

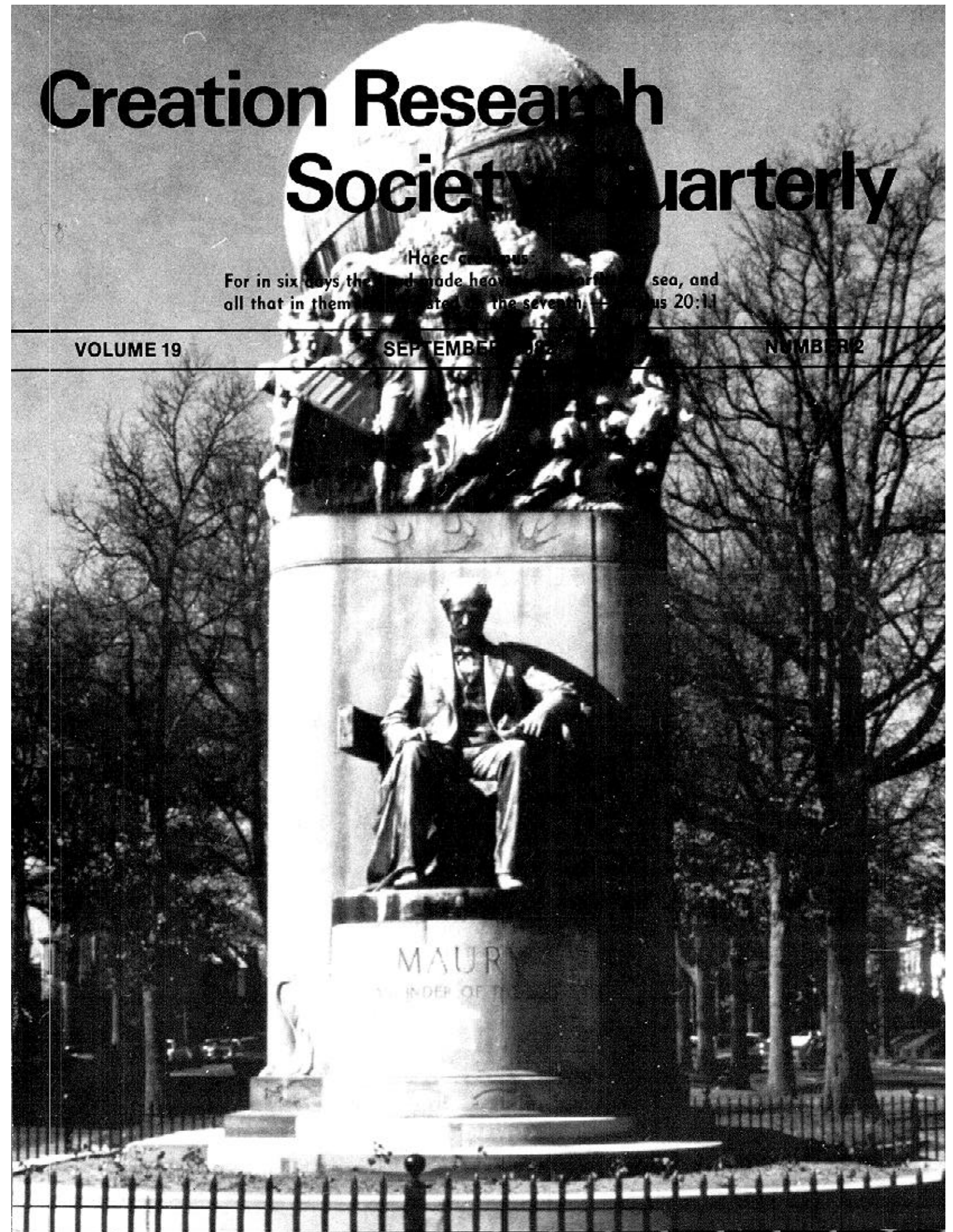
Creation Research Society Quarterly

Haec cuncta creavit
For in six days, the Lord made heaven and earth, the sea, and
all that in them is: and on the seventh day he rested: Genesis 20:11

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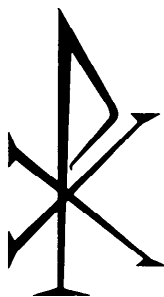


TABLE OF CONTENTS

	Page
Prehistory and the Tower of Babel Everett H. Peterson	87
The Life and Philosophy of Matthew Fontaine Maury, Pathfinder of the Sea John R. Meyer	91
Variation and the Fourth Law of Creation Colin Brown	100
Fossil Succession Glenn R. Morton	103
Darwin, the Unusual One William J. Tinkle	112
Electric Theory of Gravitation Thomas G. Barnes, Harold S. Slusher, G. Russell Akridge, and Francisco S. Ramirez, IV	113
Radiocarbon: Ages in Error Robert E. Lee	117
Panorama of Science	128
Book Reviews (8)	131
Letters to the Editor (7)	140
In Memory of William John Tinkle Walter E. Lammerts	145
Special Notice About Election, 1983	147
Report of the 1982 Board of Directors Meeting Wayne Frair	147
A Brief Statement of the History and Aims of the CRS Wilbert H. Rusch	149

COVER ILLUSTRATION

The picture on the front cover is of the statue of Matthew Fontaine Maury, on Monument Avenue, Richmond, Virginia. This hand-paved street is lined with Confederate statues, and is said to be considered by many the most beautiful boulevard in the South.

Maury was an outstanding scientist in the nineteenth century, and a Christian who did not hesitate to let his Christianity be a guiding factor in his science. An account of his life and work can be found elsewhere in this issue of the *Quarterly*.

This picture was supplied by the Richmond Chamber of Commerce. Dr. John R. Meyer attended to getting it for the *Quarterly*.

PREHISTORY AND THE TOWER OF BABEL

EVERETT H. PETERSON*

Received 8 September, 1981

In the absence of written records, archaeological finds are open to various interpretations. Answers proposed to such questions as "Where was the cradle of civilization?" and "Who built Stonehenge and similar monuments and when?" will depend on one's suppositions. This paper examines Genesis, chapters 10 and 11, and concludes that all people have their roots in Babel; that 100 years after the Flood, approximately 12,000 highly civilized, intelligent, knowledgeable people spread out from there; that they carried with them a religion based on the stars and a compulsion to build monuments.

Introduction

Where was the cradle of civilization? It was previously thought that culture diffused around the earth from a single source. Now various "finds" are leading some prehistorians to abandon that idea in favor of culture arising in various places independent of each other.

Schiller wrote about one recent find in Thailand, dated more than 5000 years ago, which included "a beautifully fashioned bronze socketed spearhead . . . half a millenium older than anyone suspected bronze had been made . . . found where the textbooks said it had no right to be."¹

Another commonly held idea is that human culture evolved slowly from the Palaeolithic hunter and cave-man to the Neolithic farmer to the Bronze and Iron Age societies. In Britain, for example, the Neolithic peoples have been regarded as little more than barbarians. This view has been challenged by some, who after extensive study of megalithic structures such as Stonehenge, conclude that the level of technological expertise and conceptual thinking necessary to produce such works was far beyond that of a primitive neolithic farming culture.

This new view is not universally accepted. Daniel wrote that the new ideas present "extravagant and unconvincing claims" and that those who hold them are "no doubt bored by the prosaic account of megaliths to be got from archaeological research."²

Tyler, however, examines the new ideas, especially in the light of Stonehenge, and concludes that the evidence for them is "strong" and "compelling".³

What is the most reasonable explanation of prehistoric man?

This writer agrees with Tyler when he states, "The quest for explanations should not be placed in abeyance before considering the Biblical information relevant to the cultural achievements of early man and the way men came to inhabit different parts of the earth."⁴ He then presents a picture of a highly civilized, intelligent and knowledgeable people that were spread abroad from Babel to set up similar societies elsewhere.

This paper examines some ideas suggested by Genesis chapters 10 and 11 and suggests how they relate to prehistory.

Population Explosion

Before the Flood, Noah and his family were just eight members of a world population that could easily have numbered over a billion people. Just after the Flood,

Noah and his family became the total world population, a population numbering eight people. Those eight people must have felt a deep sense of being alone and thus had a great longing for children. That they started to fulfill that longing right away is indicated by the fact that the first recorded post-Flood birth was in the year they came out of the ark. (Genesis 11:10)

Several factors would have favored a rapid population growth. According to the table of nations in Genesis 10, large families must have been normal. Sixteen sons are listed for Noah's three sons. As each boy had a wife, Noah's three sons must also have had sixteen daughters for a total of 32 children, or just under 11 per couple. Eleven sons are listed for Caanan and thirteen sons for Joktan. How many daughters they each had is, of course, unknown. From these examples it seems reasonable to suggest that the average family had at least ten children.

A second factor favoring a rapid population increase was longevity. The first recorded death after the Flood was that of Peleg at 339 AF (years after the Flood). Thus it is reasonable to suggest that there were no natural deaths for at least 200 years AF.

Two other reasonable suggestions that would promote population growth are (1) the average marrying age was 14 and (2) the children were spaced two years apart.

In view of the above, what would the population have been in 100 years AF? In 200 years AF?

A yearly population growth chart has been made for years 1-100 AF, based on having three couples to start, each couple having 10 children spaced 2 years apart, the young people marrying at 14, and having their first child at 15. The following are four listings from that chart.

Years AF	Population
60	719
70	1490
85	4225
100	12008

The yearly average population growth from years 60-100 AF was 7.29%. At that yearly rate the population would have been over 13.5 million at 200 AF.

Nimrod

Of Nimrod we are told that "He began to be a mighty one in the earth", and "the beginning of his kingdom was Babel". (Genesis 10:8, 10). Surely this information is telling us that Nimrod was the instigator and the leader of the Tower of Babel project, including the

*Mr. Everett H. Peterson's address is 918 Hummingbird Drive, San Jose, California 95125.

building of the city at the same time. As to how he became the leader, I suggest the following series of events.

Nimrod is listed last of the six sons of Cush, who was the first listed son of Ham. If indeed he was the youngest, including sisters, he perhaps was born around 40 AF. As he grew to manhood, he showed an aptitude for hunting, and eventually excelled at it, over and above all the others. At that time he must also have been pious towards God for it is said that "he was a mighty hunter before Jehovah." (Genesis 10:9) His powers at it earned him the admiration of the people so the people said, "even as Nimrod, the mighty hunter before Jehovah." (Genesis 10:9)

The adulation of the people turned his heart away from God and eventually gave him a strong desire to be the leader of the people. This, of course, would require turning the people away from great-grand-father Noah. Outright rebellion would have been counter-productive, so he waited for an opportune moment. It came, I suggest, one time when Noah gathered the people together and admonished them to follow God's command to spread out and "fill the earth".

Nimrod, knowing that the people really wanted to stay together, suggested the tower building project. The people accepted that idea enthusiastically and exclaimed, "let us make a name for ourselves lest we be scattered on the face of the whole earth." (Genesis 11:4) Thus the people willingly followed Nimrod. His plans called for more than a tower, however. To insure his continued leadership, he had the people build a city of permanent dwellings and he subtly weaned the people away from Noah's God.

The Prophet's Message

Jesus told us that Abel was a prophet. (Luke 11:50, 51) Prophets are special messengers sent by God to the people with His special message. Many times God told his prophets to write the message down and it is now a part of the Bible. In Abel's case, I believe that God had already written His message at Creation in the stars. To Abel He gave the signs of the Zodiac, telling him the name of each constellation and explaining its meaning.⁵ The story in the Zodiac was then Abel's message to the people. Noah knew the message and preached it to the post-Flood people.

I suggest that it was the message in the stars that Nimrod corrupted in order to draw the people away from Noah and Noah's God. In a show of false piety he stationed his own appointed "priests" on top of the continually rising tower to "study the heavens" for the supposed purpose of more fully understanding God's message. But little by little the message was altered and fed to the people until by the time the tower was complete, it was primarily the stars that were being worshipped. In this way, I believe Astrology was born.

The Tower—When?

I suggest that the Tower of Babel was started in 85 AF and the Dispersion occurred in 100 AF. Several considerations lead to such a conclusion.

Nimrod, as we have seen, was the leader of the pro-

ject. If he was born around 40 AF as suggested, it would have been around 60 AF when his power as a hunter was becoming known and his reputation as a "mighty" person would start to grow. In 85 AF, at around 45 years of age, he would be at the peak of his popularity. If the tower had not been started for another 25-50 years, Nimrod's influence would have waned, as others would have risen in popularity.

According to the population chart there were 4225 people living in 85 AF, of which 1490 were over 15 years of age. The group was still small enough to feel a sense of oneness, which held them together. However, if they had not soon been bound together in some unifying project, the rapidly increasing numbers of people would have forced them to split up into groups.

A third consideration is that if the Dispersion was in 100 AF, the project would have had to be started at least by 85 AF in order to get the tower built as well as a city. The people started from nothing. They had to make all their tools for digging, carrying, shaping bricks, etc. They had to build furnaces to fire the brick. All labor was hand labor; there was no machinery. And all this was done while crops were tended and hunting parties were bringing in meat.

The Dispersion date of 100 AF is derived from Genesis 10:25, "The name of the one was Peleg, for in his days the earth was divided." According to the chronology of Genesis 11, Peleg was born in 100 AF. Peleg's father, Eber, was a prophet, for only God could have informed him of what would happen in his son's lifetime. Just before his son's birth he must have informed the people what God had revealed to him.

I believe that the prophecy, to be meaningful, would have to be fulfilled shortly after its proclamation. I also believe that it had a two-fold fulfillment. The first stage was in the year of Peleg's birth when the earth, i.e., the people were divided due to the confusion of tongues which scattered them abroad. The second stage, as written in a previous paper⁶, was 150 years or so later, still within Peleg's lifetime. This occurred when the rising waters due to the second emptying of the Canopy flooded land bridges, thus dividing the earth (i.e., the land masses) with water.

Biblical chronological studies by Bishop Ussher and Ozanne⁷ lead them both to date Creation at 4004 B.C. Based on that figure the dates for the Flood and the Dispersion are then 2348-2347 B.C. and 2248 B.C. respectfully. Courville⁸ has shown that the facts of archaeology do not demand those dates to be earlier.

The Dispersion

A study of the Table of Nations in Genesis 10 reveals some interesting statistics.

Of the 70 names listed, 14 were descendants of Japheth, 30 of Ham and 26 of Shem. Of the Japhethite leaders, 7 were the first generation from the Flood and 7 were second generation. Of the Hamite leaders, there were 4 first generation, 24 second generation, and 2 third generation from the Flood. It is most likely that all the Japhethite and Hamite leaders were all born before 50 AF and thus were all over 50 years of age at the Dispersion.

Of the Shemite leaders, 5 were first generation after the Flood, 5 second generation, 1 third, 2 fourth and 13 fifth generation. Eber, the third generation from Shem, was born in 66 AF. (Genesis 11:14) and his son Peleg in 100 AF. Eber's son Joktan could have been born as early as 81 AF, the first of his 13 sons being born as early as 96 AF. Thus, only 11 Shemite leaders were old enough to lead a group away from Babel in 100 AF. The other 15 Shemite leaders undoubtedly split away from Eber's group in the years following the Dispersion.

Since only 11 Shemite groups left Babel, there was only a total of 55 groups that were dispersed. If the population in 100 AF was 12,008 as suggested, and the groups had equal numbers, there were then 218 people for each leader. The Japhethites numbered 3056, the Hamites 6550, and the Shemites 2402.

At least 15 of the 30 Hamite groups settled in the area from Babylon to Egypt; Nimrod built Babel, Nineveh and surrounding areas (Genesis 10:10-11), Canaan and his 11 sons settled the land of Canaan (Genesis 10:19), Casluhim became the Philistines (Genesis 10:14), and Mizraim settled Egypt (Genesis 10:11).

Apparently the 11 Shemite groups settled in the same general area which, if so, meant that at least 26 of the 55 groups that left Babel settled in the small area which we now call the Middle East. This certainly accounts for the rapid rise of the great civilizations in that area. It also accounts for the Hamites being the first world rulers.

With 26 groups, or just a little less than half of the dispersed people settling in a small area, only 29 groups, or a little over half the people had the rest of the world in which to spread out.

By the year 200 AF each group could have numbered over 245,000 and many would undoubtedly have split up, perhaps several times by then.

Brick vs Stone

"And they had brick for stone." (Genesis 11:3)

This statement tells us that when the builders of the Tower built with brick, they were using a substitute material. God's choice of building material for such a structure is stone. The above quote is significant in the light of Peter's statement about Christ that He "is the Stone which the builders rejected." (I Peter 2:7) He also says that believers are "as living stones . . . being built up into a spiritual house." (I Peter 2:4) God also expressed great displeasure when incense was burned on "altars of brick". (Isaiah 65:3)

In some way God must have informed the people at the same time as He confused their language, that religious monuments should be built with stone. This knowledge they carried with them as they dispersed and resolved to use only stone for future monuments lest they incur further wrath from the Almighty.

After Babel

The Dispersion from Babel was not a haphazard event; it was God-directed. Each group He wanted together received the same language. He put it in the mind of each leader what direction to lead his group

and how far; from Nimrod who kept his group at Babel to those who went halfway around the world and finally settled on a different continent or on an isle of the sea. Each group possessed the same technical knowledge and skills. They all carried with them the desire to build monuments (out of stone this time), and thus to "make a name" for themselves. They also carried with them a common religion, the corrupted version of God's message in the stars which Nimrod had turned into Astrology. This star-worship is what caused them to orient so many of the Megalithic monuments to the heavens.

Berlitz writes at length of present day discoveries of buildings, temples, walls, roads, ports, and cities which are under the waters of the continental shelves of America, primarily in the area of the Bahamas.⁹ Obviously, the sea level was lower at the time of their construction, which time was immediately after the Flood.¹⁰ Thus, the explanation for the existence of these under-water remains is that some of the groups that left Babel crossed the ocean and settled and built their stonework there.

Babel

Several other items of information that need a comment are given in the story of Babel in Genesis 11.

The tower was completed before God intervened. "And Jehovah came down to see the city and the tower which the sons of men had built"; i.e., it was already completed (vs 5). God then scattered the people, "and they quit building the city." (vs 8) If the tower had not been completed, it would have been stated that they left off building the city "and" the tower. Nimrod and his group had a completed tower and the city was already larger than their immediate needs so they quit working on it.

The total human population at the time of the Dispersion was living at Babel. This fact is emphasized three times. It was "there" that "Jehovah confused the language of all the earth". (vs 9) It was from "there" that Jehovah scattered them ". . . over the face of the whole earth." (vs 8) And again it is repeated that it was from "there" that "Jehovah scattered them abroad on the face of the earth." (vs 9)

God did not confuse the language at Babel because the people had refused to spread out over the earth. Rather, it was because if they had been allowed to stay together, "nothing which they have imagined to do will be restrained from them." (vs 6)

Our present knowledge and technology is such that there does not seem to be anything that we can dream of that we cannot find a way to do. There are those who believe that man should be allowed to do whatever he can think of. Others are scared that ability to do such things as tap nuclear forces, or manipulate genes, will have detrimental results or even destroy mankind. The Bible believer, however, takes comfort in the Tower of Babel incident. If God stopped mankind once when he reached the point where "nothing which they have imagined to do will be restrained from them", then surely when man again reaches that point God will again intervene.

Summary

The first eleven chapters of Genesis contain much information which is useful for interpreting prehistory. They tell of a world-wide flood a little over 4300 years ago that destroyed the world and all people except for the eight persons who were saved by the ark. Thus, all that is now classified as prehistoric is *post-Flood*. Except for the eight Flood survivors, all the builders of the Tower of Babel were born after the Flood into a low technological society. Farming and hunting were the chief occupations. Necessary articles such as bows, arrows, spears, knives, tents, clothes, cooking utensils, etc., were hand made.

