossils, to a depth of 16,000 ft. Such records as this help make possible a study of both the chemical and physical nature of the contrasting layers in the column, as well as of some of the types of animals and plants present at the times of deposition. The availability of these well logs and drilling cores makes it possible for interested persons to study the geologic record directly, without having to depend on composite columns or abbreviated summaries.[13]

Distribution of Marine Fossils

The unequal distribution of marine fossils in limestone and other formations. An example of this is the abundance of certain kinds of very dense, thick-shelled mollusks of Class Pelecypoda in the upper strata, but an absence of the same types in lower layers. Conversely, some of the less dense animals, e. g., numerous species of arthropods of Class Trilobita, are abundant in lower strata but are not found in upper layers. Recent electron microscope studies of the chitin of trilobite skeletons give evidence for a low density for these animals. Similarly, many species of the cephalopods, of Phylum Mollusca, though very buoyant due to the air chambers of their shells, are found only in the deeper strata of the earth, indicating that they were buried before the formation of the Mesozoic and Cenozoic strata, and that they became extinct before the Mesozoic and Cenozoic strata were laid down. Thus, the unequal distribution of marine fossils is another indication of the long history which these organisms have, and the theory of some of the proponents of "flood geology" which says that the unequal distribution is largely due to densities is shown to be erroneous.

Even the very fact that many types of fossils are abundant in only a small percent of the stratigraphic column in a given locality, but not found at all in other parts of that column, should be a cause for much serious study. In such columns a great many species which are present at the lower levels are not present in the upper strata at that site, nor in the corresponding strata at other sites. The prevalence of this condition calls for recognition of a long period of time for the formation of the larger (thicker and more extensive) stratigraphic columns.[14]

Forest Deposits

The multiple forest deposits in Yellowstone National Park. The data collected during the study made by Dorf and his associates, concerning the numerous types of fossil vegetation and preserved foliage in the strata of Specimen Ridge and Amethyst Mountain, have apparently not been used to any extent by creationist writers. Whitcomb and Morris have tried to explain these forest deposits by saying the trees were floated into place during the Flood, forming a semblance of successive forests preserved in volcanic ash. The work of Dorf makes this theory completely unacceptable.[15]

Sea-Floor Spreading

The present and past rates of sea-floor spreading as exhibited in the oceanic ridges, and the thicknesses of pelagic sediments which lie upon the ocean floor at

various distances from the present mid-line of the ridges. The present rate of sea-floor spreading along the Mid-Atlantic ridge is estimated to be only a few centimeters per year. The fact that the sediments are thin near the center line of the ridge, and become gradually thicker farther away from the ridge, on each side, is an indication that the spreading has been practically continuous and gradual for a long period of time. Also, the linear strips of igneous rock which lie to the west of the ridge are practically identical to the linear strips extending along the east side. Thus, one side forms a "mirror image" of the other, with respect to the chemical and magnetic nature of the parallel trends of igneous rock. This gives us much reason to believe that each pair of corresponding strips was formed at approximately the same time, from the same mass of magna along the ridge, and that the slow spreading of the floor at the rift has resulted in their now being widely separated. The above mentioned symmetry along the Mid-Atlantic ridge has been carefully mapped, and the two sides correlated for a distance of about 125 miles out from the center of the ridge.[16]

Magnetic Reversals

The geologic records of magnetic reversals in igneous bodies of rock (both on the continents and in the ocean floors), and in sediment cores taken from the ocean floor. A great many extensive rock masses of these types, which exhibit an orderly series of reversals, have been discovered during the past ten years. For example, there is a close agreement between the series of reversals found in ancient lava flows of the Rocky Mountains and those in the Atlantic sea-floor. There are many strong evidences that most of these reversals which are "frozen" into the igneous rocks are separated from one another by at least hundreds of thousands of years.[17]

K-Ar "Clock"

Even though we are presenting here a list of types of non-radiometric data, there is one phase of radiometric dating which should be mentioned, because it has apparently gone unnoticed by a great many creationists.

The discovery that the potassium-argon "clock," in rocks which effectively retain radiogenic Ar^{40}, is restarted whenever the rocks are heated (or reheated) to a temperature of 300° C., or more. Recent writers on this type of dating state that all original argon is lost, when such heating of igneous and metamorphic rocks occurs. Thus when the amount of argon present is measured, only the amount produced in the rocks since they were last heated can be detected. This characteristic is often listed as a disadvantage, because this means that potassium-argon dates can give only the length of time since the rock mass was last cooled to a temperature below 300° C. However, this feature is an advantage for those who are interested in determining how long it has been since igneous or metamorphic rock masses were in a heated condition.