The eight Flood survivors had lived in a high technological and cultural society which produced metal objects and made engravings and musical instruments. They undoubtedly had taken such objects with them on the ark and passed along the knowledge of such things to the new generations. Thus the people were well qualified to conceive, design and produce things that they had never seen, not only a tower and a city, but the necessary tools and furnaces to fire brick, etc. In fact, it was just that ability to dream and to carry out the dream that caused God to scatter them over the face of the earth.

This then is the type of people that produced the earliest buildings and artifacts which we term prehistoric. As they were all knowledgeable and

capable, it is no wonder that evidence of advanced cultures in various parts of the world should make it appear that they each arose independent of each other. The people that spread out from Babel carried with them a compulsion to build monuments to make a name for themselves (a compulsion mankind has to this day). They also took with them Nimrod's new religion of the stars which is why so many monuments are oriented to the heavens.

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Fossil Succession

(Continued from page 111)

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- ¹⁵Reference 9, p. 276.
- ¹⁶Reference 8, p. 165.
- ¹⁷Reference 9, p. 275.
- ¹⁸*Ibid.*, p. 427.
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- ²⁰*Ibid.*, pp. 273 & 274.
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- ³⁴*Ibid.*
- ³⁵*Ibid.* See also Lull, Richard Swann, 1925. Organic evolution. Macmillan Co., New York. P. 103.
- ³⁶Reference 33, p. 4.
- ³⁷Reference 32, p. 114.
- ³⁸*Ibid.*
- ³⁹Reference 6.
- ⁴⁰Editor's note by Walter E. Lammerts to reference 6.
- ⁴¹Reference 32, p. 110.
- (Editor's Note) Readers may wish to compare the ideas put forward by Hedtke, Randall, 1971. A geo-ecological explanation of the fossil record based upon divine creation. *Creation Research Society Quarterly* 7(4):214-221; and Northrup, Bernard E., 1974. Comments on the Stuart E. Nevins paper (post-flood strata of the John Day County, northeastern Oregon.) *Creation Research Society Quarterly* 10(4):205-207 and 228. I have no doubt that these men all reached their conclusions independently.

VERSES FOR A CREATIONIST UNDER ATTACK

... let him alone, and let him curse, ... it may be ... that the Lord will requite me good for his cursing this day.

—2 Samuel 16:11 & 12.

THE LIFE AND PHILOSOPHY OF MATTHEW FONTAINE MAURY, PATHFINDER OF THE SEA¹

JOHN R. MEYER*

Received 15 December, 1981

Let us now praise famous men, and our fathers that begat us. Ecclesiasticus 44:1.

"There is a river in the ocean: in the severest droughts it never fails, and in the mightiest floods it never overflows; its banks and bottom are of cold water, while its current is of warm; the Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. It is the Gulf Stream. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon, and its volume more than a thousand times greater." From The Physical Geography of the Sea by Matthew Fontaine Maury.²

It is a rather poorly understood fact that many of the founding fathers, of what we know today as modern science, were individuals who believed the natural world was understandable because the Creator endowed it with order and thus evidences the handprint of design.³ The accomplishments and philosophy of Matthew Fontaine Maury "pathfinder of the sea" and "father of modern oceanography" are little known today even in creationist circles. However, in the middle of the last century he was considered by many to be the foremost scientist in North America; and there was hardly a civilized country untouched by his work and reputation.

The purpose of this paper is to document the life and work of Matthew Fontaine Maury, demonstrating that his allegiance to Scripture and his theistic world view were the basis for his outstanding achievement which revolutionized the science of oceanography and meteorology and significantly advanced astronomy.

Early Years

Born of staunch Huguenot ancestry in Spotsylvania County, Virginia, in 1806, Matthew Fontaine Maury was destined to become one of the world's foremost scientists of the last century. Early in life he was taught a deep and abiding respect for the authority of Scripture, a view which was to directly influence his life's work and color his future writing.

Fulfillment of his boyhood dream of following in his brother's footsteps as a Naval officer came true in 1825 when, as an acting midshipman, he was assigned to the new 44-gun frigate *Brandywine* being prepared on the Potomac for her maiden voyage. It was a memorable trip, not only because it was his first, but also because the ship's first assignment was to carry a very famous guest to France—the General Marquis de Lafayette.

This part of the mission completed, the *Brandywine* sailed for Gibraltar to join Commodore Rodger's Squadron, taking advantage of the relative calm of the area to ride out the winter. During this time the midshipmen were supposed to begin formal training as professional naval officers. Of this attempt however, the 19 year old Maury wrote that the teacher "... was well qualified and well disposed to teach navigation, but not having a school room, or authority to assemble the midshipmen, the cruise passed off without the opportunity of organizing his school. From him, therefore, we learned nothing."⁴ It was from disappointing experiences such as this that Maury would later effectively argue for formal training of naval officers on either a teaching ship or a land-based naval school.

The ship returned to New York that spring and early in the fall set sail for South America, rounded Cape Horn, and took up patrol duties from its station at Callao Bay, Peru.⁵ Maury was soon transferred to the *Vincennes* also on patrol in the area. For the next two years his

ship cruised the West Coast of South America. Again, formal training aboard the ship was a total failure, the school master finally being kicked off the ship as a nuisance.

Maury did not let the lost opportunity for formal education deter him from his quest for knowledge. The ship's library had a number of volumes on navigation and he set to work mastering them. For example, even while on duty he took advantage of spare moments to work problems in spherical geometry and often chalked them on the cannon balls stored in racks on the deck, thus considering the solutions as he paced back and forth.

After several years of patrol duty the *Vincennes* was ordered to strike west, visiting a number of small islands (including the Marquesas and Hawaii) on its way to Canton, China. It then sailed into the South China Sea, through the Sunda Straits and into the Indian Ocean on a course designed to bring it around the tip of Africa and thence home to New York. Arriving home on June 8, 1830, the *Vincennes* was the first U.S. sloop of war to circumnavigate the globe.

In 1831 Maury went before the Naval Examination Board to pass on his qualifications to become a warranted midshipman. Several of the candidates had prevailed on Maury to tutor them as they recognized his superior grasp of the theoretical and practical aspects of navigation. These individuals ranked high in the test, but Maury himself stood 27th in a field of 40. The reason was that instead of merely memorizing formulas for navigational problems posed by the mathematics professor on the board, Maury derived the solution using spherical trigonometry which the professor could not follow. In order to save face the professor declared the solution incorrect and a hastily called conference with his colleagues resulted in the board supporting the professor.⁶ The result was that Maury passed the exam, but at such a low level that future promotion in major rank was delayed.

*John R. Meyer, Ph.D., receives mail at 27117 Langside Avenue, Canyon County, California 91351.

Maury's next order from the Navy attached him to the sloop of war *Falmouth* as "acting sailing master." This position placed him second under the ship's commander and gave him direct responsibility for navigation, course steerage, sail trim, as well as a number of other supervisory tasks. Taking his newly assigned position seriously, Maury attempted to find information regarding winds and currents which the ship would encounter in her voyage to the West Coast of South America via Cape Horn. Finding to his amazement that such data did not exist, he determined to keep extensive and accurate observations on the upcoming voyage which might be of use to others. In rounding Cape Horn and encountering the usual furious weather in that vicinity, Maury noted the dramatic instability of the barometer and its uselessness in that region in forecasting approaching storms. Based on these observations he wrote the first scientific paper entitled "On the Navigation of Cape Horn", which was published in the *American Journal of Science and Arts*.⁷ While on duty with the squadron patrolling the Pacific coast of South America, Maury began his initial notes which were to become a textbook, replacing the time-honored, but poorly-written and out-of-date *New American Practical Navigator* by Bowditch,⁸ introduced 30 years before.

Returning to the states in 1834, Maury married Ann Herndon. They made their home in Fredericksburg while he was awaiting further orders for sea duty. At that time it was not uncommon for a Naval officer to spend considerable time ashore between orders—in this case almost 2 years. During this period, with excess time on his hands, he pressed on in writing his book which was published in 1836 as *Treatise on Navigation*.⁹

The book received high praise from many individuals including Alexander Dallas Bache, who was later to become one of his most dedicated opponents. It was also reviewed by Edgar Allen Poe who praised its style saying, "The spirit of literary improvement has been awakened among officers of our navy."¹⁰ By 1844 the book had become so popular and its worth so well established that it almost exclusively replaced Bowditch by order of the Secretary of the Navy.

Returning from a trip to Tennessee to visit his parents in 1839, Maury was riding on top of an overloaded stagecoach just east of Somerset, Ohio. As the stage rumbled along in the night, it encountered a newly built and still soft roadbed. The wheels on one side sank into the soft dirt, throwing the stage to the side. The frightened horses lurched ahead and the stage tipped over, throwing Maury to the ground. The result was a dislocation of the knee joint, a torn patellar ligament, and a fractured femur. It was soon painfully clear that return to sea duty was to be severely delayed, if not altogether forfeited. The anguish this brought to the budding young Naval officer so full of adventure and promise was immense. It was, however, this accident which resulted in his eventual assignment to a land-based position that was to place his name on the lips and charts of nearly every blue-water navigator in the world. It would catapult him to a position of prominence in the scientific world of which he could have scarcely dreamed.

During his convalescence, Maury turned his productive mind to writing an additional 7 articles under the pen name of "Will Watch" as a continuation of his 5 previously-published articles under the pen name of "Harry Bluff". These articles, revealing graft, corruption, and inefficiency within the navy, pressed for naval reform. Published in the popular *Richmond Whig* as a series called "Scraps From the Lucky Bag," they had immediate and wide-spread impact on the naval community, in political circles, and on the public at large.¹¹ The real author of these articles was soon revealed, providing fertile ground for the growth of animosity which was later to be revealed in the acts of the Navy Retiring Board.

In these articles Maury argued for an organized naval academy instead of the haphazard method then in existence for training midshipmen on board vessels using civilian instructors. He suggested that the curriculum should contain courses in chemistry, natural history, astronomy, mathematics, naval architecture, international and maritime law, gunnery, tactics, and languages. Maury's voice was not the only one calling for better training of officers and for general Naval reform, but it was clearly one of the most effective. The Navy has honored Maury as a major contributor to its effectiveness by naming a destroyer (1918) in his honor.¹² In addition, the main academic hall at Annapolis carries his name in recognition of his efforts that became a key factor in the origin of the Naval Academy.¹³ Many other reforms espoused by Maury were put into effect during his lifetime, thus significantly improving the morale of seamen, the efficiency of the navy, and the state of military preparedness of the United States.

The Depot and the Observatory

Prior to 1842 the Navy Depot of Charts and Instruments was a quiet and unimaginative branch of the Navy, relatively unknown even in the U.S. except to the seamen who had direct need of its services. Thus when Maury became its superintendent in July of that year, it served a rather limited function. As a depot its job was to store the log books from every cruise of a U.S. naval ship since the Navy department was instituted. It also distributed charts for navigation—handling primarily those developed by other countries (especially England), as the depot had done little original work in this area even of U.S. shores and harbors. Its final major function was to set the time standard for both the Navy and the country at large. This was done by noting the time of the transit of the sun or stars through the field of its telescope. From this, calculations were made to determine precise time for the standard clock of the observatory; and from that, chronometers on hand were checked. The Depot acted as recipient for all navigational and meteorological instruments, including chronometers, sextants, barometers, and thermometers of navy ships returning from voyages and in turn supplied these items to ships leaving on ocean treks. While under possession of the Depot the instruments were checked for accuracy. For instance, chronometers were not adjusted because of their sensitivity; but their devia-

tion from true time was noted, and this record was delivered along with the chronometer to departing ships. Thus, when Maury was appointed as superintendent, the Depot performed a rather routine function. Within a few short years under his direction, it was to become an institution of world-wide recognition.

Soon after his appointment Maury began to work through the piles of old log books, attempting to extract data that would be of use to navigators. Several minor charts were prepared, but the detailed and extensive charts that were needed could only be obtained by systematic collection of vast amounts of data on standard forms.

The year Maury was appointed head of the Depot, Congress appropriated sufficient funds to build a national observatory. It was completed in 1844 and the question of who should direct it became a hot political issue.¹⁴ Maury was the natural one to head it as it was to incorporate the Depot in its function. Some argued, however, that a national observatory should be headed by a civilian. In the end Maury was chosen and the observatory became a U.S. Naval Observatory. This was another significant opportunity for Maury to advance science, and he soon took advantage of it.

Astronomical and Oceanographic Observations

One of the most famous studies afforded to the observatory was the observation of the return of Biela's comet which had just been reported by European astronomers. He instructed his aides to watch for the comet, which was soon found. A contemporary writer describes the event: "That night of January 13, 1846, he beheld the ominous and inconceivable. On its way toward perihelion, Biela's comet had split in two."¹⁵ This significant observation, establishing the fragile and ephemeral nature of comets, was published under the title "Duplicity of Biela's Comet" in the English *Royal Astronomical Society Monthly*.¹⁶

Also in 1846 the Observatory produced Vol. #1 of *Astronomical Observations*. This was the first major work by an American observatory; and it produced considerable comment not only in the U.S. but also abroad, establishing the institution as equal to those in Europe.¹⁷

The following year the first *Wind and Current Charts* were published. These along with later volumes which were to revolutionize sailing, were published under Maury's directions. As example of their impact, the first ship to follow Maury's instruction on sailing to Rio de Janeiro was able to undertake a round trip voyage in 75 days, rather than the usual 110 days. By 1851, with the California Gold Rush at fever pitch, clipper ships were engaged in extensive commerce between New York and San Francisco by way of Cape Horn. Due to great competition between shipping companies and ship captains, the route was turned into a full-fledged race course; news of their departures and arrivals was a major topic of conversation on both coasts. With the aid of Maury's charts, their average trip time was reduced from 187½ days to 144½ days, and by 1855 to only 136 days. That year the *Flying Cloud*, using Maury's charts, was able to set a world's record for this journey of just a few hours under 90 days.¹⁸

By the end of 1851 over 1000 ships were turning in logbooks to Maury based on the guidelines laid down in his *Abstract Log for Use of American Navigators* in return for his *Wind and Current Charts*.

In a few short years three-fourths of the shipping of the world was carried out by captains using these charts, and they in turn provided more data for future charts. So valuable has been Maury's contribution in charting both ocean currents and winds that even today *Pilot Charts* carry the inscription "Founded upon the researches made in the early part of the nineteenth century by Matthew Fontaine Maury while serving as a lieutenant in the U.S. Navy." Maury thus soon became recognized as the world's foremost authority on ocean currents and marine meteorology.

Since 1840 he had been working on ideas relating to deep sea sounding and recovery of bottom sediments. In 1849 he began supervision of soundings in the Atlantic. Over the next few years he was able to construct the first accurate profile of the Atlantic ocean bottom, covering the 39th parallels between America and Europe. Later studies of the bottom sediments using sampling devices developed in the Observatory allowed him to show that sediments were composed of foraminifera and a few diatoms. The shells showed no sign of abrasion and no sand or gravel was present. Maury thus concluded there were no ocean currents at great depths and noted this would be advantageous for a possible transatlantic cable.

Even as Maury was completing this report to the Secretary of the Navy he received a letter from Cyrus Field asking about the very possibility of a transatlantic cable. Following this, Field consulted with Maury extensively as the project developed. Primary information supplied by Maury related to recommendations about the best time to lay the cable in view of the intense storms often encountered in the North Atlantic, the area of the ocean best suited for the project based on his discovery of the "Telegraphic Plateau", as well as recommendations regarding the nature of the cable itself and the actual laying procedure.

Thus, Maury, along with another Christian man of science, Samuel F.B. Morse,¹⁹ played key roles in the development of the transatlantic cable. I have not had opportunity to research the availability of documentation regarding interaction between these two scientists, but it is interesting to note that Alexander Dallas Bache of the Coast Survey and Joseph Henry, secretary of the Smithsonian, were pitted against both Maury and Morse.²⁰

Francis Leigh Williams provides some tantalizing insights into the attitude of Bache and Henry toward the Observatory and its superintendent.²¹ Apparently they were fearful that the reputation of the Observatory would overshadow their own organizations and remove some of the national spotlight from them. Both Henry and Bache "held belief in their mission to establish a criterion for American scientists and their determination to deny authority to those who did not meet their criterion."²² "Bache . . . conceived a messianic role in American science for himself and his 'elite corps' of friends—an idea shared by Henry."²³ An instructive

sidelight is to note that Bache and Henry played a leading role in forming the National Academy of Sciences with the ultimate purpose that it should act as a "high tribunal" of science which would sit in judgment on others.

The Quest for International Cooperation

As the work of Maury proceeded at the Observatory, it became increasingly clear that there was great need for a system of uniform observations of meteorology and hydrography, producing results to be shared by all nations. To this end he worked toward an international meeting of ten of the major maritime powers. Overcoming monumental obstructions in its formation, Maury finally brought this meeting to pass in Brussels in 1852. Maury was the keynote speaker and clearly the leading figure in the entire international conference, probably a first of its kind. The conference resulted in unanimous agreement on the kinds of observations to be made and how they were to be recorded for processing. Maury returned home from the conference triumphant, having gained international cooperation on a project so dear to his heart. During the next 35 years, over 30,000,000 abstract logs, from many nations, were turned in to the observatory for development and revision of wind and current charts.²⁴

Maury was always a man with a practical bent, believing that laymen could understand science and holding that the results of science should be conveyed to the populace. To this end in 1855 he published his first volume of *Physical Geography of the Sea*.²⁵ It and following editions provided the first popular textbook on marine science and were in print for over 20 years in at least 6 languages.²⁶

Maury had long promoted the idea of Naval reform in many aspects of the service's operation. For example, it was clear that there were numerous ineffectual officers in the navy, some of high rank. A move was abroad to remedy this situation; and Maury lent his voice the cause. A Naval commission, called the Retiring Board, was instituted and at the end of their deliberations, several hundred officers were placed on Reserved List on leave-of-absence pay—Maury ironically was one of them. The Retiring Board had amongst its members a number of Maury's enemies who saw this as a chance to settle old scores. Using his lame leg as a pretext, these vindictive naval officers claimed he was unfit for active service, in spite of the fact that he was, in the same communication, ordered to continue his work at the Observatory.²⁷ This tragic decision was eventually overturned nearly three years later after a continuing outcry from newspapers, fellow naval officers, politicians, and the public at large.

The Civil War

As the years immediately preceeding the Civil War moved on, Maury not only continued his work at the observatory, but also began to travel widely, speaking to numerous local and national scientific societies and other groups interested in his work. One of his favorite themes during this time was urging a system of observation stations for collecting data on land-based

meteorology. Agriculture and other commercial interests had often suffered greatly at the hands of the elements, and Maury knew well that weather generated over the open sea did not stop at the shoreline. He perceived the atmosphere as a universal integrated system and argued that its pattern on land could be evaluated in a similar fashion to what he had already accomplished with marine observations.

In the months before the War, Maury spent considerable time, both in speaking and in writing, trying to cool off the impending domestic strife and urging a number of plans for reconciliation between the North and the South.²⁸ Maury was not in favor of separation of the Union; but as state after state seceded, it became clear that there was little that could be done to save the South. The final blow came when his native state, Virginia, seceded. Remembering its open arms to his persecuted Huguenot forefathers, his loyalty dictated that he resign his commission in the U.S. Navy, give up the magnificent Observatory and all of the promise that the future held for scientific recognition and advancement, and join his native state in her fortunes, whatever they were to be.

Because of his national and international prominence, Maury was singled out by the North for special verbal attacks. The \$3,000 price on his head was second only to that of Jefferson Davis.²⁹ A further step of mockery was taken by the National Academy of Science in January of 1864 when it passed a resolution that:

"The volumes entitled *Sailing Direction*, heretofore issued to navigators from the Naval Observatory and the *Wind and Current Charts* which they are designed to illustrate and explain, embrace much which is unsound in philosophy and little that is practically useful, and that therefore these publications ought no longer be issued in their present form."³⁰

It is difficult to imagine a statement more contrary to universally demonstrated and accepted facts, but the National Academy was clearly operating within its founding philosophy. I have not found documentation of any effect this had on the use of Maury's works; but the charts and directions were so well-founded and universally used that it is doubtful that any navigators would heed the advice of the National Academy, since their usefulness and accuracy had been such an important part of their experience on the high seas. Thus, the "high tribunal" could pass all the judgments it wanted but out on the blue water, and along unknown shores where all was at stake, navigators still turned to Maury.

During his time in the Confederate Navy he was responsible for developing the first practical electric mines (then called torpedoes) for marine warfare. However, since many of his former enemies had gone over to the Confederacy, his ability to assist the South was greatly hampered. Before the termination of hostilities, Maury was sent to England on diplomatic affairs for the Confederacy. Thus, at the end of the war he was not included in the general amnesty which excluded those who had been diplomats or agents of the Confederacy, those who had resigned their commissions to

aid in the rebellion, and those who served the Confederacy above the rank of lieutenant in the Confederate navy.

During this time he used his influence with Maximilian in attempting to establish colonization of Mexico by dispossessed Southerners. He was given a cabinet post by the emperor, was made the Imperial Commissioner of Colonization, and was made Director of the Astronomical Observatory of Mexico. Seeing that the colonization efforts were destined to fail and sensing growing antagonism to Maximilian by the nationals, Maury returned to England.

When a general amnesty was issued that included Maury's circumstances, he was invited in 1868 to occupy the Chair of Physics at the Virginia Military Institute. Accepting the offer, he returned to his native state and proceeded in efforts to help rebuild the South. He produced a booklet entitled *Physical Survey of Virginia*³¹ designed to aid in its reconstruction. While at the Virginia Military Institute he proposed the establishment of a polytechnic college before the Virginia Educational Association.³² As a result, in 1872 the present Virginia Polytechnic Institute was opened in Blacksburg, Virginia. Though declining the offer, Maury was asked to become its first president.³³

During this time Maury spoke widely; and it was due to a lingering illness produced by exhaustion from an extended speaking trip, that he died on Feb. 1, 1873. Thus closed the career of one of America's most colorful scientists of the last century.

Honors to Maury

In evaluating Maury's reputation, it is clear that in many respects he was held in higher esteem abroad than in his own country, reminding us that "a prophet is not without honor except in his own country."³⁴ A great many honors were bestowed on Maury. He was made an honorary member of a number of scientific societies including the Imperial Academy of Sciences of Russia, The Royal Academy of Sciences, Letters and Fine Arts of Belgium, and Associate of the Royal Astronomical Society of England as well as over 40 other societies at home and abroad. High honors of many kinds were received from a large number of countries including Denmark, Germany, Portugal, Belgium, Russia, France, (what is now) Czechoslovakia, and the Papal States. He also received the Gold Medal of Science and the Kosmos Medal from the King of Prussia. The latter medal was a source of pride to Maury as it was awarded at the request of the venerable Alexander von Humboldt, a veteran naturalist for whom the Humboldt current was named. His five-volume description of the physical universe was considered by some to be one of the world's greatest scientific writings, and there was probably no other scientist for whom Maury had a higher regard.³⁵

Other honors awarded to Maury from academic institutions included LL.D's from Columbian College (now George Washington University) and the University of North Carolina and Cambridge University. During the Civil War he was offered a home, wealth, and a position of honor by Constantine, Grand Admiral of

Russia. Louis Napoleon invited him to make his home in France under similar conditions.³⁶

Recent vindication of Maury's competency as a scientist and of the enduring quality of his work comes in the form of the *Matthew Fontaine Maury Memorial Symposium on Antarctic Research*, published as Geophysical Monograph #7 by the American Geophysical Union. The opening address of the symposium includes these comments:

"It is a pleasure to open this Symposium on Antarctic Research, named in honor of Matthew Fontaine Maury. It is fitting that this Symposium, based on results obtained by scientists of many countries, working harmoniously and fruitfully in Antarctica during and after the International Geophysical Year of 1957-58, should be dedicated to Maury—a pioneer in cooperative international studies on the oceans, the atmosphere, and the polar regions."

After surveying Maury's life and recounting his unsuccessful efforts to develop international cooperation in Antarctic research in the days immediately preceding the Civil War, the speaker closes:

"One hundred years later, sixty nations did pool their resources in a vast cooperative effort to study the Earth and its Sun and twelve of these participated in research in Antarctica. As Maury predicted, they would 'unbar the gates of the south' and each would become a '... fellow citizen in the great republic of human knowledge...' So today in this Centennial Year of Maury's proposal, as we gather here to listen to scientists of many nations describe their investigations of the atmosphere, ice, and geology of Antarctica, and the oceans surrounding this continent, let us continue with fulfillment of Maury's plea for concerted study of Planet Earth by all of its nations."³⁷

Thus, in this one respect at least, Maury was a scientist clearly a century ahead of his time.

Maury's Writing Style

Maury's writing style was not universally appreciated either by his contemporaries or present day critics. Nevertheless Coker, in his introductory oceanography and marine biology text, *This Great and Wide Sea*, states:

"The rhetorical aspect of his book . . . has been the occasion of comment, and perhaps sometimes disparagement. Although it is now the fashion in scientific writing and textbooks to be sparing of rhetoric (and sometimes, it would seem, to be wary of clarity), it can hardly be questioned that Maury's style of expression, combining rhetoric, clarity, and piety, was one of his most effective implements of trade."³⁸

Of his *Physical Geography of the Sea* Coker continues: "His book is still well worth reading as a whole with the understanding that the facts and conclusions in many cases are not now acceptable in the light of subsequent and precise observations and of a far better understanding of many oceanic phenomena. A glance at the list of contents gives some indication of the comprehensive scope of his

work, as we see chapters upon the Gulf Stream, the atmosphere, the currents of the sea, the depths of the ocean, winds, climates, drifts, storms, etc.”³⁹

With regard to his writing style it should be noted that Maury did not write his *Physical Geography of the Sea* exclusively for academic scientists, but for the layman in general, perhaps with specific thought to young midshipmen. Scientific writing need not be dull and boring, but with some attention can be made to sparkle with life. Maury was clearly a master in this arena.

The Moral Influence of his Work

Modern scientific writing on any subject related to origins, both technical and popular, usually has, as an underlying motif, obeisance to the evolutionary hypothesis and its attendant moral and philosophical implications. The underlying theme of Maury's work was quite different. In speaking of his own work, he said:

“As great as is the value attached to what has been accomplished by these researches in the way of shortening passages and lessening the dangers of the sea, a good of higher value is, in the opinion of many seamen, yet to come out of the moral, the educational influence which they are calculated to exert upon the seafaring community of the world.”⁴⁰

The following excerpt of a letter to Maury from Captain Phinney of the ship *Gertrude* in 1855 illustrates the impact his writings had on one individual.

“... I am happy to contribute my mite toward furnishing you with material to work out still farther toward perfection your great and glorious task, not only in pointing out the most speedy routes for ships to follow over the ocean, but also of teaching us sailors to look about us, and see by what wonderful manifestations of the wisdom and goodness of the great God we are continually surrounded. For myself, I am free to confess that for many years I commanded a ship, and, although never insensible to the beauties of nature upon the sea or land, I yet feel that until I took up your work, I had been traversing the ocean blindfolded. I did not think; I did not know the amazing and beautiful combinations of all the works of Him whom you so beautifully term, ‘the Great First Thought.’ I feel that, aside from any pecuniary profit to myself from your labors, you have done me good as a man. You have taught me to look above, around and beneath me, and recognize God's hand in every element by which I am surrounded. I am grateful for this personal benefit.”⁴¹

The *In Memoriam* published by the Virginia Military Institute upon Maury's death in 1873 evaluates the life of Maury as follows:

“The benefits conferred upon mankind by Maury cannot be measured by any estimate of their pecuniary value, great as that value may be. If we include the general gain to civilization, by increased facilities of communication between widely separated parts of the earth, we shall not then have

the measure of his work. Ranking higher than these are the moral results of his teaching. The directions by which seamen were enabled to apply the principles and laws which his genius had wrought out of the vast mass of material which, from all parts of the world, they spread before him, were accompanied by other teachings. Passionately devoted to the study of natural phenomena, seeing in all the guiding hand of the Creator, profoundly conscious of a Ruling Providence, he strove to convey to others knowledge of those things which filled him with admiration and joy—singing ever a song of praise; and by the power of this master mind was there awakened in the sea world a spirit of observation and research, a love of Nature, and a respect for God in His works and Majesty, which those unfamiliar with the sea and its affairs, may hardly be expected to understand.”⁴²

Design in Nature

Maury's philosophy of nature and his recognition of Scriptural authority and accuracy in those areas of natural science upon which it touches, is best seen by examining his work. Thus, the remainder of this paper will draw heavily upon his original material.

The concept of design and harmony in nature was prominent in Maury's thought. His speeches and writings, especially his *Physical Geography of the Sea* are liberally laced with frequent allusions to this subject. For example, in addressing the Virginia Historical Society regarding his experience in astronomical studies at the Observatory, he said:

“To me the simple passage through the transit instrument of a star across the meridian is the height of astronomical sublimity.

At the dead hour of the night, when the world is hushed in sleep and all is still; when there is not a sound to be heard save the dead beat escapement of the clock, counting with hollow voice the footsteps of time in his ceaseless round, I turn to the Ephemeris and find there, by calculation made years ago, that when the clock tells a certain hour, a star which I never saw will be in the field of the telescope for a moment, flit through and then disappear. The instrument is set;—the moment approaches and is intently awaited;—I look;—the star mute with eloquence that gathers sublimity from the silence of the night, comes smiling and dancing into the field, and at the instant predicted even to the fraction of a second, it makes its transit and is gone! With emotions too deep for the organs of speech, the heart swells out with unutterable anthems; we then see that there is harmony in the heavens above; and though we cannot hear, we feel the ‘music of the spheres.’”⁴³

In commenting on the unique proportions of the surface of the earth given over to land, sea and air, he suggests:

“... if the proportions and properties of land, sea, and air were not adjusted according to the reciprocal capacities of all to perform the functions required by each, why should we be told that *He*

'measured the waters in the hollow of His hand, and comprehended the dust in a measure, and weighed the mountains in scales, and the hills in a balance?' Why did He span the heavens but that He might mete out the atmosphere in exact proportion to all the rest, and impart to it those properties and powers which it was necessary for it to have, in order that it might perform all those offices and duties for which He designed it? Harmonious in their action, the air and sea are obedient to law and subject to order in all their movements; when we consult them in the performance of their manifold and marvelous offices, they teach us lessons concerning the wonders of the deep, the mysteries of the sky, the greatness, and the wisdom, and goodness of the Creator, which makes us wiser and better men. The investigations into the broad-spreading circle of phenomena connected with the winds of heaven and the waves of the sea are second to none for the good which they do and the lessons which they teach. The astronomer is said to see the hand of God in the sky; but does not the rightminded mariner, who looks aloft as he ponders over these things, hear His voice in every wave of the sea that 'claps its hands', and feel His presence in every breeze that blows."⁴⁴

The currents of the ocean were of particular interest to him and in these he saw strong evidences of design and purpose. Speaking of the Gulf Stream, first identified by Ponce de Leon in 1513 and crudely plotted by Benjamin Franklin in 1786,⁴⁵ Maury suggests:

"If the current of the sea, with this four-mile velocity at the surface, and this hundreds of tons pressure in its depths, were permitted to chafe against its bed, the Atlantic, instead of being two miles deep and 3000 miles broad, would, we may imagine, have been long ago cut down into a narrow channel that might have been as the same ocean turned up on edge, and measuring two miles broad and 3000 deep. But had it been so cut, the proportion of land and water surface would have been destroyed, and the winds, for lack of area to play upon, could not have sucked up from the sea vapors for the rains, and the face of the earth would have become as a desert without water. Now there is a reason why such changes should not take place, why the currents should not uproot nor score the deep bed of the ocean, why they should not throw out of adjustment any physical arrangement in the ocean; it is because that in the presence of everlasting wisdom a *compass was set upon the face of the deep; because its waters were measured in the hollow of the Almighty hand; because bars and doors were set to stay its proud waves; and because, when He gave the sea His decree that its waters should not pass His command, He laid the foundations of the world so fast that they should not be removed forever.*"⁴⁶ (emphasis his)

Of the sea and marine organisms he says:

"The inhabitants of the ocean are as much the creatures of climate as are those of the dry land; for the same Almighty hand which decked the lily and cares for the sparrow, fashioned also the pearl and

feeds the great whale. Whether of the land or the sea, the inhabitants are all His creatures, subjects of His laws, and agents in His economy. The sea, therefore, we infer, has its offices and duties to perform; so may we infer, have its currents, and so, too, its inhabitants; consequently, he who undertakes to study its phenomena, must cease to regard it as a waste of waters. He must look upon it as a part of the exquisite machinery by which the harmonies of nature are preserved, and then he will begin to perceive the developments of order and the evidences of design which make it a most beautiful and interesting subject for contemplation."⁴⁷

Maury believed that even when the principle of design was not readily apparent it was nevertheless of value to look for it.

"In studying the workings of the various parts of the physical machinery that surrounds our planet, it is always refreshing and profitable to detect, even by glimmerings ever so faint, the slightest tracings of the purpose which the Omnipotent Architect of the universe designed to accomplish by any particular arrangement among its various parts."⁴⁸

Maury also wrote:

"He that established the earth 'created it not in vain; He formed it to be inhabited.' And it is presumptuous, arrogant, and impious to attempt the study of its machinery upon any other theory; *it was made to be inhabited* . . . The theory upon which this work is conducted is that the earth was made for man; and I submit that no part of the machinery by which it is maintained in a condition fit for him is left to chance, any more than the bit of mechanism by which man measures time is left to go to chance."⁴⁹

This does not imply that he rejected apparent stochastic processes in nature. However, even behind what appears to be random events are subtle but all pervading laws which govern the entire process.

He goes on to say:

"In observing the working and studying the offices of the various parts of the physical machinery which keeps the world in order, we should ever remember that it is all made for its purposes, that it was planned according to design, and arranged so as to make the world as we behold it—a place for the habitation of man. Upon no other hypothesis can the student expect to gain profitable knowledge concerning the physics of the sea, earth, or air."⁵⁰

Thus, the philosophy of order and design is seen by Maury to be not only all pervading in extent, but foundational in nature for a complete understanding of physical geography, and by implication, all of science.

Use of Scripture

Maury was severely criticized by some of his contemporaries for using Scripture in support of his scientific ideas. For example, Sir David Brewster said:

"It is now, we think, almost universally admitted and certainly by men of the soundest faith . . . that the Bible was not intended to teach us the truths of science. The geologist has sought in vain for geolo-

gical truth in the inspirations of Moses, and the astronomer has equally failed to discover in Scripture the facts and laws of his science. Our author, however, seems to think otherwise, and has taken the opposite side, in the unfortunate controversy which still rages between the divine and the philosopher."⁵¹

Maury, however, was firm in his conviction of the appropriateness of quarrying from Scripture all of the science it had to offer. His defense of Scriptural authority in scientific matters is perhaps best seen in the keynote address at the laying of the corner-stone for the University of the South in the Sewanee Mountains in East Tennessee on Nov. 30, 1860.

"I have been blamed by men of science, both in this country and in England, for quoting the Bible in confirmation of the doctrines of physical geography. The Bible, they say, was not written for scientific purposes, and is therefore of no authority in matters of science. I beg pardon! The Bible is authority for everything it touches. What would you think of the historian who should refuse to consult the historical records of the Bible, because the Bible was not written for the purposes of history? The Bible is true and science is true, and therefore each, if truly read, but proves the truth of the other. The agents in the physical economy of our planet are ministers of Him who made both it and the Bible. The records which He has chosen to make through the agency of these ministers of His upon the crust of the earth are as true as the records which, by the hands of His prophets and servants, He has been pleased to make in the Book of Life.

"They are both true; and when your men of science, with vain and hasty conceit, announce the discovery of disagreement between them, rely upon it, the fault is not with the witness of His records, but with the worm who essays to interpret evidence which he does not understand.

"When I, a pioneer in one department of this beautiful science, discover the truths of Revelation and the truths of science reflecting light the one upon the other, how can I, as a truth-loving, knowledge-seeking man, fail to point out the beauty and rejoice in its discovery? Reticence on such an occasion would be sin, and were I to suppress the emotion with which such discoveries ought to stir the soul, the 'waves of the sea would lift up their voices' and the very stones of the earth cry out against me.

"As a student of physical geography, I regard earth, sea, air, and water as parts of a machine, pieces of mechanism, not made with hands, but to which, nevertheless, certain offices have been assigned in the terrestrial economy; and when, after patient research, I am led to the discovery of one of these offices, I feel, with the astronomer of old, 'as though I had thought one of God's thoughts,' and tremble. Thus, as we progress with our science, we are permitted now and then to point out here and there in the physical machinery of the earth a design of the Great Architect when He planned it all."⁵²

His view of the authority of Scriptures in areas of science was not just academic but found practical expression in the conduct and decisions of life. For example, Scriptures appear to have played a major role in his decision to study ocean currents and winds. After months of intense study of the old log books in the Observatory, he was convinced that accumulation of detailed atmospheric and marine data would enable him to produce entirely new and greatly improved charts and sailing directions. From years at sea he had seen the truth of Psalm 107 ("They that go down to the sea in ships, that do business in great waters; these see the works of the Lord, and his wonders in the deep.") Of this Williams says:

"As he weighed the proposal he would make, Maury later told his family, that verse came often to his mind but even more frequently the words of the 8th Psalm: 'Thou madest him to have dominion over the works of thy hands . . . and whatsoever passeth through the paths of the seas.' Those words convinced Maury that he was right in his belief that there were natural paths through the seas, even as there were natural paths through mountain passes, if man would but persist until he discovered them."⁵³

"As our knowledge of nature and her laws has increased, so has our knowledge of many passages of the Bible been improved. The Bible called the earth 'the round world,' yet for ages it was the most damnable heresy for Christian men to say the world is round; and finally, sailors circumnavigated the globe, and proved the Bible to be right, and saved Christian men of science from the stake. And as for the general system of atmospherical circulation which I have been so long endeavoring to describe, *the Bible tells it all in a single sentence*; 'The wind goeth toward the South and turneth about into the North, it whirleth about continually, and the wind returneth again to his circuits.'"⁵⁴ Eccles. 1.6.

"Solomon in a single verse, describes the circulation of the atmosphere as actual observation is now showing it to be. That it has laws, and is as obedient to order as the heavenly host in their movements, we infer from the fact announced by him, and which contains the essence of volumes by other men, 'All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again.'

"To investigate the laws which govern the winds and rule the sea is one of the most profitable and beautiful occupations that a man, an improving, progressive man, can have. Decked with stars as the sky is, the field of astronomy affords no subjects of contemplation more ennobling, more sublime or more profitable than those which we may find in the air and the sea.

"When we regard them from certain points of view, they present the appearance of wayward things, obedient to no law, but fickle in their movement, and subject only to chance.

"Yet when we go as truth-loving, knowledge-seeking explorers, and knock at their secret chambers, and devoutly ask what are the laws

which govern them, we are taught, in terms most impressive, that when the morning stars sang together, the waves also lifted up their voice, and the winds, too, joined in the mighty anthem. And as discovery advances, we find the marks of order in the sea and in the air, that is in tune with the music of the spheres, and the conviction is forced upon us that the laws of all are nothing else but perfect harmony."⁵⁵

Again, Maury states the importance of an understanding of the Scripture in attempting to interpret scientific data:

"I will, however . . . ask pardon for mentioning a rule of conduct which I have adopted in order to make progress with these physical researches, which have occupied so much of my time and so many of my thoughts. The rule is, never to forget who is the Author of the great volume which Nature spreads out before us, and always to remember that the same Being is the author of the book which revelation holds up to us, and though the two works are entirely different, their records are equally true, and when they bear upon the same point, as now and then they do, it is as impossible that they should contradict each other as it is that either should contradict itself. If the two cannot be reconciled, the fault is ours, and is because, in our blindness and weakness, we have not been able to interpret aright either the one or the other, or both."⁵⁶

Conclusion

Matthew Fontaine Maury was clearly one of the outstanding figures in science during the middle of the 19th century. His dedication to the highest goals in science, his ability to collect vast quantities of data, his attention to detail and his commitment to the authority and accuracy of the Scripture, not only in his personal life but in his scientific work, may well serve as a pattern to contemporary men and women of science beset on every hand by secular and atheistic philosophies.