Perhaps we should also mention that Dalrymple, Moore, and others recently discovered that some of the earlier potassium-argon dates obtained for igneous rocks which had been formed in deep water were very incorrect (much too old). Their research showed that whenever lava is erupted into a deep-water environment, the hydrostatic pressure, and the rapid cooling caused by the cold water, causes excess Ar^{40} to be "frozen" into the *outer parts of* the lava mass. Earlier, when this principle was not known, numerous samples of marine volcanic basalt were wrongly dated. However, now that the scientific world has been alerted to this principle, only the potassium-argon dates from continental formations and from samples taken from the interior of submarine masses of rock are considered reliable.[18]

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Meteoritic Influx and the Age of the Earth

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The argument that the rate of meteoritic influx should give a young age for the earth is examined and shown to be fallacious. Recent measurements of influx show that no increase in nickel should result in ocean floor sediments. Lunar measurements of infall rates are consistent with the terrestrial value. Possible explanations which could be proposed by young earth creationists are shown to be inadequate.

Introduction

One of the arguments which has been advanced in favor of a young earth (a few thousand years old) has been the rate of accumulation of meteoritic dust. A measured accretion rate has been used to show that the present rate could not extend over 4.5×10^9 years without adding an enormous amount of nickel to the surface of the earth. Since the additional nickel has not been found, it is concluded that meteoritic material has accreted upon the earth for only a few thousand years.

Statement of the argument

A precise statement of the argument runs as follows:[1,2] In 1957 the Swedish geologist Pettersson[3] estimated that the total influx of meteoritic dust upon the earth's surface was 14.3×10^6 tons/year (3.92×10^4 tons/day). His measurement was made by determining the amount of nickel in airborne dust which had been collected at 11,000 feet near the summit of Mauna Loa, Hawaii, and at 10,000 feet on Mt. Haleakala on the island of Maui.

The component of nickel averaged over all kinds of retrievable material is 2.5 per cent, whereas terrestrial material contains only 0.008 per cent nickel. Assuming that all of the nickel collected by Pettersson upon the mountain tops originated with extra-terrestrial matter, one need only multiply the measured quantity of nickel by 40 to obtain the total amount of dust from meteoritic sources. This comes to 14.3×10^6 tons/year. In five billion years, there would be a layer of dust 54 feet thick upon the surface of the earth if it were undisturbed. Clearly, this has not been the case. Hence, either a crustal mixing process has diluted this dust with enough terrestrial material to bring its concentration down to 0.008 per cent, or the added nickel has been swept into the oceans, thereby greatly increasing the amount of nickel in ocean floor sediments.

Morris and Whitcomb reject the crustal mixing hypothesis:

> For example, the average nickel content of meteorites is of the order of 2.5 percent, whereas nickel constitutes only about 0.008 percent of the rocks of the earth's crust. Thus, about 312 times as much nickel per unit volume occurs in meteorites as in the earth's crust. This means that the 54 ft. thickness of meteorite dust would have to have been dispersed through a crustal thickness of at least 312 x 54 ft., or more than three miles, to yield the present crustal nickel component percentage, even under the impossible assumption that there was no nickel in the crust to begin with! Similar calculations could be made for cobalt and other important constituents of meteorites, all testifying that there simply *cannot* have been meteoric dust falling on the earth at present rates throughout any five billion years of geologic time![1] (p. 380)

Slusher dismisses the possibility that the extra-terrestrial nickel could have been swept into the oceans:

> Nickel, on the other hand, is acutally a rare element in terrestrial rocks and continental sediments and is nearly nonexistent in ocean water and ocean sediments. This seems to indicate a very short age for oceans. Taking the amount of nickel in the ocean water and ocean sediments and using the rate at which nickel is being added to the water from meteoritic material, the length of time of accumulation turns out to be *several thousand years* rather than a few billion years.[2] (p. 56)

Discussion

The above arguments hinge upon the correctness of Pettersson's value for the influx. Actually, many influx measurements have been made. Techniques vary from the use of high altitude rockets with collecting grids to deep-sea core samples. Accretion rates obtained by different methods vary from 10^2 to 10^9 tons/year. Results from identical methods also differ because of the range of sizes of the measured particles.[4,5] One, therefore, looks for methods which strive to measure all of the cosmic material regardless of size.