He has left to us an heritage of outstanding achievement, not only in science, but also in the successful integration of both natural and Biblical revelation. How different might have been modern science if his ideas and philosophies had not been largely swamped out by the impending Darwinism which was soon to engulf the Western World!

Acknowledgements

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MFM = Matthew Fontaine Maury

FLW = Frances Leigh Williams, 1963 Matthew Fontaine Maury, scientist of the sea. Rutgers University Press, New Brunswick, New Jersey. This scholarly work must serve as a starting point for any serious study of Maury. In addition to nearly 480 pages of superbly written text, this volume contains almost 230 pages of documentation evidencing the highest standards in historical research.

PGS = Physical geography of the sea.

JWW = John W. Wayland, 1930, The pathfinder of the seas, Garrett & Massie, Inc., Richmond, Virginia.

¹The phrase, "The Pathfinder of the Sea" is taken from the book entitled The pathfinder of the seas, by Wayland, John W., 1930. Garrett & Massie, Inc., Richmond, Virginia.

²MFM, 1855. The physical geography of the sea and its meteorology, p. 38 ed. John Leighly. The Belknap Press of Harvard University Press, Cambridge, Massachusetts, 1963. This is perhaps the most famous quote from Maury and reveals his literary style. The editor's 20-page introduction to this recent edition is so totally negative regarding the value of Maury's work that it is difficult to understand why a publisher would consider reproducing it. It is interesting to compare Leighly's caustic criticism of Maury to the highly commendatory work of FLW.

³For an excellent short summary of the lives of Lord Kelvin, Robert Boyle, Johannes Kepler, Michael Faraday, Samuel F.B. Morse and James Clerk Maxwell see table of contents in Williams, Emmett L. and George Mulfinger, Jr., 1974. Physical science for Christian schools. p. XI. Bob Jones University Press. Greenville, South Carolina.

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¹⁸For a detailed account of reduction of sailing times attributable to Maury's works see FLW, pp. 190-195.

¹⁹For a brief account of the life of Samuel F.B. Morse see Reference 3.

²⁰See FLW, pp. 167-175 and associated footnotes.

²¹*Ibid.*

²²*Ibid.*

²³*Ibid.*

²⁴FLW, p. 221.

²⁵MFM, 1855. The physical geography of the sea and its meteorology. Harper and Brothers, Cambridge, Mass.

²⁶See FLW, p. 698 for complete list of reprints and editions.

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VARIATION AND THE FOURTH LAW OF CREATION

COLIN BROWN*

By the fourth law of creation, is meant that living beings remain within their kinds, although limited variation is allowed. Various aspects of this, one of the most important principles of biology, are examined in this article.

The law which governs the reason why species will remain within their kinds (what I mean is that descendants do not cross the boundary into a different kind from their ancestors) I have called the fourth law of creation. There are six other laws which I have been able to name and hope to discuss. The present one, while fourth in the order of things, is of such importance that it is worth discussing immediately.

The Fourth Law

When we look at the world around us we find that the plants and animals are very well adapted to their environment. How, we may ask, did this adaptation come about? Were these animals and plants first non-adapted; and did they later gradually adapt? No, these organisms had already within themselves adaptation, to a greater or less degree, to their environment.

Now consider the fossil record. Many plants and animals, represented by fossils, have also come through the corridors of time right up to the present day as living creatures; and they have changed only within their kinds, sometimes very little indeed. How and why should this be so? After all, even organisms which are well adapted to the environment cannot stop mutations from taking place. For the main sources of mutations are radiation from the sun and from the ground, and certain gases, elements, and other chemicals in the environment. (Incidentally, is there something already strange here? For, according to the usual geological

time-table, mutations seem to have taken longer in the past. But according to physics the amount of radiation from radioactive minerals should have been greater in the past.)

Now these organisms could not have said: "Would you please stop the radiation? I don't need any more mutations. I am very well adapted. Thank you very much." No, the organism undergoes mutations willy-nilly; all it can do is try to cope with them. How?

As already mentioned, organisms are (and were) adapted to their environment. So only two types of mutation can take place:

- (1): Mutations with lethal, or deleterious, effects, and
- (2): Mutations that do not cause lethal effects in the functions of the adapted organism, but rather add to its adaptive variation.

Both of these types of mutation occur without reference to any future adaptation (i.e., they do not anticipate future needs); so any mutation, in a given environment, can be accepted only if it helps the organism in its adaptive role; and in so doing it therefore keeps the organism within its kind.

As for any damaging mutations, they are either:

- (1): Removed by enzymes which remove the damaged or mutated parts and replace them with new material, or

(2): Any which get through to cause lethal or deleterious results will in time be eliminated. For the mutated line, being in an unfavourable position, will in time die out.

What if the environment changes? When the organism comes to cope with a change in the environment,

*Mr. Colin Brown's address is 61 Derby Road, Golborne, Greater Manchester, England.

the mutations which occurred before, of the sort which add to the adaptive variations, and which at the time helped to keep the organism within its kind, still do just that. For they come to the forefront, and help to make those adaptive adjustments needed. And so the creature continues to live in this world, and within its kind. It might be called, in the conventional classification, a variant within the species, or maybe a new species; but still it remains within the original kind.

In other words, if a species cannot keep itself afloat within its kind it dies out, and so leads to no new kinds. If it can adapt, it will remain within its kind while doing so, and so will lead to no new kinds. So there is no evolution of new kinds.

To recapitulate, while an organism is adapted to its environment it can accept only those mutations which keep it adapted—and within its kind. Any other mutations, being lethal or deleterious, would sooner or later cause the elimination of the mutated line. The organisms which carry the adaptive mutations will survive, either as a variant or a new species (in the sense already mentioned), but will remain within the original kind.

The same remarks will apply to chromosome mutations as well as to gene duplication. All known gene duplications either have gene copies or they produce what is known as infinite affinity for each other, i.e., they produce what might be called a variation on a theme.

In summary, there are indeed many different kinds of genetic mechanism which add to the genetic variability of a species. This fact is reflected in the vast amount of variation within one species, and the numerous species within one kind.¹ These are correlated with the many adaptations which have been and indeed still are with us, as can be seen by studying living organisms and the fossil record. But throughout all of this the fourth law holds: there may be great variation within a kind, if the environment should favour that variation; but one kind does not turn into another.²

Genetic Mechanisms and the Fourth Law

Now we come to the second part of the subject. We must consider the various genetic mechanisms which there are, and how they have to do with the fourth law.

Marsh has pointed out that both laboratory findings and general experience show that, without exception, basic types are so different in their cellular chemistry as to make any departure from the law of each after its kind physically impossible. I suggest that the matter can be considered in this way.

Each cell in the body of an organism has only a certain range of capabilities, whether that range be large or small. There is a sort of permutation within the cellular chemistry. The genes make, or control the making of, proteins, enzymes, etc. These are pre-programmed, as it were; and with the base nucleotides they dictate the permutations to the enzymes. The enzymes, in turn, dictate back to the cellular chemistry, and make sure that permutation is kept within whatever the limits may be. This outline, I believe, applies to all

known genetic mechanisms, save one to which I shall come shortly.

The genetic mechanisms include chromosome polymorphism, recombination, bi-chromosomes, cross-overs, and others. The exceptional one, which it was desired to discuss further, is the gene of the third type. It is called "third type" for the following reason.

Type 1 has to do with the case in which genes make copies of themselves. In type 2, some of the copies change to produce what has been called an infinite affinity, or a variation on a theme. In type 3 the change goes further, and the result turns into something sub-standard.

Type 1 is common, and needs no comment.

Type 2 includes the following examples:

In the brain of the rainbow trout there may be two versions of the vital brain enzyme acetylcholinesterase. One of them functions in warm water, the other in cold. This is an example of a variation on a theme.

Bacteria, fed on foreign material, produce, among many copies of certain enzymes, some which have changed, again so as to produce a variation on a theme. In this way the bacteria can adapt to a variety of circumstances.

In man, variations on a theme may occur in the hemoglobin chain. One of these leads to the well-known sickle-cell anemia.

As for the third type, if it does exist among related species, chromosome differences may lead us to it.

In *Bos* (cattle), for instance, the chromosome number is large, and there is a difference of 53 chromosomes: 16 on the one hand and 60 on the other. In general, the greater the difference the better the prospect of finding this kind of thing, if it does exist; the smaller the difference the poorer the prospect. But however this may turn out, it is plain that differences between related species do not indicate evolution across the boundaries of the kinds.

It may well be that one instance of the sort of thing being considered is that certain areas or sites of the genetic material break down, in much the same way as chemicals may break down into simpler ones upon e.g. heating. Of course, heating is not involved here, but rather some biochemical change. In a hemoglobin chain, e.g., it might be that some of the amino acids change, others do not. Or, rather, if the latter should change, the changes would be lethal, and hence quickly removed from circulation. Here again is why the enzymes must stand guard, so to speak, to protect these vital regions. It may be, then, that in practice changes in most of the chain cannot be tolerated. In that case, only minor changes (i.e., continuing ones) are possible. Similar things might be said about many other molecules, amino acids, and genetic material; so again major changes, leading to evolution out of the kind, are impossible.

So this third mechanism, if it occurs, can only produce variations within the kinds, i.e. within the Fourth Law of Creation.

As a matter of fact, the third type, while a hypothetical possibility, has never, to the best of my knowledge, been detected in any related organisms. So about all that anyone wishing to use the third type as a

cause of evolution can say is that it happened very quickly at some time in the past, but can no longer be detected. This seems to be getting very close to the hopeful monster. Some have suggested, indeed, that maybe radiation from the sun, or some other source, was greater in the past, and so gave rise to large changes and to evolution. Yet today our shield against such radiation, the Earth's magnetic field, screens out only about fourteen per cent of the total background radiation. Again, some have said that the cosmic rays, and the radiation from radioactive minerals, etc., account for only about one out of twenty of the genetic mutations in human bones. From such a viewpoint, a possible increase of fourteen per cent would not seem to be enough to cause any significant evolution, although it must be said that any increase is not good news as far as life on Earth is concerned.

Recapitulation. Contrast with the Evolutionary View

Most evolutionists have believed that small changes over long periods of time could bring about a change from one basic kind to another. That claim, however, becomes implausible in the light of the discussion already completed, and the following further considerations.

There are only so many amino acids in a cell, many of them of similar composition. The allowable changes in them will be small, in most cases. The all-over change, it is true, might be considerable, but still it would not result in the formation of a new basic type or kind.

For all of the genetic material is pooled in the genotype, and the characteristics of the phenotype are sorted out thence. Now as for large effects, as already noted they may be classified as: useful, deleterious, lethal. If deleterious or lethal, they will show themselves in the phenotype. They can also be made evident in the genotype, when through experiments they are seen to be in what is called a balanced lethal state.

Now evolutionists suggest that while, as things are, these changes are deleterious or lethal, in another environment they might possibly be useful. It is hard to think of a possible case; the standard one seems to be a mutation of the fruit fly which is more tolerant of high temperatures. But surely that would be of little consequence in the state of nature.

Indeed, suppose that the environment should change, what then? All that we should have is more or less of what we already see; there would be no different basic type or kind. For instance, the mutations of *Drosophila* with odd wings are still very much flies—certainly not spiders or lobsters!

So if these kinds of change are what evolution is about, we see what it can and can not do. If a large change which is of some use it would be brought out into the phenotype through real need. Or, it might be shown through experiment, to be in the genotype.

Now in the state of nature such large changes are not seen in the phenotype. So if they exist at all it is in the genotype. Now something useful and not harmful in this present environment (it may be questioned whether there are any absolutely neutral mutations) if in the genotype should show up in the phenotype. If, on the

other hand, it should be useful in some other environment, in this present environment it would be deleterious or lethal in the genotype or phenotype, and would be seen or detected. It would be detected, in fact, by the elimination of the line carrying it.

Now in nature even such variations as the odd wings of fruit flies are not seen, or do not spread in the phenotype. Even if they did, the case would be nothing more than another variation within the basic kind.

What evolution is about, then, is this: as an experimental study it is about minute variations within the kinds. As a body of talk, it is, as Paley remarked³, about changes as wide as those in Ovid's *Metamorphoses*—and about as plausible! The Fourth Law: no variation outside the kinds, holds true.

Ways, Means, and Mechanisms

Thus far the fourth law has been discussed as something which is observed to happen. Now it is time to go a little behind the scenes, so to speak. The situation is rather as in physics. One may say, on grounds of conservation of energy, that a proposed perpetual motion will not work. But it is also possible to point to some principle of mechanics, for instance, maybe some force which has been overlooked, to see a more particular reason.

One may go yet further back, and recall that, as Paley pointed out, a law is only the mode according to which an agent proceeds.⁴ So back of it all we can see the hand of God.

As was remarked, all living things undergo mutations. But they are not necessarily changed much thereby. The relict groups, the so-called living fossils, undergo mutations, but they come through practically unchanged. Why is this so?

The body has an elaborate repair mechanism which works on the DNA. When mutations, i.e. errors, occur, some, which may be useful to allow adaptation to different environments, are tolerated. Others, if not lethal, are removed by the enzymes, or the situation is repaired.

For instance, the base nucleotides in the DNA helix are as follows: G, guanine, connects with C, cytosine; and A adenine, with T, thymine.⁵ The restriction on the manner of base pairing is due to the limited ability of the hydrogen bonding on the helix itself. If the G should break from the C through some damage, the enzyme will repair the G base. If a wrong base should appear, the enzymes remove it and put in the right one. If a base pair should be lost, change within the type, possibly deleterious, may occur.

The enzymes, of course, can be considered chemicals, albeit complicated ones. Yet there seems to be more than a chemical reaction here. The selective action of the enzymes is not a thing which is found in simple chemical activity. Rather, we must look upon this as a physio-chemical action; and, as remarked earlier, back of it we may see the hand of God.

Incidentally, the arguments considered here tell against saltation, which Goldschmidt and others have suggested has occurred. For it seems very likely that a major mutation, of the kind envisaged, if not im-

mediately lethal, would be removed. So again the boundaries of the kinds would not be crossed.

Neither do these considerations lead to any hope for the automatic, mechanistic, origin of life, which some have alleged to have happened. For the processes of life are more than just chemical reactions. There is this ordering and keeping in order. Such an activity would never be brought about by a broth of chemicals, brought together at random.

It might be argued, incidentally, that the last two points are maybe not all that much different. For to say that one kind of life originated, i.e. created, another, e.g. the reptiles the birds, is, in effect, to say that life created itself. And is that so much different from saying that it arose spontaneously? In each case the problem is the same. There are hundreds of adaptations and correlations needed for the simplest living thing of which we know; and other hundreds of new adaptations and correlations would be needed to go e.g., from reptile to bird. But we simply do not see such a correlation of changes coming about by chance.

Nor would the enzymes help here. For their new forms, in order to carry out the new duties which would fall upon them, would be precisely one of the things needing explanation.

Summary and Conclusion

It has been shown that, while the enzymes, amino acids, etc., in the genetic material have an important function, they are not by themselves enough to explain heredity, and the stability of the kinds. For mere chemical activity is not enough; back of it there must be an ordering and guiding. And this fact, that thus

organisms are kept within their kinds, but allowed room for limited variation which may be required by the environment, I have called the fourth law.

Natural selection has been put forward as accomplishing the same purpose by some. But I urge that there is a great difference. The fourth law has a much more personal and specific role to play, so to speak. It has to steer a middle course between excessive rigidity and excessive variability; to keep creatures within their kind while allowing them some room for variation. Natural selection, on the other hand, which is really differential elimination, merely acts to eliminate those which are grossly unfit. (Blyth noted natural selection as a conservative and stabilizing force, before Darwin persuaded people that it worked the other way.)⁶

To use a pedagogical analogy, natural selection is an examiner who expels undesirable pupils; the fourth law is a teacher who instructs.

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FOSSIL SUCCESSION

GLENN R. MORTON*

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The problem with the order in which different fossil groups appear in the geologic record has always been a difficult one for Creationists. Many facts are left untouched by the usual paleoecological explanation of the fossil record; and these are noted. An explanation of the fossil succession as a partial capturing of the repopulation of the world following the flood is presented.

Creationists have always had a difficult time explaining why there is a succession of different species vertically in the fossil record. Why are the mammals only found in the uppermost or later part of the stratigraphic column? Why are the protozoans the first to appear in the Precambrian followed by soft-bodied, multicellular invertebrates in the late Precambrian and hard shelled invertebrates in the Early Cambrian? Why is man the last to appear? The evolutionary explanation of this order, it must be admitted, is perfectly logical given their assumptions.

This paper will present a view that the fossil succession represents neither evolution nor the order that the habitats were inundated by the flood, as has previously been proposed by creationists, but instead represents "snapshots" of the repopulation of the earth following the flood. This view would require that the majority of the post-Precambrian strata were deposited after Noah, his family, and the animals left the ark. It is envisioned that Noah was safely aboard the ark during the most turbulent period of the flood and emerged from it when the worst was over. The earth's surface would have remained in turmoil for several centuries more.

The impetus for this view arises from this author's attempt to explain the non-existence of certain short-lived

*Mr. Glenn R. Morton's address is 3313 Claymore, Plano, Texas 75075.

Table 1: Suggested Chronology of the Early Chapters of Genesis

Time Since Creation	Birth of	True Age* Before Present	Radio-active Age
0	Adam†	5986	5.07B‡
130	Seth	5856	4.71 B
235	Enosh	5751	4.43 B
325	Kenan	5661	4.18 B
395	Mahalalel	5591	3.99 B
460	Jared	5526	3.81 B
622	Enoch	5364	3.38 B
687	Methuselah	5299	3.20 B
874	Lamech	5112	2.69 B
1056	Noah	4930	2.20 B
1556	Shem, Ham, Japheth	4430	841 M
1656	The Flood	4330	570 M
1659	Arpachshad	4327	561 M
1694	Shelah	4292	471 M
1724	Eber	4262	400 M
1758	Peleg	4228	326 M
2788	Reu	4198	268 M
1820	Serug	4166	211 M
1850	Nahor	4136	164 M
1879	Terah	4107	158 M
1949	Abram	4037	52 M
2049	Isaac	3937	2 M

*On the assumption that the flood occurred in 2349 BC, and that Arpachshad was born two years after the end of the flood.

†To be sure, Adam was created, not born.

‡B indicates billion, M, million.

radioactive isotopes by the suggestion that there was a (possibly miraculous) change in the constant of electrical permittivity.¹ Table 1 shows the result of that previous investigation. Noah would have left the ark early during the time that the Cambrian deposits were being laid down. Nahor and Terah would have lived while the Cretaceous rocks were deposited. Abraham would have lived during Tertiary times.

In order to illustrate the problems that the fossil record presents to current creationist explanations of that succession we must first look at the fossil record to see what facts need explaining.

The Fossil Record

In the lowermost rocks, the Precambrian, and in the oldest of them, appear what certainly looks like single-cell organisms. Although generally poorly preserved, as far as details are concerned, these are the first fossils which appear. For a creationist, the appearance of single-celled organisms in the earliest portion of the fossil record presents a problem, but it fits nicely with the evolutionary explanation. These beings are found in rocks believed to be 3.5 billion years old.

Algae, in the forms of algal stromatolites, are found in the Precambrian strata also. Stromatolites are formed when silt particles cover a mat of algae. As the mat is covered filaments of algae push up through the silt and

form another mat which, in turn, is also covered by silt. In this fashion a finely laminated sedimentary structure is formed—the stromatolite.² Stromatolites are found in strata dated from two billion to the present.