Terrestrial Influx Measurements

Non-selective terrestrial influx methods center around chemical analysis of various elements in ocean floor sediments. Core samples are taken from the ocean floor and the concentration of various elements is meas-

ured. Quantities which are in excess of terrestrial abundances are assumed to be extraterrestrial. Nickel, iridium and osmium have been used as indicators. These elements indicate infall rates from 8×10^4 (iridium) to 4×10^7 (nickel) tons/year. The 4×10^7 measurement, however, is suspect since it is not clear that the excess nickel was of cosmic origin.[6] Excluding this value leaves a more realistic range for meteoritic infall rates, between 8×10^4 (iridium) tons/year to 3×10^6 (nickel) tons/year.

Even Pettersson feels that his measurement of 14.3×10^6 tons/year is high, and he prefers a figure of 5×10^6 tons, year.[7] This seems to have been overlooked by Whitcomb, Morris and Slusher.

Nevertheless, the iridium and osmium measurements disagree with the nickel measurements for ocean floor sediments. The former indicate an influx of approximately 10^5 tons/year, or a factor of 30 lower than the nickel value. On the other hand, the value from the iridium and osmium measurements are in agreement with determinations of the flux from nickel found in Antarctic ice where the probability of pollution by terrestrial nickel is much less than at other locations.[8]

Since iridium and osmium are ten-times less abundant in the earth's surface than nickel, they are more sensitive indicators of the influx of cosmic matter. It seems to indicate, therefore, that the mean accretion rate is about 10^5 tons/year.

Lunar Influx Measurements

In addition to terrestrial measurements, two lunar measurements have also been made of the influx of cosmic matter.[9,10] The concentrations of a number of trace elements from core samples of the lunar surface reveal an excess of rare-earth elements when compared to their value in lunar rocks. The enrichment of these trace elements on the lunar surface can be accounted for by a 1.5 to 1.9 per cent addition of carbonaceous chondrite-like material. The total addition of this matter corresponds to an influx rate of 2.9×10^{-9} gram per square centimeter per year (gm/cm^2yr) to 3.8×10^{-9} gm/cm^2yr. These values compare favorably with the analogous estimate for the earth. (10^5 tons/year corresponds to 1.2×10^{-8} gm/cm^2yr).

Conclusion

The value for the meteoritic infall rate used by Whitcomb, Morris and Slusher is too large by a factor of 140. The lunar results of Keays *et al* and Ganapathy

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et al indicate that carbonaceous chondrite-like material is the major contributor to the accreted matter. The nickel content of carbonaceous chrondrites is 1.03 per cent, or a factor of 2.5 less than the figure computed from retrievable meteorites.[11] Since the total cosmic infall is 140 times less than Pettersson's value, the depth of crustal mixing required to disperse the excess nickel is $2.5 \times 140 = 350$ times less than the value given by Whitcomb and Morris, or 48 feet! Driving down a highway that has been cut through a small hill will reveal more crustal mixing than this!

The increase of nickel in ocean floor sediments also presents no problem. The total amount of weathered material carried into the oceans by the major rivers of the world has been estimated as 30×10^{15} grams/year, or 3.26×10^{10} tons/year.[12] Since the nickel content of crustal material is 0.008 per cent, 2.6×10^6 tons of terrestrial nickel is carried into the oceans each year. The total amount of extraterrestrial nickel is 10^3 tons/year, which is insignificant when compared to the terrestrial value. Contrary to Slusher's claim, no appreciable increase in the nickel content of the oceans is expected from cosmic matter.

Possible Objections

The rate of infall was determined by assuming a 4.5×10^9 year age for the earth, which is rejected by young earth creationists. They may accept the above value for the total influx of cosmic material, but they may argue that it has been falling at a constant rate for only the past 10,000 years. Such an assumption necessitates an increase in the infall rate by a factor of 4.5×10^5, or 4.5×10^{10} tons/year (1.2×10^8 tons/day).

Direct measurement of airborne particles and lunar micrometeoroid flux, however, give influx values which are five orders of magnitude below this figure.[13,14] Hence, the assumption of a constant influx over such a short period of time must be rejected.