Just before the Cambrian in South Australia, Precambrian multicellular, soft-bodied forms are found.³ Since these creatures lacked hard parts, their fossils are merely molds of their bodies. The significance of these creatures is that they are multicellular and are supposed to have come next within the evolutionary framework. How is a creationist to explain this apparent evolutionary order from single cell to multicellular organisms within the Precambrian?

As we come to the base of the Cambrian we find an interesting geological feature, the Cambrian-Precambrian unconformity. This unconformity represents a nearly world-wide break in the deposition of strata due to a universal period of erosion. Walter S. Olson describes it thusly:

“This is the most striking and universal break in the succession of rocks covering the earth. The event which they represent has been used to divide the history of our planet into two unequal and contrasting parts. The continental nuclei at that time were largely stripped down to the crystalline basement. Ancient mountain systems were worn down to their roots reducing the continents more nearly to a plain than they have ever been before or since, leaving a clean slate on which the record came to be written which is usually called historical geology.”⁴

It is after this erosional interval that the first fossils appear in large numbers. The creatures which appear at this time includes arthropods, in the form of trilobites, molluscs, echinoderms, and fish.⁵ The invertebrates are the most numerous, trilobites constituting 60% of all Cambrian fossils. Only traces of fish have been found; they become important later. The important point about the Cambrian is that every kind of invertebrate is represented and yet in these rocks not one shred of evidence of any vertebrates other than fish appear.

Higher, in the Silurian, the first land plants and animals are found. Surprisingly, the first fossil land animal is a scorpion.

In the Devonian, called the Age of Fishes, fish reigned supreme. Modern teleost, or bony fish, and sharks are found in profusion. One large Devonian fish, the dinichthys, attained a length of thirty feet or more. Today it is extinct.

In both the Silurian and the Devonian the species that do not appear are just as important as those that do. There is as yet no evidence of reptiles, birds or mammals. The first amphibian is fossilized in the Devonian but they do not become important until later.

By the Pennsylvanian, the liverwort, insects and the first reptiles appear. The mammals don't appear until the next geologic period, the Permian. This is after the appearance of the reptiles.

The Triassic rocks yield the first example of frogs, ichthyosaurs (dolphin-like marine reptiles), pterosaurs and modern corals.

Salamanders and birds first appear in the Jurassic while snakes, fleas, and deciduous trees and other flowering plants are first found in the Cretaceous.

The Cenozoic is divided into two periods: the Tertiary and Quarternary. The Tertiary is subdivided into five epochs: the Palaeocene, Eocene, Oligocene, Miocene, and Pliocene. The Quarternary is split into two epochs: the Pleistocene and the Recent. Rocks of these ages are always stratigraphically higher than those of the previous eras and thus they must have been deposited last. It is in these rocks that the modern mammals first are found. Rabbits and rodents appear in the Palaeocene; bats, whales and elephants in the Eocene; Cows, seals and New World monkeys in the Miocene; cat-like types in the Pliocene; and monotremes, those egg-laying mammals, are not seen until the Pleistocene.

Man as a fossil does not occur to any extent until the Pleistocene, although occasional evidence of him does appear earlier.⁶ Evidence of human habitations does not occur until the Recent epoch.

One other fact needs to be mentioned concerning the Tertiary record. There is an increase in percentage of occurrence of fossilized specimens of living species with each succeeding epoch. In the Eocene, only 3 per cent of the fossil specimens are of currently living species. In the Miocene, this percentage increases to 17 percent, while 50 to 67 percent of Pliocene fossils are of creatures currently living.⁷ How can stratigraphic position have a relationship with the survival of a percentage of creatures if these creatures were on the ark while the strata containing them were deposited? Obviously an increasing percentage of fossilized examples of living creatures as one goes from older to younger beds is hard to explain if those fossils represent the burial of animals excluded from the ark. Noah could not have chosen to take on the ark only those animals which would survive until the latter stages of the flood. Neither does it seem reasonable to believe that God chose to send to Noah animals thusly selected since this would appear deceptive on God's part. The only reasonable explanation for this Tertiary puzzle is that at least the Tertiary strata are later than the departure from the ark, and the animals in repopulating the world were taking their chances on survival.

These are the facts which creationists must deal with when explaining the fossil succession. The basic facts outlined above are shown in Table 2.

The Ecological View

The primary creationist explanation of the fossil record can be called an ecological theory. It has been used by many, and it is uncertain who first proposed it. This theory proposes that the succession of fossils primarily reflects the order in which the habitats were overcome and buried during the deluge.^{8,9} It assumes that all of the sedimentation of the geologic record occurred within the year that Noah was on the ark. Ocean-bottom (benthonic) animals should appear first in the record since they live at the lowest elevation and are unable to move rapidly in order to escape the rain of sediments pouring down on them. Primarily these animals would be marine invertebrates such as the

Table 2. Pertinent facts concerning the fossil record which need a creationist explanation.

Epoch or period	First Appearance of:
Recent	Human habitations in abundance
Pleistocene	Monotremes, humans, first human habitations
Pliocene	Cat-like types
Miocene	Cows, Seals, New World Monkeys
Oligocene	
Eocene	Whales, Elephants
Paleocene	Rabbits and Rodents
Cretaceous	Two human skeletons, Snakes, Fleas, Flowering Plants
Jurassic	Salamanders
Triassic	Frogs, Ichthyosaurs, Pterosaurs, Modern coral
Permian	First Mammals
Pennsylvanian	Liverworts, insects, first reptiles
Mississippian	
Devonian	Sharks, Teleosts, Dinichthys, Age of Fish, first Amphibian
Silurian	Scorpion, first land plants
Ordovician	
Cambrian	Trilobite, Brachiopods, Fish
Precambrian	Single cell organisms, few soft bodied forms later.

trilobite, molluscs etc. The next creatures to be buried would be the fish since they are the next lowest in elevation. They would be able, we are told, to escape the initial onslaught of sediments because of their mobility. Shore-dwelling creatures, such as amphibians would be next. They would be swept into the ocean and covered with sediments after the fish. Inland animals would follow the shore-dwellers. Reptiles would come next since their intelligence is not as great as that of the mammals. Mammals, being smarter, would be more able to intelligently plan their escape from the waters and thus be able to postpone their entombment. Man, being the smartest of all, would be able to escape to the mountains and be buried last.

The order presented here does superficially represent the order of first appearance of each group. Ocean bottom invertebrates do occur first, followed, by fish, amphibians, reptiles, birds, and finally mammals. As we shall see, this view does not explain the details at all.

Whitcomb and Morris add a further constraint on the fossil succession—hydrodynamic sorting of the fossils.¹⁰ They correctly point out that the settling velocity of a large particle (and for depositional purposes a dinosaur is a large particle) is proportional to the square root of the size, the sphericity and the specific gravity or density of the creature. They then explain why the Cambrian invertebrates are on the bottom of the fossil record. Being denser than most animals their settling velocity would be faster. This is not entirely true, as will be shown later.

The ecological view explains only part of the nature of the fossil record. It only explains the first occurrence of the different groups; it does not account for the continued occurrence of each group from their first appearance onward to the present. Invertebrates don't just appear in the Cambrian and then in no later strata. They appear in the Cambrian first but they appear in each succeeding era. Fish first appear in abundance in the Devonian but they also appear in abundance in each following epoch. The same goes for reptiles, birds and

mammals. The ecological theory strongly implies that once a particular habitat is buried it is unlikely that a similar environment would be deposited again at a later time. For example one would have difficulty in explaining an invertebrate bed covering a fossil forest. Clark typifies the current thinking in explaining the fossils. He states,

"It is easy to understand why mammals are not found in Pennsylvanian rocks, for these rocks show a type of environment that would not be suitable for them. In fact about the only vertebrates found in these rocks are fishes and amphibians, and a few small reptiles. The presence of amphibia correlated with the general belief that the Pennsylvanian "coal forests" were dense, damp regions quite unlikely to shelter mammals."¹¹

In order for Clark's view to be correct the situation must be as that shown in Figure 1. Only where the habitats are localized vertically can it be stated that flood covered habitat after habitat producing a picture of the pre-diluvial ecological zones. And only then can it be said that the Pennsylvanian rocks display an environment unsuitable for mammals.

The correct view of the fossil record is illustrated in Figure 2. If one attempts to determine the habitat which a layer portrays, it is discovered that the habitats are all out of order. Marine layers are on top of terrestrial

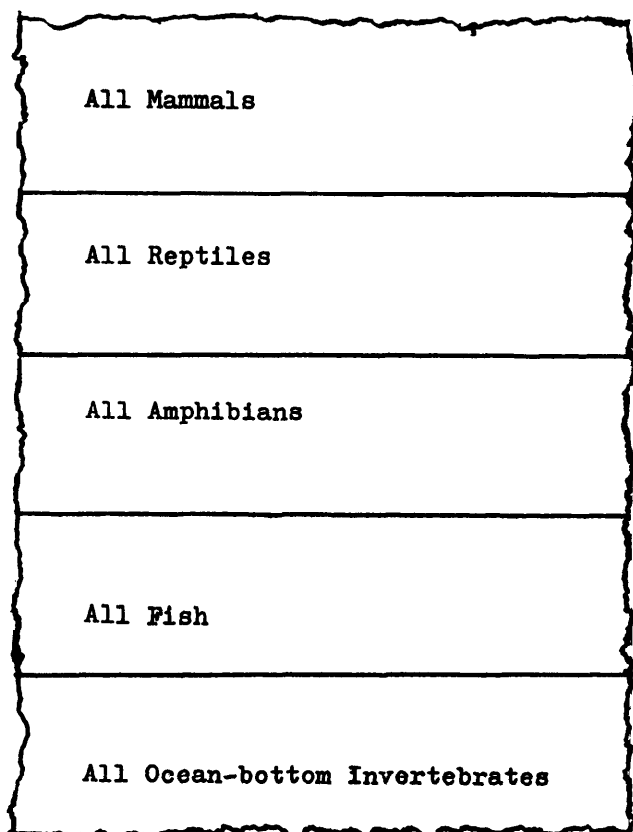


Figure 1. Implications of the paleoecological theory of fossil succession. One would expect fossils to be grouped according to habitat, all benthonic forms on the bottom and mammals on the top. But that is not what is found.

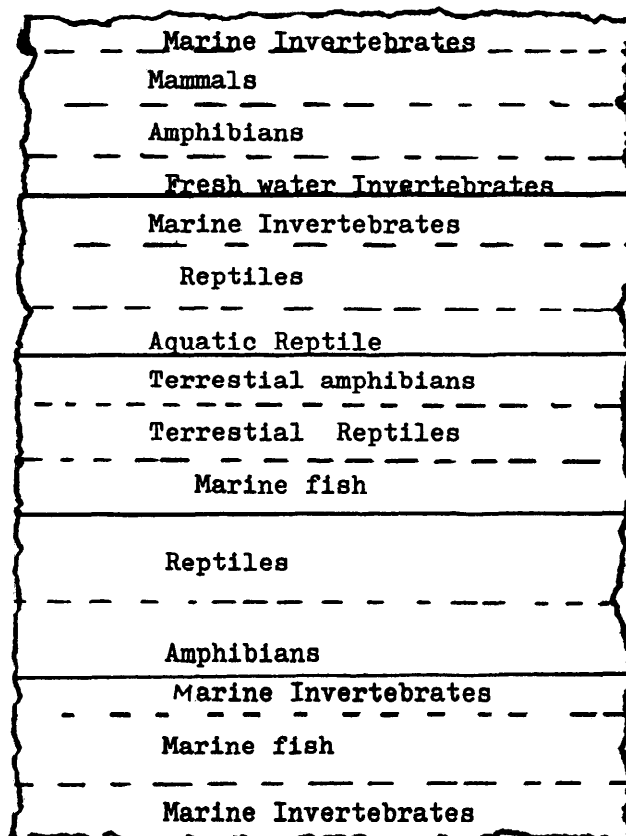


Figure 2. The order found in the fossil record is more nearly as shown here. The order does not agree with that according to habitats, which would be expected according to the paleoecological interpretation.

rocks. Oysters, a marine benthonic creature, are found in rocks higher than reptiles and mammals. This should not be if the geologic record is a record of the habitats being covered by the flood. Velikovsky gives an interesting example,

"In Cromer, Norfolk, close to the North Sea coast and in other places on the British Isles, 'forest-beds' have been found. The name derives from the presence of a great number of stumps of trees once supposed to have rooted and grown where they are now found . . ."

"Bones of sixty species of mammals, besides, birds, frogs, and snakes, were found in the forest bed of Norfolk."¹²

This forest bed would definitely give the impression that it was a forest habitat. The beds above it, however, are difficult to reconcile with the habitat theory because they represent vastly different environments. On top of the forest bed is what appears to be a fresh-water deposit with arctic willow, dwarf birch and land snails fossilized in it.¹³ Above this layer is a marine layer with mollusk shells in the life position, meaning they died suddenly. Thus the same locality illustrates three different environments in three successive layers. The order of these habitats is backwards to what would be expected in the ecological theory. Examples like this are not difficult to find. Thus the ecological theory doesn't account for the observed order.

Clark, as well as others, believe that the mammals were able to migrate to avoid burial. Clark states,

"Thus it is possible that the mammals migrated upward until eventually they were overwhelmed by the waters. Their presence in the Tertiary rocks, therefore, is best viewed as resulting from their migration and final destruction rather than burial in their natural habitats."¹⁴

Whitcomb and Morris present a similar view,¹⁵ but this migration hypothesis does not explain why whales and dolphins appear late in the fossil record. Surely the whales didn't crawl up the mountains to escape the inundation! If habitat alone were the consideration, whales, seals, walruses, dolphins and ichthyosaurs should all appear in the Devonian with the rest of the marine vertebrates. Not one solitary specimen of mammal or ichthyosaur has been collected from that period.

The whole mammal migration idea is based upon the assumption that the mammals, en masse, would have known where to flee to. Frankly, if this author had never had geography, he would not have the slightest inkling of which direction to go to escape the rising waters. It is doubtful that rodents, who don't appear until the Palaeocene, would know their geography well enough to escape.

Even if the proper direction were known three factors would most likely prevent one from migrating to the mountains. Suppose one were to try to flee rising waters by traveling from Dallas, Texas, to the Rockies. The first obstacle is the number of small hills along the path and it would be likely that one could be trapped on a hill top and cut off by the water. This would be especially likely after a night's rest. Secondly, the waters rushing down from the highlands, would make it increasingly difficult to make it to the Rockies the closer one got. One would have to swim upstream in order to get to the mountains. And finally, the distance from Dallas to the Rockies, along with the very wet and muddy ground, would make it difficult to march that far within the allotted forty days.

Another problem for the ecological theory is the extinction of the placoderms and ostracoderms, the Devonian fish with thick exterior armor. Clark hypothesizes,

"It is quite easy to imagine that the heavily armored, sluggish bottom-feeders or mudgrubbers would be overwhelmed and buried in muddy sediments, while active fishes like the sharks and teleosts could escape, for the most part, and survive to a certain degree throughout the whole surge of flood water."¹⁶

If lack of mobility killed the Devonian fish, then how in the world did the oysters and clams survive? They are even less mobile. We find oyster-like creatures from the Cambrian up to the present. The ecological view is illogical at this point or at the very least *ad hoc*.

If, as the ecological view advocates, the Devonian represents the period during which the marine habitat was being buried, why do we find huge fish graveyards in strata of all ages? The Devonian Old Red Sandstone,¹⁷ the Eocene Green River formation,¹⁸ and the Miocene Monterey shale¹⁹ all contain vast quantities of fossilized fish. Why did the Eocene and Miocene

fish not die during the Devonian? How did they survive until late in the flood?

Whitcomb and Morris' hydrodynamic sorting during deposition is not borne out in the fossil record. As we saw, they propose that the Cambrian invertebrates are on the bottom of the fossil record because of their high density, and their habitat. The settling velocity of a particle is proportional to the square root of the diameter, proportional to the sphericity, and proportional to the density difference between the animal and the water. Animals which have the fastest settling velocity within each habitat should be expected to be on the bottom of that habitat. According to the equation, if everything else is approximately equal then the larger animal should be expected to be on the bottom. The larger the particle; the larger the settling velocity.

Even if the densities are not equal, size should play the major factor in determining which animal should be deposited first. The density of a living creature is very unlikely to exceed a value of 3 grams per cubic centimeter nor dip much below 1.2 grams per cubic centimeter. This means that the density difference term in the settling velocity formula can only vary over one order of magnitude (e.g. the density of water is 1 so the density factor can vary from .2 to 2). Size however can vary over 3 or 4 orders of magnitude meaning that size will play a larger role in hydrodynamic sorting than density. In spite of this, Whitcomb and Morris mention nothing concerning size as it relates to which animals would be deposited first.²⁰

Figure 3 illustrates the size and habitat distribution which would be expected if Whitcomb and Morris' hydrodynamic sorting were true. The largest specimens of each species in each habitat should be on the bottom of the rocks deposited. As one climbs higher in the column, successively, smaller specimens should be found until the next habitat is inundated. At that time the largest specimens of the newly inundated habitat should appear on top of the smallest specimens of the last habitat. This, however, is not seen in the fossil record. Very nearly the opposite case is observed. E.C. Olson notes,

"Increase in size is the usual course followed in the evolution of phyletic lines and adaptive radiations. It is, of course, by no means universal . . ."²¹

George Gaylord Simpson states of the laws of evolution, "Among these, one of the best substantiated is a tendency for increase in size."²²

Small trilobites occur earlier in the fossil record than do large ones. The largest Cambrian trilobite is 18 inches long while the largest trilobite, thirty inches long, occurs later in the Ordovician. This is backwards to what would be predicted on the basis of hydrodynamic sorting. Since the sphericity and densities of the trilobites were approximately the same, the only major difference in their settling velocity would have to be due to the size. The larger specimen should have been deposited first; that is not what is found.

The same situation applies to dinosaurs. Small Triassic dinosaurs appear before the gigantic Cretaceous ones. Small mammals precede large ones. Small fish precede large ones. Why wasn't the thirty

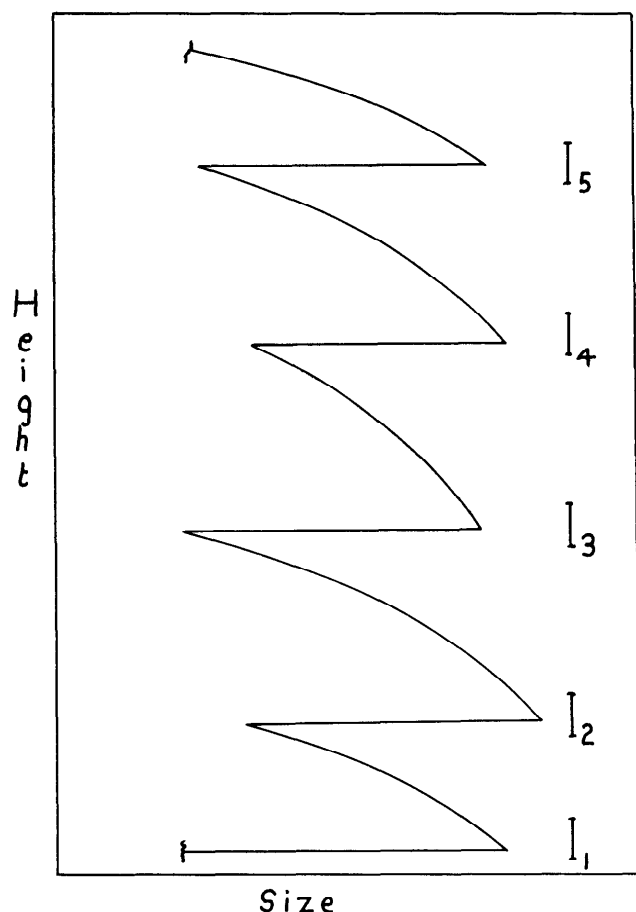


Figure 3. If hydrodynamic sorting played a dominant role in determining the locations of fossils, one would expect the variation of size of fossil with height in the geological column to be somewhat as shown here. Greater height, of course, goes along with more recent time of fossilization. $I_1, \dots, I_5$, represent the successive inundations of habitats 1, . . . 5.

foot long dinichthys of the Devonian period deposited before the smaller Silurian examples? The hydrodynamic model would predict such a situation, but it is contrary to fact.