Another possible explanation would be that the entire amount of material was dumped upon the earth and the moon at one time either before or during the Flood. The Flood could then have distributed the cosmic matter throughout the earth's crust and ocean floor sediments.

But this is nothing more than *ad hoc* speculation. If the Flood distributed the iridium and the osmium uniformly throughout the ocean floor sediments, then it should have similarly distributed other elements as well. But this is not the case.

For example, thorium-230 and proactinium-231 are two radioactive elements with similar chemical properties. Thorium-230 has a half-life of 75,000 years and proactinium-231 has a half-life of 34,300 years. Both elements form insoluble phosphates which precipitate in the oceans. Hence, both thorium-230 and proactinium-231 are removed from ocean water and deposited upon the ocean floor.

Now, suppose all of the thorium-230 and the proactinium-231 found in ocean floor sediments had been deposited over the course of one year by the Flood. One should expect either the same concentration of thorium-230 and proactinium-231 throughout all the sedimentary layers; or, one would expect that the insoluble thorium-230 and proactinium-231 phosphates remained suspended in the turbulent Flood waters and were then deposited upon the surface of the ocean floor as the turbulence subsided. In the latter case, one would expect a heavy concentration of thorium-230 and proactinium-231 near the top of the ocean floor covered by a few centimeters of sediment corresponding to the deposition of material since the Flood.

On the other hand, if the thorium-230 and the proactinium-231 have been deposited at a constant rate for a time which is long compared to their half-lives,

then one would expect a logarithmic decrease in the concentration of these elements with increasing sedimentary depth. This is characteristic of radioactive decay. And this is exactly what is found to a depth of ten meters in a Caribbean core![15] A similar analysis for sedimentary depths up to 140 meters using potassium-argon decay also gives the characteristic logarithmic decrease.

Notice that I have not relied upon radioactive techniques for the purpose of establishing the absolute ages of ocean floor sediments. I have shown only that the logarithmic decrease in the concentration of radioactive elements as a function of increasing sedimentary depth argues strongly against rapid deposition of these sediments. Hence, one should reject any attempt to explain either the accumulation of ocean floor sediments or of meteoric material during the time of the Flood.

One concludes that the meteoritic influx argument of Whitcomb, Morris and Slusher is invalid. In fact, it is now up to young earth creationists to explain the accord between the accepted age of the earth and the rate of meteoritic infall.

Acknowledgements

The author wishes to thank Professors Robert C. Newman and Robert J. Dunzweiler at the Biblical School of Theology for their comments and encouragement.

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CONCLUDING REMARKS

You have noted a variety of viewpoints in the articles in this volume. Some writers have sharply disagreed with others. You may be asking, which views are *true?* Unfortunately, the broad problems of Origins and Change addressed here are not amenable to simple true-false answers. Scientists and theologians have grappled with these issues for centuries without reaching a unanimous decision.

The biblical record clearly reveals the omnipotent God as Creator of all things. However, it is remarkably silent as to how and when this was accomplished. Several interpretations of the creation account in Genesis appear equally valid. Likewise, the scientific evidence, although much vaster in scope, is incomplete and subject to varied interpretation. While certain general answers to questions about Origins and Change seem more likely than others, dogmatic insistence on any single viewpoint is out of place.

It appears that we must be content with tentative and partial answers to questions of Origins and Change. Many people are unwilling to live with such uncertainty and tentativeness. They dogmatically insist on final answers now. Jumping to hasty conclusions regarding Origins and Change, however, may be as intellectually and spiritually dangerous as leaping from the Golden Gate Bridge.

In conclusion, the 1500-year old counsel of St. Augustine has considerable contemporary value in relating science and the Scriptures:

> ". . . . . if we find anything in Divine Scripture which may be variously explained without injury to faith we should not rush headlong, by positive assertion, either to one opinion or the other; lest, if perchance the opinion we have adopted should afterwards turn out to be false, our faith should fall with it; and we should be found contending, not so much for the doctrine of the Sacred Scriptures as for our own; endeavoring to make our doctrine to be that of the Scriptures, instead of taking the doctrine of the Scriptures to be ours."[1]

[1]Augustine, *De Genesi ad Litteram,* Lib. i, Cap. xviii, n. 37 (as quoted in Everest, *Modern Science and Christian Faith,* 1948, p. 73).

CONTENTS