Because of these and many other examples of contradictions to the ecological-hydrodynamic model of fossil succession, this theory should be rejected. It is dangerously *ad hoc* and is only capable of predicting the *first* appearance of a group but is not able to explain why these groups persist through the record.

The Basic Problem

What is the basic problem with the ecological view of fossil succession? Why won't it predict the details of the record? The problem seems to lie in the implicit assumption that all of the geological phenomena were finished and in place the day that Noah left the ark. This view of the speed with which the geologic work was completed seems to be a natural outgrowth of the creationists' need for speedy deposition due to the very stringent time constraints. Creationists only have a few thousand years with which to explain the geology. This has forced them to emphasize the items in the geologic

record which demanded rapid action while ignoring those items which need time.

Many items in the geologic strata are indicative of a passage of some time between the deposition of two successive strata. Mud-cracks are found lithified and buried on the boundary between two layers. Mudcracks can only form when the surface of the mud dries out causing volumetric shrinkage. This shrinkage causes cracks to develop on the surface. If the dried cracked mud layer is quickly inundated and covered by sediments before the clay has had time to absorb water from the next influx, the cracks will be preserved in the fossil record. Laporte²³ shows a picture of Silurian mud-cracks in limestone. Features like this strongly imply that the layer was exposed to air long enough for it to dry out before subsequent sedimentation.

Some, and I emphasize some, fossil plant beds in which the plants are preserved in an upright position just may represent *in situ* burial. If any of these deposits are truly *in situ* then the surface upon which the plants grew had to be free of sedimentation at least long enough for the plants to grow. Chester Arnold cites the Rhynie chert,

"An outstanding example of *in situ* preservation is furnished by the plants in the Rhynie chert bed, of Middle Devonian age in Scotland, where numerous small rushlike plants are preserved upright where they grew."²⁴

Hatched dinosaur eggs also indicate time separated two different periods of deposition. Twenty-five eight-inch dinosaur eggs were found near Choteau, Montana in Cretaceous strata.²⁵ All of the tops of the eggs were broken in a manner indicating that the dinosaurs had hatched. This find certainly implies that the surface upon which the eggs were laid was free of deposition long enough for the eggs to be laid and hatched. It is unlikely that the eggs were washed into place since they were found together (an unlikely happening if they were transported by water); and the eggs were not smashed as would be likely to occur under transport.

Another indicator of a time separation between bedding layers is the fact that worm burrows are often

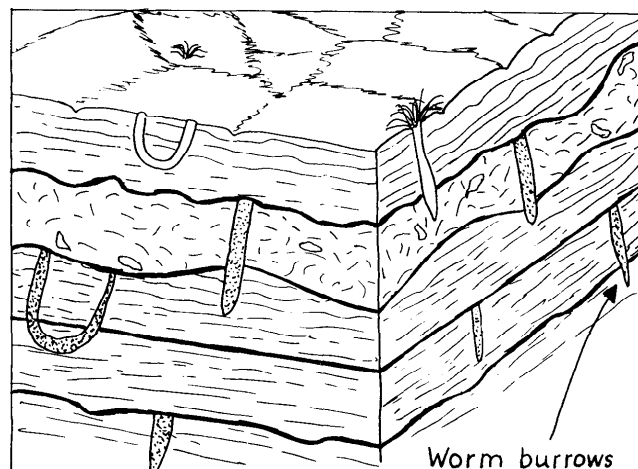


Figure 4. Worm burrows truncating into bedding planes indicate a certain amount of time separating the deposition of successive beds.

found truncated into the upper bedding plane as shown in Figure 4. The Black River and Manlius limestones of New York exhibit this phenomenon.²⁶ Obviously each bedding plane was an ocean bottom long enough for the worms to set up housekeeping.

Although equivocal evidence, fungal attack on plant material included in coal seams could be interpreted easily within the framework presented here. The particular fungus which is seen in coal beds can only attack the plant above water. Wilfred Francis reports, "The theory that *in situ* brown coal plants grew and decayed above the water level is supported by the frequent occurrence in the deposits of the remains of fungal hyphae and sclerotia."²⁷

Partial erosion of pre-existing beds and the redeposition of the eroded material in younger beds has also been observed. Pennsylvanian fossils have been reported in Tertiary strata due to the erosion, partial weathering and redeposition of the Pennsylvanian source rocks.²⁸ Obviously, this would require a significant amount of time between the deposition of the Pennsylvanian rocks and the deposition of the Tertiary stratum. The Pennsylvanian rocks would need to be lithified then eroded before this situation could occur.

If the flood accomplished all of its work within a one-year period, why are sandstones nearly always void of fossils? Uniformitarianists explain this in a perfectly reasonable manner. They claim that the shells are oxidized and abraded by the action of the sand until they are no longer there. If the flood dumped everything into place over a year, then the deposition of even a modest sediment thickness on top of the crystalline basement of 3,650 ft., represents an average deposition of 10 ft. per day. At this rapid a rate any shell trapped in the sand should remain to be fossilized. If the deposition took longer, say several centuries, then shells and other organic remains would be destroyed in the manner suggested thus explaining the paucity of fossils in sandstone.

Angular unconformities present problems for the creationist view that everything occurred in a one year period. The author has seen seismic data from the

eastern United States which reveals the structure shown in Figure 5. Initially the lower beds were deposited horizontally. After they lithified, they were thrust along the fault. The top of the anticline was then eroded. After all of this had occurred, the upper layers were deposited also horizontally. The thrust fault had ceased its movement since it does not cause a break in the upper layer. The whole area was then tilted. This sequence of events requires a certain amount of time.

Many other geological indicators of time could be presented such as footprints in the record. The surface upon which the being walked was free of deposition at least long enough for the stroll to be completed. Space does not permit others to be cited but it is clear from these already cited that it is difficult to fit them all into a strict one-year period.

Before attempting to explain the fossil record one other question has to be raised. Whitcomb and Morris estimate that the pre-flood population was over 1 billion.²⁹ Rehwinkle estimates from 1 billion to 11 billion antediluvian souls.³⁰ Both say they are making conservative estimates. If these estimates are true, where are their fossilized remains? Where are the bells, plows, trumpets, eating utensils, houses and other cultural artifacts? We find trilobites, oysters and other animals by the billions but we have only a few human fossils and these are from the highest levels of the fossil record. Why? The answer to that question is, I believe, the key to understanding the fossil record.

Fossil Succession and Reproductive Rates

If the missing humans are the key to the fossil record then that is the place to start. There appears to be only two ways to explain the lack of humans in the fossil record. The first is to assume that they all were able to climb to the highest peaks and thus avoid the burial and fossilization. We have, however already seen the problems associated with that view. Houses and other cultural artifacts could not have participated in that migration.

The second explanation could lie in the Cambrian-Precambrian unconformity. As will be recalled, this unconformity represents a tremendous world-wide erosional interval during which ancient mountain systems were worn down. If this event is the evidence of the onset of the flood then the lack of humans can be explained easily. Due to the fact that all of the sediments are resting on top of crystalline basement and therefore the basement had to be eroded to its permanent basement depth before permanent sedimentation could occur, nearly all of the sedimentary and metamorphic material had to be eroded before sedimentation first occurred. If the onset of the flood were catastrophic enough to erode solid rock and many millions of cubic miles of it, think what that would do to flesh! Thus it is suggested that the most reasonable explanation of this puzzle is that the humans, the houses and other cultural artifacts were totally obliterated by the tremendous erosive forces at the onset of the flood.

The general lack of Precambrian fossils and the early appearance of protozoans can be best explained as the result of slow prediluvial sedimentation rates. The

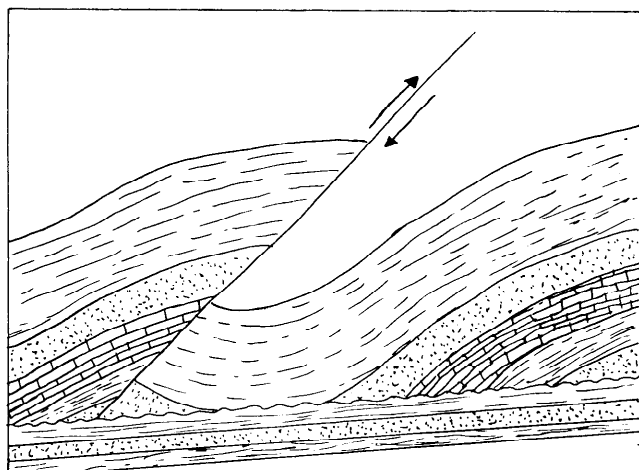


Figure 5. Angular unconformities also indicate a separation in time of the deposition of the lower layers and the upper tilted layers.

Precambrian strata, as was pointed out earlier, are believed to be prediluvial sediments. If the sedimentation rates before the flood were similar to the rates measured today, then fossils would not be expected. Modern sediments average around 1 percent organic material³¹ and most of that is merely chemical compounds, not recognizable proto-fossils. There are practically no fossils in modern sediments. The reason for this is that in order for a plant or animals to be fossilized it must be buried under sediments deeply and rapidly or it will rot or be eaten by scavengers. Under today's rates of sedimentation not many fossils are formed. If the rates of sedimentation before the flood were similar to the present's then fossils would be unlikely then also.

Under a regime described above, the only likely candidates for fossilization would be the bacteria. Being small they would be likely to escape being eaten. Decay of larger animals is caused by bacteria; so unless a living bacterium were able to eat the dead one it wouldn't rot either. Also, they were present in huge numbers. The multicellular Precambrian fossils which appear just before the Cambrian might be due to rapid burial caused by a precursor local catastrophe to the flood. This could explain the order of fossils found in the Precambrian.

Getting back to the obliteration of the humans at the onset of the flood, it must be admitted that the same obliteration would face the other organisms especially marine ones, not carried on the ark. If this were true, then a few lucky survivors would be necessary to repopulate the earth. It would seem certain that Noah did not carry marine creatures on the ark. He would not have had that much water on board, nor are marine creatures mentioned in the Biblical account.

Thus the fossils would be post-flood, as would the rocks containing them. The fossil record is therefore a series of "snapshots" of the repopulation of the earth. Local catastrophes after the flood were the cause of the fossils being trapped in sedimentary layers and buried deep enough to preserve the bodies.

Within this model the order of the appearance of fossils will primarily reflect a species' ability to spread around the earth. Two things would be necessary for a species to be preserved. First, the species must be widely dispersed in order to maximize its exposure to local catastrophes. Secondly, a local catastrophe must occur in the region inhabited by the species. Thus the more rapidly a species becomes widely dispersed the earlier it will appear in the record. The more offspring that a creature can produce the sooner the species will become widespread.

The invertebrates, the first group to appear in the record, are also the most prolific reproducers. Birdsell states, "The potential rate of increase among some marine invertebrates which produce free-swimming larval forms is so great as to involve very large numbers,"³² Oysters produce 114,000,000 eggs per spawning.³³ A hog parasite, *ascaris limbricoides* var. *suum*, has been observed to produce 700,000 eggs in a 24 hour period.³⁴ Because of the invertebrates reproductive capacities they would be the first to repopulate the earth.

Fish generally produce fewer offspring than the in-

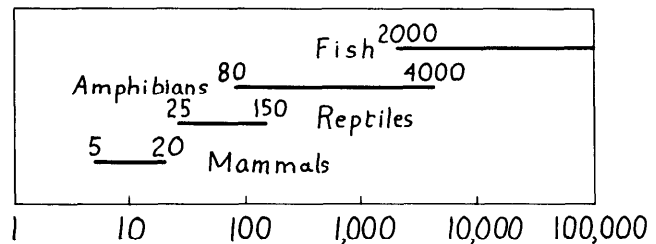


Figure 6. The number of offspring produced during the lifetime of a breeding pair of different groups. Note that the horizontal scale is logarithmic.

vertebrates, but still enormous numbers by human standards. An oceanic codfish produces over 6 million eggs per season. Turbot produce 9 million per year; ling 28 million; herring 20 to 47 thousand; freshwater trout 25 thousand; and freshwater sunfish only 1000 per season.³⁵

Amphibians are the next prolific reproducers. The bullfrog *Rana catesbeiana* is a very prolific amphibian producing 20,000 eggs per year.³⁶ Most generally the rate in frogs is around 2000 per year. Salamanders on the other hand produce only 40 eggs per year.³⁷ It is interesting to note that the frogs appear in the Triassic while the salamanders appear later in the Jurassic: a perfect correlation with their reproduction rates.

Reptiles produce fewer offspring than the amphibians. They generally produce between 25 and 175 offspring per year. Small lizards produce an average of 8 eggs per year while monitor lizards produce 25 per year.³⁷

Mammals are the slowest reproducers of all. They average between 5 and 20 offspring per year. Thus they should be the last creatures, on the average, to become widely dispersed and subject to fossilization in a post flood catastrophe. Figure 6 shows the reproductive rate for some fish, amphibians, reptiles and mammals.

As one can see there is a remarkable correlation of reproduction rates with the order of appearance of the various groups in the record. In a world where the population has been decimated the repopulation would be fairly rapid at first since predators would also be few in number. A larger percentage of offspring would be expected to survive in a nearly predatorless world. As time went on and the predator's numbers increased, the rate of repopulation would slow until the present population stability was reached.

This post-flood view of the sediments and fossils allows an easy explanation for why or how humans could have left evidence of themselves in Glen Rose and elsewhere. Underneath the rocks on the bed of the Paluxy River there is around fifteen thousand feet of other sedimentary rocks. If all of those deposits were laid down in one year, how did the people who walked on the mud at Glen Rose survive the deposition of nearly three miles of material? Where were they hiding? The same problem applies to the human skeletons found in Cretaceous strata.³⁹ Lammerts notes of these two skeletons,

"Admittedly this discovery offers as much of a problem for Flood geologists as for those of the orthodox point of view. For it is difficult to explain

Table 3. Longevity and the number of offspring in Deer mice. (After Birdsell)³²

Species	Lifespan (days)	Number of Offspring per year
<i>Peromyscus maniculatus</i>	152	20
<i>Peromyscus truei</i>	190	12
<i>Peromyscus californicus</i>	285	6

how two men could still be alive after such a depth of strata had been deposited. And if already drowned, why were they not buried later in the Mesa Verde formation? A more detailed and clear cut concept of just how the Flood accomplished its work is badly needed in order to be able to see how such finds as these fit into theoretical expectations, or creationists will be guilty of the same *ad hoc* explanations as evolutionary-minded colleagues."⁴⁰

If these two men do not represent prediluvial people but instead are among the first pioneers to enter the new world, and some area-wide catastrophe killed and buried them, then the answers to Lammerts' questions are obvious. These men didn't live through the flood; they were Noah's descendants.

It was earlier noted that there is a general tendency in the fossil record for the individuals of a particular group to increase in size with the passage of time (e.g. in higher strata). This tendency, unexplainable by the ecological model, is perfectly logical on the repopulation assumption. The longer an animal lives, the fewer offspring per year are produced. An example is shown in Table 3 for three species of deer mice.⁴¹ *P. maniculatus* lives the shortest time, 152 days, but produces the most offspring: 20 per year. *P. californicus* lives the longest, 275 days, but produces the fewest offspring: 6 per year. This inverse correlation of life span with reproductive rate is general, as is shown in Table 4. It can be converted to a size-reproductive-rate inverse correlation by noting that generally larger animals

Table 4. Reproductive Potential versus Lifespan in Mammals.

Animal	Lifespan (years)	Offspring per year
Elephant	70	1/6-1/10
Wild Ass	50	1
Baboon	45	1/2-1
Whale	35	1/2
Bison	30	1
Lion	18	3/2
House Cat	15	10-16
Dog	12	8
Hamster	1	54
White-footed Mouse	< 1	130

Table 5. Reproductive Potential versus Size in Mammals

Animal	Weight KG	Offspring per year
Whale	31,751	1/2
Elephant	5,443	1/6-1/10
Hippopotamus	3,600	1
Bison	900	1
Bear	360	2
American Elk	340	1
Gorilla	170	1
Lion	150	3/2
Aardvark	82	1
Pronghorn	45	2
Sea Otter	35	1
Baboon	24	1
Beaver	16	4
Dog	13	8
Agouti	10	8
Bobcat	9	4
House cat	3	10-16
White-footed Mouse	< 1	130

have longer life-spans. It takes longer for their bodies to grow to a larger size. This would imply that the larger animals would take a little longer in repopulating the world and appear later in the record than the smaller members of the group. See Table 5 for some comparison of reproductive potential vs. size.

The greater explanatory powers of the reproductive-repopulation model of fossil succession presented here should, it is hoped, aid the flood geologist in explaining how the flood accomplished its work. This new view does explain more of the details of the geologic record than the previous creationist explanation and therefore should be given serious consideration.

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(Continued on page 90)

DARWIN, THE UNUSUAL ONE

WILLIAM J. TINKLE*

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Start talking with a stranger about evolution and soon he will mention Charles Darwin; to the man on the street Darwinism and evolution have the same meaning. That theory started before the time of the man of our discussion; but he was the first one to induce a majority to believe in it.

Since this man had such influence we might think he had much education, but such is not the record. When Charles was a young man he delighted in hunting. Then he decided to become a physician like his father; but he was galled and oppressed by the lectures on anatomy, and finally he gave up this line of training without graduating.

Later Charles decided to be a minister and finally completed that course; thus the only degree which he ever earned was in theology. But getting an opportunity to go on the ship *Beagle* which charted navigation routes and harbors, Darwin spent several years on this course, his father paying him an allowance. In his report of this exploratory trip he describes in particular two interesting places. One was *Tierra del Fuego*, the southern end of South America, where the native people wore only a cloak of skin to keep off the wind and snow. The ship brought a missionary to be established there, but he did not stay, because he could not endure the natives' treatment of him.

The other place of interest was the *Galapagos Islands* off the west coast of South America. Here Darwin observed among other things, finches which were slightly different from finches on the mainland from which he supposed they had migrated. In colleges of that day when biological matters were discussed no changes within a species were recognized; this made a problem for our wanderer. This kind of variation is now easily explained by the findings of Gregor Mendel, of whom Darwin apparently knew nothing. After his death, one of his sons looked through his books and letters but found no mention of Mendel.

Returning to England, our traveler married and settled in a good house but never took charge of a church; in fact his activity in the life of the church became less and less. This gives reason to think that his belief in Christianity went likewise. He spent the time classifying his collection of sea animals, taking walks, and writing books and letters to scientists.

Perhaps the most noted work, certainly the best known, was what he said about natural selection. For the sake of clarity let us describe artificial selection first; for many years farmers and gardeners have chosen the plant or animal which they liked best to be the parent of the next generation. In this manner, after many generations they secured a crop which yielded more of that which they could use. Darwin called attention to this work which he saw his countrymen doing. Then he went on: nature is more powerful than man and so could achieve greater results in her selection. Without giving observed examples of this natural selec-

tion he made it a wide system. Living things started as very simple organisms, as they struggled among themselves for life, some lost their lives; but the victors grew more complex and thus more successful in their living. Thus it is not necessary to give credit to any divine Being to account for living things; for they created themselves through acquiring the organs which they needed. It seems that Darwin, in the second edition of "the *Origin of Species*" gave God credit for creating the first species; but it is certain that he did not give this credit in any later edition.

In the days before 1900 when Mendel's work was finally recognized, people had strange notions about heredity; Darwin thought that genes (that word was not in use in his time) or whatever carriers of traits which there might be made a new association by chance at each reproduction. Thus many changes took place, just by chance. We now know that the genes are regulated according to strict rules and usually keep their order. We know also that organisms have no natural tendency to become more complex, and that the ones which are complex have not necessarily any advantage thereby to live well. One-celled animals, *Amoeba* for instance, have not been crowded out of the world; and complex orchids will not live except in very favorable environments. Simple animals have not been crowded to extinction; and the most complex ones do not have an unfair advantage. The actual effect of natural selection is that it eliminates by death the old and injured ones, thus maintaining a standard.

Darwin failed to recognize the difference between artificial and natural selection; the first type produces a plant or animal of the type which the human selector wants, while natural selection produces one that will thrive and succeed without help from man. Both types have limits. We cannot prove natural selection by examples of the other type. They are different things.

Darwin agreed with many persons on his day in thinking that response to environment may be inherited. Grain sorghum in a rainy year will grow eight feet tall for instance, and bear a large cluster of seed; in a dry year it will be three feet with only a fourth as much seed. Any change due to the environment, however, is only for one generation; seed borne in a poor year will produce a good crop in another year if the environment is favorable. And we must recognize that many species are not molded entirely by the environment, for on the same ocean floor we find animals as different as oysters, starfishes, lobsters, and salmon, all built on different plans. Likewise in the forest.

Charles Darwin was not a bad man. He was glad when other missionaries were sent to the Fuegians and Christianized and civilized them. He wrote letters to the creationist Henri Fabré of France and called him the "Inimitable observationist." But he should not be given an authority above that of the countless well-trained scientists who now are speaking out with a true and helpful interpretation of the world and its life.

*William J. Tinkle, Ph.D., deceased, 1981.

ELECTRIC THEORY OF GRAVITATION

THOMAS G. BARNES*, HAROLD S. SLUSHER**, G. RUSSELL AKRIDGE,*** AND FRANCISCO S. RAMIREZ IV****

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Independent positive and negative partial fields of equal value are assumed to be associated with every source mass. These complimentary electric fields behave like dormant fields with a net zero field strength except in the region of a proton or electron. A mass upon which these fields are impressed contains an equal number of protons and electrons. Even a neutron is assumed to contain a proton and electron. The impressed partial fields exert a combination of attraction and repulsion on proton and electrons embedded in that mass. A nonlinearity in the region of each of those charges tilts the balance such that the net electric force is one of attraction that meets the conditions of a gravitation force. The theory is then extended to include additional properties of the dormant field, such as a "medium" to take the place of Maxwell's luminiferous ether and a feedback medium in electrodynamics. This unification of electromagnetic theory and gravitation also includes gravitational radiation.

Introduction

One of the long-sought goals of physics is a unified field theory, a theory that combines the foundations of physics into a minimum of basic principles. James Clerk Maxwell was able to unify electric, magnetic, and optic phenomena into one theory, his electromagnetic theory of light. This paper attempts to extend that unification to include gravitation.

After making certain assumptions related to the electric property of matter and the superposition of electric fields, the gravitation force is shown to be an electric force. This new concept includes independent positive and negative electric fields that may add up to a zero net field but still possess dormant properties that make possible the extension of electric theory to gravitation.

Elementary Fields From Uncharged Matter

Ordinary matter is assumed to contain an equal number of positive and negative elementary charges. It is well known that an uncharged atom contains an equal number of electrons and protons. In accordance with a previous paper the neutron contains an electron and a proton.¹ This composition of a neutron should not be surprising because it is known that a free neutron decays into an electron and proton.

Each of the elementary charges in matter has its own elementary electric field and they are independent of each other. Each elementary electric field varies inversely as the square of the distance from its source charge. Since there are an equal number of positive and negative charges in the source matter the net electric field is zero. That does not mean that the positive and negative fields vanish. They are independent of each other. The net field is evaluated by the superposition of those two kinds of vector fields, a process that implies the independence of each of those fields. Figure 1 illustrates that superposition process.

One might think of these two kinds of electric fields as *partial fields* very much like the *partial pressures* in

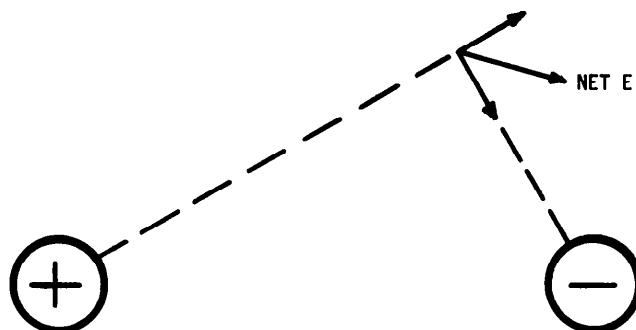


Figure 1. The vector sum of the two independent electric fields yields the net electric field.

gases. The law of partial pressures states that the total pressure is the sum of the individual partial pressures. In the case of electric fields the total electric field is the vector sum of the + and - electric fields. Those individual electric fields may be thought of as *dormant* fields that have an important part to play in the electric theory of gravitation.

Unbalanced Force on Elementary Charges

The gravitation force on an electron or proton is extremely small compared with the ordinary electric force. If the gravitation force is to be an electric force on those elementary charges it must be a very very small fraction of the ordinary electric force on them. It is indeed a second-order electric force effect that is herein interpreted as the gravitation force.

Since there are an equal number of protons and electrons in uncharged mass, an electric field acting on that mass would exert an equal attraction and repulsion force on it except for the second-order effect. That second order effect always tilts the balance to a small attraction force, the gravitation force. The unbalancing effect is due to nonlinearity in the electric field force at the proton or electron, yielding a slightly less than expected Coulomb repulsion. As will be shown later this difference in the "expected" electric force and the actual repulsion force is only about one part in 10^{36} but it is sufficient to account for the gravitation force.

It should not be surprising that nonlinearity exists when there is superposition of electric fields at the electron or proton. The self-field of an electron or proton is extremely large in the region of the charge. It is vastly

*Thomas G. Barnes, D.Sc., is Professor of Physics at the University of Texas, El Paso, Texas.

**Harold S. Slusher, D.Sc., is Assistant Professor of Physics at the University of Texas, El Paso, Texas.

***G. Russell Akridge, Ph.D., is at Westminster Schools, 1424 W. Paces Ferry Road, N.E., Atlanta, Georgia.

****Francisco S. Ramirez, IV, is a Graduate Student in Physics, at the University of Texas, El Paso, Texas.

larger than the breakdown strength of the electric field on a power transmission line. When a partial field of the same kind, having the same sign, is added to the self-field of an electron or proton the strength of the field tends to saturate, not quite reaching the numeric sum of the two fields. A similar type of field saturation phenomenon is common in electronics. It is called *overloading*.

Arnold Sommerfeld recognized the possibility of non-linearity of electric fields in the region of the electron. He stated it this way: "Who can guarantee that the Maxwell equations can be extrapolated right up to the surface or into the interior of the electron? May not their simplicity and linearity be a consequence of the fact that they are exactly valid only for weak fields and that they must be corrected in the immediate neighborhood of concentrated charges—in such manner as the theory of dilute solutions in thermochemistry?"²

The Reduction Factor

The equation for electric force on an elementary charge q in electric field E is

$$F = qE \quad (1)$$

Ordinarily the impressed electric field E_0 is considered to be unaffected by the charge on which it acts. It is now assumed, however, that the effective value E of the impressed field is diminished by the *reduction factor* k under certain conditions such that $E = kE_0$ and $F = q(kE_0)$. The *effective value of the impressed field is diminished when the impressed field has the same sign as the charge on which it acts*. When a positive field E acts on a proton the effective field is kE . When a positive field E acts on an electron the field is unaffected and it is still only E . This is in accordance with the concepts developed in the preceding section.

An impressed gravitation field is assumed to have both positive and negative partial fields and, as previously mentioned they act separately, somewhat like partial pressures in gas. Hence in a gravitation field it is only the positive partial field that experiences the reduced effect when it acts on a proton. It is only the negative partial field that experiences the reduced effect when it acts on an electron. The sign of the partial field must be the same as that of the charge for the reduction.

When a gravitation field, with its equal positive and negative partial fields, acts on an electron the result is a net attraction. The attraction of the positive field on the electron is undiminished while the repulsion of the negative field on the electron is lessened. Similarly when a gravitation field acts on a proton the result is a net attraction. The attraction of the negative field on the proton is undiminished while the repulsion of the positive field on the proton is lessened.

The reduction factor is a nonlinear function of the strength of the self-field of the elementary charge on which it acts. To get a measure of the strength of the self-field at the surface of the electron or proton one needs to know the radius of the electron and proton. In previous papers^{3,4} and a textbook⁵ the following equation is developed for the mass of the proton and electron as a function of its radius a

$$m = \frac{q^2}{6\pi\epsilon a c^2} \quad (2)$$

On the basis of this equation the radius of the proton is smaller than that of the electron. Since the electric field strength is inversely proportional to the radius squared, the reduction factor is much larger for the proton than the electron. This is as one would expect because the gravitation pull on the proton is greater than on the electron, which has less mass.

The Unbalance Factor

Consider the field due to a remote mass located at some distance r , containing N protons and N electrons. The value of the $-$ partial field due to the electrons is

$$E^- = \frac{Nq}{4\pi\epsilon r^2} \quad (3)$$

and the value of the $+$ partial field due to the protons is

$$E^+ = \frac{Nq}{4\pi\epsilon r^2} \quad (4)$$

These two partial fields are equal in value, but the reduction factor k must be included with whichever of these partial fields acts on a self-field of its same sign to convert that partial field to its effective field strength.

In order to obtain the unbalancing factor that yields the gravitational attraction force on a proton let the reduction factor be denoted as k_p and applied to the E^+ partial field. The unbalanced force, the attraction force,

$$F_p = q(E^- - k_p E^+) \quad (5)$$

and in view of the previous two equations

$$F_p = \frac{Nq^2(1 - k_p)}{4\pi\epsilon r^2} \quad (6)$$

The quantity $(1 - k_p)$ is the unbalance factor for the proton. The gravitation force of that source mass upon the proton is expressed in electric quantities in equation (6). It may also be expressed in the Newtonian gravitation form

$$F_g = \frac{GN(m_p + m_e)m_p}{r^2} \quad (7)$$

A solution for the unbalance factor can be obtained by equating Equations (6) and (7). Making that solution and substituting Equation (2) for the masses of the electron and proton one has for the unbalance factor for the proton

$$(1 - k_p) = \frac{Gq^2}{9\pi\epsilon c^4} \left[\frac{1}{a_p^2} + \frac{1}{a_e a_p} \right] \quad (8)$$

where a_p and a_e are the radii of the proton and electron. Similarly the unbalance factor for the electron can be shown to have the same form but with the radii interchanged from the positions they have in Equation (8).

Using known values of the physical constants and Equation (2) one obtains from Equation (8) the value for the unbalance factor for the proton $(1 - k_p) = 8.094 \times 10^{-37}$ and for the unbalance factor for the electron $(1 - k_e) = 4.408 \times 10^{-40}$.

Given a mass which has N protons and N electrons as the source mass, its gravitational attraction on any pro-

ton at distance r from this source mass is given by the electrical Equation (6) with the unbalance factor value listed above. Similarly the gravitational attraction of that source mass on any electron at distance r from that source is given by the same type electric equation using the unbalance factor for the electron listed above.

Total Gravitation Force

The mass upon which a gravitation field acts consists of protons and electrons. Remembering that the neutron contains a proton and electron, the total number of protons in an atom is its atomic mass number and that is also the number of electrons in the uncharged atom. To get the total gravitation force on a mass one must sum up the force on each proton and on each electron. Denoting the total number of protons as N_1 , which is also the number of electrons, and summing all the forces yields the total force of gravity

$$F_g = \frac{N_1 N_2 q^2}{4\pi\epsilon r^2} [(1 - k_p) + (1 - k_e)] \quad (9)$$

where N_1 is the number of protons and also the number of electrons in the source mass.

In light of Equation (8) the bracket factor in Equation (9) reduced to

$$(1 - k_p) + (1 - k_e) = \frac{q^2}{9\pi\epsilon c^4} \left[\frac{a_e + a_p}{a_e a_p} \right]^2 \quad (10)$$

which is the important conversion factor from electric to gravitation force, as seen in Equation (9). Note that this conversion factor is inversely proportional to the square of the geometric mean radius of the electron and proton. One would expect the electric unbalance to be inversely proportional to the square of the mean radius because the nonlinearity in the superposition of the impressed field on the strong field at the elementary charge is proportional to the strength of the self-field. The self-field strength is inversely proportional to the square of the radius of the proton or electron as the case may be.

Referring back to Equation (9) it is seen that this "electric" force varies inversely as the square of the distance, as one would expect of the gravitation force. This meets all of the conditions needed for the gravitational attraction between two masses. It does raise a question as to whether gravitational mass is equal to inertial mass. That will be discussed in the next section.

Gravitational and Inertial Mass

Gravitational mass and inertial mass are not necessarily the same quantity. Gravitational mass is the mass employed in Newton's universal law of gravitation. Inertial mass is the mass in Newton's second law of motion, the inertial reaction to any acceleration. Historically the two have been considered to be the same quantity. Certain experiments are supposed to have confirmed the equality of gravitational and inertial mass. There is always some question as to whether or not these experiments have in fact shown that the two quantities have the same value under all conditions.

There is excellent experimental evidence that inertial mass increases with speed, as one would expect from the

special theory of relativity. J.J. Thompson and others have shown that a high speed electron when acted upon by a transverse magnetic field can not make as sharp a turn as one with lower speed and the same transverse force. This seems to confirm that there is an increase in *transverse* mass with speed and this is an inertial property. Strangely there is an even greater *longitudinal* mass associated with that same speed.⁶ It is more difficult to accelerate a "speeding" electron longitudinally than transversely. Each of these masses is defined by Newton's second law in the familiar vector form $F = ma$; mass is that inertial property that makes it more difficult to be accelerated.

The question naturally arises as to how gravitational mass could possibly be the same as inertial mass if there are two different inertial masses for the same body, a transverse mass and a longitudinal mass? Some writers give this as an illustration that gravitational mass and inertial mass are not the same.

It seems that this present electric theory of gravitation requires a distinction between gravitational mass and inertial mass. Thus far the treatment has been considered independent of motion. Equation (2) for mass (2) relates to rest mass and the charge on the electron or proton are considered to be constant, independent of motion. Conversion factor (10) is not a function of motion. So at first glance it would appear that the gravitational mass in this electric theory is independent of speed. There may however be a need to include speed in the conversion factor because the self-field of a moving charge is altered and it was the value of the self-field that was considered to cause the nonlinearity, the greater the self-field the greater the nonlinearity. So it may be necessary to alter the conversion factor so as to take care of high speed motion effects. But a cursory look at this theory does not seem to yield mass increases that would correspond to the transverse and longitudinal inertial masses. The increase in the self-field of an electron in high speed motion is in the transverse direction and not in the longitudinal direction.

The increase in nonlinearity appears to be in the opposite direction from the increase in inertial masses. But that problem must be studied more carefully before drawing a firm conclusion.

It may be that the difference in inertial and gravitational mass can be shown to cause the well known precession of the perihelion of Mercury, which Einstein considered to be proof of his general theory of relativity. This would be a totally different approach to that subject.

Extension Of The Theory

The concepts included in this electric theory of gravitation may be extended to unify additional areas of physics. The dormant field, the + and - partial field, may be the medium in which light is propagated. In a previous paper, A Classical Foundation For Electrodynamics⁷, an alternative to special theory of relativity was developed. It made use of feedback from the ambient medium, associated with a preferred frame of reference. This dormant field is now considered to be

that ambient medium. Since it has also been considered to be the gravitation field, the conclusion is reached that the gravitation field is the light-bearing field. It may be the answer to that elusive search for the luminiferous ether which was originally proposed by Maxwell in his electromagnetic theory of light.

The concept of the gravitation field as the field in which electromagnetic waves are propagated has far reaching consequences. If that be correct, it means that Einstein's second postulate of special relativity is wrong. It means that one can reject the concept of relative time, the so-called time dilation, and the concept of space contraction. It means that modern physics can now return to ordinary time and ordinary geometry, as was proposed in the previously mentioned paper. A justification for the abandonment of Einstein's special theory was treated in the previously mentioned paper and its companion paper, A New Theory of the Electron⁸. Numerous other authors have challenged Einstein's second postulate, including Herbert Ives of the Bell Telephone Laboratories⁹. There is no longer any reason for blind faith in the special theory of relativity. Modern cosmology has acknowledged that special theory of relativity can not hold for extended regions. Cosmologists have adopted an absolute rest frame, which is completely contradictory to Einstein's special theory. However, they hedge by using special theory locally and rejecting it for space in general. That contradictory turn of events is seen in Martin Harwit's *Astrophysical Concepts* page 178: "Rather, the establishment of an absolute rest frame would emphasize the fact that special relativity is really only meant to deal with small-scale phenomena and that phenomena on larger scales allow us to determine a preferred frame of reference in which cosmic processes look isotropic."¹⁰ It is much more reasonable to have a unified theory of electromagnetic and gravitational phenomena than to follow the present practice of attempting to "have the cake and eat it too".

A further step in the development of a unified field theory is taken by combining the electric theory of gravitation with the concepts developed in the paper by Barnes and Upham, Another Theory of Gravitation: An

Alternative to Einstein's General Theory of Relativity¹¹. In that paper gravitational fields d , g , b , and h were defined to be analogous to the electromagnetic fields D , E , B , and H and postulated to obey four field equations that were analogous to Maxwell's four field equations of electromagnetic theory of light. One difference in those equations and the Maxwell equations was that a negative sign had to be introduced to specify attraction between "like" masses whereas the electric equation has repulsion between like charges. One can now extend the present paper's electric theory of gravitation to give the justification for that negative sign and to ascribe electric properties to each of those gravitational fields. That paper developed equations for gravitational radiation.

Gravitational radiation can now be described as the radiation of both elements of the dormant field, the $-$ partial field and the $+$ partial field, and only detectable on the order of magnitude of gravitational effects and due to the nonlinearity of the electric fields at the protons and electron as previously described in this paper.

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- ¹¹Barnes, T.G. and R.J. Upham, Jr. 1976. Another theory of gravitation: an alternative to Einstein's general theory of relativity. *Creation Research Society Quarterly*: 12(4):194-197.

AUSTRALIAN CREATIONIST JOURNAL

We understand that the Australian Journal *EX NIHILO* is now available in the United States, at P.O. Box 281, Glen Ellyn, Illinois 60137. The cost of a subscription is \$15.00 per year.

EX NIHILO seems to be published quarterly. The position taken in it seems to be much like that usual in our *Quarterly*, for instance, the young-earth viewpoint. The articles and items are perhaps on the whole somewhat less technical than those in the *Quarterly*; but it is intended to have one technical article per issue, for instance those by Setterfield, mentioned in *Panorama of Science* in this issue of the *Quarterly*.

PLACEMENT SERVICE

Do you know of academic vacancies to which Creationists might be directed? The Creation Research Society would like to be in a position to be able to inform Creation scientists of such vacancies. If you know of such positions, will you please inform Dr. John W. Klotz, 5 Seminary Terrace North, St. Louis, Missouri 63105, describing the position, and the academic requirements and training required, and giving any other information which might be available?

Graduate students who are interested in placement may write to Dr. Klotz for information about any available positions which are known to the C.R.S.

RADIOCARBON: AGES IN ERROR†

ROBERT E. LEE*

"It may come as a shock to some, but fewer than 50 percent of the radiocarbon dates from geological and archaeological samples in northeastern North America have been adopted as 'acceptable' by investigators". J. Ogden III.

Discusses problems that have made radiocarbon unreliable, from ancient carbon-14 levels and contamination to abuse of reported ages. Illustrates effect of faulty chronology on genuine knowledge, with Ernst Antevs as example. Drastic change in attitude essential, if radiocarbon is to become a valid means of dating the past.

The troubles of the radiocarbon dating method are undeniably deep and serious. Despite 35 years of technological refinement and better understanding, the underlying *assumptions* have been strongly challenged, and warnings are out that radiocarbon may soon find itself in a crisis situation. Continuing use of the method depends on a "fix-it-as-we-go" approach, allowing for contamination here, fractionation there, and calibration wherever possible. It should be no surprise, then that fully *half* of the dates are rejected. The wonder is, surely, that the remaining half came to be *accepted*.

It was in the early fifties that archaeologists and geologists alike adopted the method itself as acceptable,¹ placing it above all other means of dating sites and materials. The previously-determined age estimates and cultural sequences did show radiocarbon to be in error, but were themselves tossed aside—even though this meant turning the physical evidence of stratigraphy upside down.² The cautionary words of Dr. Willard Frank Libby, who with J.R. Arnold developed the method, were thrown to the winds; readily apparent warning signs were ignored; skeptics were scornfully called "non-believers". Indeed, radiocarbon swept the scientific world with all the fervor of religious fanaticism, as the new and "absolute" chronology was established.

The Radiocarbon Method

Radiocarbon dating can be applied to virtually anything that is carbon-bearing, such as charcoal or bone, provided that it is not much more than 40,000 years old. The basic theory, worked out in the late 1940's, is attractively and deceptively straightforward.

In any suitable material, the amount of one particular type of carbon gradually decreases with the passage of time, at a *fixed rate*. By measuring what remains, the age of the sample can be calculated. This carbon-14, as it is called, can be detected through the radioactive disintegration of its individual atoms.

Carbon-14 exists in fixed proportion to ordinary carbon. Green plants draw both of them out of the air at the same time, in the process of photosynthesis, while aquatic organisms use bicarbonate ions that are dissolv-

ed in the water. Thus, carbon-14 enters the food chain and is distributed to every living thing.

At death, this fixed proportion begins to change, because the slow radioactive decay of carbon-14 is no longer balanced by food intake. Like the sand in an hourglass, carbon-14 trickles away, until too little is left to be measurable.

An accurate determination for some long-buried object is not quite so simple as might at first appear, though. Indeed, a great part of the original assumptions and methods have been called into question. Some of them can be modified, perhaps, for continuing use. But for others, no one ever yet has found a sure solution.

Synchronizing Radiocarbon with Reality—Maybe

It was necessary to assume, in the early days of radiocarbon dating, that the supply of carbon-14 to living things had always been constant. Had it been otherwise, the radiocarbon clock would have started its run from different initial settings, and all of the dates from a given period would be out of kilter. Over the years, as we are now aware, evidence continually mounted against that assumption of constancy. The production of carbon-14, in fact, has been known to vary over long periods, causing dates from much of the past seven millennia to be too recent by nearly a thousand years. Beyond that range, the difference between the radiocarbon age, as it is called, and the true age, can only be *guessed* at.

Libby began with the most estimable caution in this matter of constancy. As his method grew in importance, however, he became increasingly inflexible and, after several years of rising challenges, sought to defend what had become his *position*.

Examining the information then available, he did find that the age discrepancies were real, but argued that they were too inconsistent to have meaning. The fledgling tree-ring studies he dismissed, because "some trees add more than one ring per year". Egyptian historical dates that also failed to match radiocarbon, he said, "may be somewhat too old".³

Having managed to shift attention away from the shortcomings of his own methods, Libby then felt able to apply rigid restraints to the potential causes of carbon-14 variation—on the mistaken grounds that carbon-14 *production* seemed to have been constant.

In the face of this desperate attempt to stem the tide of doubters, research into tree-ring comparisons accelerated tremendously. Well over a thousand radiocarbon dates were checked by dendrochronology. It thus became clear that many of the samples previously dated

*Mr. Robert E. Lee is Assistant Editor of the *Anthropological Journal of Canada*. His address is 1575 Forlan Drive, Ottawa, Ontario, Canada.

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by radiocarbon were, in fact, much older than the determinations arrived at. A *new* radiocarbon revolution was touched off immediately. Ages past began to stretch, and the "facts" of prehistory were drastically altered in the process.

1) Checking Against Tree Rings

The gnarled form of the bristle-cone pine has become symbolic of radiocarbon calibration. This tree, a native of certain upper mountain slopes along the California-Nevada border, provided a 7000-year record, against which checks have been made on radiocarbon dates. The accuracy of that record, however, has been challenged by Gladwin,⁴ who characterizes the bristlecone as a tree "even more undependable than the junipers", which may not grow annual rings at all in dry years. They respond so closely to local weather, he argues, that ring patterns from within a few hundred miles of each other "show no similarity whatever". Understandably, therefore, he was leery of the practice of forcing patterns to match by arbitrarily inserting "missing rings" to bring them into line.

Whether accurate, or merely approximate, comparison with tree rings did prove that radiocarbon dates were wrong—usually being much too young. At the same time, it seemed that the precise *extent* of the errors was indicated. When plotted against counted rings, radiocarbon dates fall into a wandering line that runs some hundreds of years from where it ought to be. By means of this *calibration curve*, any appropriate radiocarbon date can be corrected. As seen in Figures 1 and 2, such curves have several important characteristics—and these have been tied to variation in atmospheric carbon-14 levels.

2) Magnetic Field Effects

The general trend of dates away from what they should be is thought to reflect major shifts in the shielding effect of the earth's magnetic field. Carbon-14 is produced high in the atmosphere by the action of cosmic rays. A weaker magnetic field, some 4000 years ago, would have allowed *more* cosmic rays to reach the atmosphere, resulting in excessive concentrations of the radioactive isotope. Samples from that period would consequently have a C-14 activity equivalent to only 3000 *true years*.

It is believed that only in times of magnetic-pole reversal does the shielding effect diminish noticeably. Theoretically, however, a reversal could throw radiocarbon dates off by enough to make 18,000 years come out as 13,000—quite enough discrepancy to upset a lot of firmly held beliefs.⁵ The actual timing of such events is not known, but there is evidence of at least two of them, in the past 35,000 years. Measurement of ancient field strengths, as preserved in artifacts of fired clay, support the inference that the magnetic field has indeed been weaker in earlier times.

3) The Presumed Influence of the Solar Cycle

Most calibration curves are not really so smooth and simple as that shown in Figure 1, but record numerous small fluctuations in radiocarbon activity. These ir-

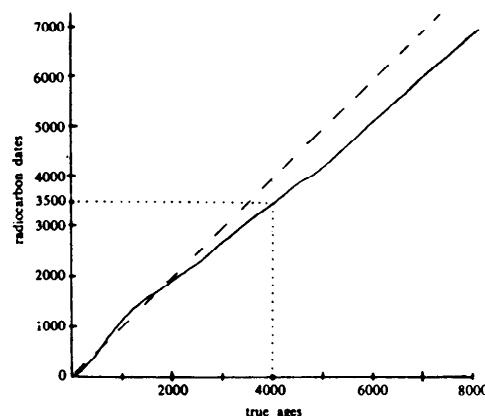


Figure 1. A smooth calibration curve allows correction of some Carbon-14 dates. Thus, 3500 years comes out as 4000 true years.

regularities are commonly attributed to the effects of the 11-year sun-spot cycle, for sudden bursts of cosmic rays are known to produce greater quantities of carbon-14. It is quite reasonable to assume, of course, that these episodes of high carbon-14 concentration would show up in tree rings. The resulting wriggles would make calibration curves much less useful, because many radiocarbon dates now match more than one position in time, as indicated by the curve (Figure 2).

These minor fluctuations are obvious, explainable, and expected. Yet there is good reason to believe that they do *not* represent cycles in solar activity. It seems that different calibration curves may wriggle in *opposite* directions, so that a date corrected on one curve may come out 400 years different from the same date "corrected" on another curve.

Applying statistical principles to what is really a statistical problem,⁶ Clark found that there is simply too much error inherent in the radiocarbon technique to permit measurement of such fine fluctuations. Those wriggles that were so easily tied to solar activity are actually nothing more than random variations in radiocarbon measurement. By gathering the dates from

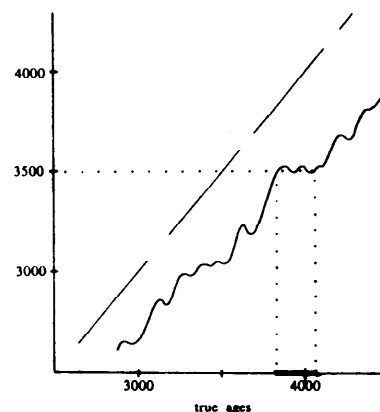


Figure 2. Most calibration curves wriggle up and down, giving multiple—hence unreliable—values for a single radiocarbon sample. (Vertical scale, radiocarbon dates; horizontal scale, true ages.)

many radiocarbon labs, Clark assembled and published his own very smooth, *statistically-sound* calibration curve, much like that sketched in Figure 1.

There has been no agreement, however, on which calibration curve to use. It is plainly not possible for *all of them* to be right, and the final version may be a long time coming. Meanwhile, no informed person is eager to use obviously uncalibrated dates in his work. "Eventually", noted Stuckenrath,⁷ "those 'corrected' dates will have to be uncorrected in order to be re-corrected in order to be correct". It *could* become confusing, with different dates for the same sample appearing at different times in different journals—especially if conclusions have to be changed as a result.

4) Extension of the Calibration Curve

At best, the bristlecone calibration curve reaches back only 7000 years. Beyond that point, at which the difference between radiocarbon and real ages is about 1000 years, the discrepancy is more or less unknown. True, there have been attempts to extend our knowledge, but with uncertain results. Radiocarbon dating of a single long core of varved clay, for instance, appeared to show general agreement with the tree-ring curves where they overlapped, and suggested a continuation of the 1000-year difference back to at least 10,000 years ago.⁸

On the basis of comparison with the more recent dating method, *uranium-series*⁹, Stuiver was also led to claim¹⁰ that the difference should not exceed 2000 years over the period of 22,000 to 32,000 B.P. (years before present, as of 1950). In discussing magnetic pole reversals, though, Barbetti and Flude¹¹ see support in uranium-series for a theoretical 5000-year discrepancy. Whatever the truth may be—and it does seem a little hard to come by—it should be remembered that this uranium-series method was originally *validated* by the very technique now under question, a clear case of applied circular reasoning!

Atmospheric and Oceanic Mixing

Once produced, radiocarbon seems to spread around the world fairly rapidly and evenly, through movement of the air. There are, however, some tricky situations of local scope. In the vicinity of a volcano, for instance, living plants can absorb enough inactive carbon-14 to date to more than 4000 years ago. Ancient materials, too, can seem to be that much older than they really are.¹²

The amount of carbon-14 actually available is kept fairly stable by the action of the great ocean reservoirs. The seas have an enormous capacity for soaking up carbon dioxide from the air, thereby moderating changes in atmospheric levels of radiocarbon. The rather slow circulation of ocean waters also allows time for radioactive decay—and this balances the continuous production of carbon-14 in the upper atmosphere.

Organisms such as shellfish, seals, and whales obtain their carbon from seawater, rather than from atmospheric sources, and are getting radiocarbon already in circulation for some hundreds of years. Although this "reservoir effect" is usually estimated at 350 years, it is

not everywhere equal. In Scottish coastal waters, modern shells do indeed date 350 years too old.¹³ But off Norway the apparent age is 440 years, at Spitsbergen 510, and all of 750 years off Ellesmere Island¹⁴. Further, *some* shallow-water species appear to use a certain amount of atmospheric carbon, after all, and *their* dates are not nearly so far off. Much as a correction factor is needed in dealing with marine remains, no single figure is properly applicable. Yet it is common practice to use a standard estimate of the reservoir effect to cancel out the opposite fractionation effect—without direct measurement of either!

Vastly older carbon can affect dates on shellfish and aquatic plants when, for instance, limestone underlies the water. The "hard-water effect", as it is called, varies considerably from place to place, but is claimed not to exceed 3000 years.¹⁵

Carbon in Living Things

Carbon-14 generally appears, in plants and animals, in the same proportion as prevails in the air or water about them, since the isotopes of carbon are chemically indistinguishable. This should mean that, at death, all radiocarbon clocks start running from the same initial setting.

Carbon-14 is a little *heavier* than ordinary carbon-12, however, and some plants actually *prefer* these heavier atoms when they are building food molecules. This separation of different carbon isotopes is called fractionation. Plants of arid lands, and also of salt marshes, thus *enrich* the carbon-14 in their tissues, so that they date a couple of hundred years too young. Certain other plants handle the isotopes indiscriminately, except when facing adverse growing conditions. Alteration of *their* radiocarbon age depends on *what life was like* for the plant in question.

Among animals, fish-flesh dates 50 years too young; bone, horn, antler, and shellfish-meat 175 years too young; and mammoth-ivory 250 years too young. Shellfish carbonate is even more strongly affected, giving readings of 400 years too young. Stubbornly, blubber leans the other way, dating 200 years too old.¹⁶

By good fortune, another isotope, carbon-13, can be measured in an affected sample, and the results used to correct the radiocarbon date for fractionation. These extra determinations, now made individually, will someday be available for each species in turn.

Contamination in the Ground

At the death of every organism, the absolutely unalterable process of radioactive decay begins to change the isotope *ratio* in its tissues. All exchange of carbon is presumed to cease. A piece of bone or a lump of charcoal is supposed to lie inert and isolated in an earthen tomb.

However, modern carbon, which is high in carbon-14, continually penetrates the soil and is absorbed by materials buried there. Some, the product of recent decomposition, washes downward, while growing plants push their *living* roots far more deeply into the ground than is commonly realized. Modern carbon appears to be the usual contaminant,¹⁷ causing most

radiocarbon dates to be younger than their true ages. Sometimes, modern carbon *itself* is so contaminated by radioactive fallout that such materials as ancient American Indian pottery actually date into the future!¹⁸

Even the most minute amounts of contamination are significant in extremely old samples. In the case of a sample that is really 75,000 years old, for instance, introduction of just *100 parts per million* of modern carbon lowers the apparent age by 5000 years.¹⁹ Five percent contamination would simply overwhelm the depleted original radiocarbon, yielding a date of 25,000 years. Is it not possible that some of the samples we now accept as 25,000 years old are actually *vastly* older?

Indeed, 5% contamination may not be all that uncommon. Stuckenrath²⁰ was even more pessimistic: "The majority of organic samples from the northeast are contaminated in this direction and the likelihood of 10 percent is probably a conservative estimate". Under these conditions, any date published as 7500 BP could really be read as 10,000 BP.

Materials

A wide range of carbon-containing substances have been subjected to dating, with inconsistent results. Charcoal, being the nearest thing to elemental carbon, is favored as the most reliable, while shell and bone are usually viewed with well founded mistrust.

1) Charcoal and its Problems

Although so porous as to readily absorb organic compounds from the soil, charcoal can be thoroughly cleansed of contaminants—if the sample is large enough, and *if* cleansing is done. If it is *not* done, an erroneous date, influenced by contaminants, will result.

Without these special techniques, not even the most meticulous collecting and handling can ensure accurate dates. In an early test case, designed to demonstrate the absolute consistency and reliability of radiocarbon, five samples of good charcoal were carefully collected from a single Paleo-Indian hearth some 12 feet below the surface, at the Lehner Kill site in southern Arizona. But alas! when tested,²¹ the radiocarbon dates were spread from 7022 ± 450 to $12,000 \pm 450$. In great glee, Ernst Antevs wrote, "This proves beyond all doubt that the Indians kept a fire burning for 5,000 years!"²²

Another experiment, intended to show that charcoal-bearing soil could be concentrated for dating, also took an unexpected turn. In the field, the larger chunks and bits of charcoal were separated by hand, and the visible plant rootlets removed. Smaller particles of carbon were caught when the soil was subsequently washed through fine-mesh screens, and again when dust-like carbon floated to the top of the water. With a fair degree of consistency, the finer the material, the younger the radiocarbon dates. The maximum difference was about 10%. No satisfactory explanation has been given.^{23, 24}

2) Peat and Other Soils

The widespread belief that peat is another highly reliable material no doubt stems from the superb preservation

of organic material within it, such as seeds, leaves, and insect eggs in undisturbed clusters. So great is the degree of confidence in it that few people trouble themselves to ask for special pre-treatment. Not even the chilling warning of "less than 200" years for sample W-130 has shaken their faith—even though *that* sample of peat was obtained from 30 feet down, *under* glacial till!

Actually, peat is subject to a high degree of contamination and consequent error. The various chemical parts of a single block of peat can be separated by treatment with a series of organic solvents and acids, yielding different dates on each compound. Reasoning that the most resistant compounds are the least likely to be affected, the last remaining part is thought to represent the original carbon content. Dates on this residue are older than dates on the other fractions, and older than on the whole sample, indicating that the contaminant is modern carbon. The more ancient the sample, the greater the difference—sometimes adding more than 15,000 years to the age that would normally be determined!²⁵

Using such chemical treatments, other soils too can be broken into fractions, and dated. Again the most resistant part, the humic fraction, is found to give the oldest dates. But even this most-nearly-original carbon appears to be contaminated, since the humic acid dates still fall well short of the true ages, as determined by other means. Apparently, no chemical or physical process can isolate the original carbon of the sample. Concluded Gilet-Blein *et al.* "Most fossil soils cannot be dated by [C-14] measurements."²⁶

3) Bone

Similarly, radiocarbon dates on bone have never been satisfactory. Not only do they disagree with associated charcoal dates, but among themselves too. From the famous Cooperton Mammoth site in Oklahoma, for instance, a single animal produced leg bones dated at $17,575 \pm 550$, and ribs $20,400 \pm 450$ years old. Still another figure came from testing its tusks!

Bone dates can be determined either upon the solid carbonate, which is the easier method, or on the organic (collagen) fraction. Because the carbonate is subject to exchange with modern atmospheric carbon, it gives falsely *young* dates, and is not well regarded. The collagen fraction is not without problems, either. Fungus hyphae, plant rootlets, and bits of charcoal or wood—too small to be removed by hand—can contaminate the sample, and standard methods of decalcification fail to remove them.²⁷

In all cases studied by Tamers and Pearson²⁸ the bone-dates were too young. The discrepancies between associated bone and charcoal dates were more pronounced in older samples, ranging to so much as 3000 years at determined ages of 10,000 BP. Through experiment they found that bone carbonate exchanges only with atmospheric carbon, and not with old carbon in ground water. They also took issue with the normal chemical treatments given bone samples, and made improvements. Even so, two-thirds of their dates came out too young. They, too, concluded that "the majority of radiocarbon dates on bone are in error."

4) Shell

Even more than bone, shell is deserving of suspicion. Not only must reservoir and hard-water effects, as well as fractionation, be taken into account, but contamination can throw dates off unexpectedly. To illustrate: a fossiliferous shell horizon of apparent Pleistocene age gave a series of dates, stretching from 2000 to 3500 BP.²⁹ In Egypt, another Pleistocene deposit (determined on charcoal as 19,000 BP) also yielded erroneous shell dates: 12,850, 4040, and 3170 BP; these were rejected as "much too recent" by Wendorf *et al.*³⁰ Apparently, the fault lies with modern carbon replacing the original material. This kind of exchange should be expected in well drained sites, especially on raised beaches.

Naturally, contamination is worse on the surface of a piece of shell than in its core. Separation by acid treatment shows that the surface tends to date younger than the innermost fraction of the same shell—occasionally, by so much as 500 to 1000 years. It is an unfortunate, though quite common practice to wholly dissolve shells for dating³¹.

Contamination in the Hands of the Collector

After untold ages in the ground, material destined for the radiocarbon lab will be unearthed by some dedicated geologist or archaeologist—often by an inexperienced student. To get a good sample, this individual must exercise the greatest care—requiring a degree of knowledge that he may not have. The material must not be handled as it comes out of the soil, nor be dusted off with organic tools, such as bristle brushes. Even cigarette smoke is a contaminant, to say nothing of the ashes that tumble into the sample.

A proper container ought to be on hand—exposure to the air allows fresh dust and pollen to settle. The sample should be gathered as quickly as possible, and wrapped in *new* aluminum foil—not dropped into a lunch bag or one's pocket. Samples submitted in cloth, plastic, paper, or any kind of tissue "are almost useless"³². Naturally, it is folly to put different samples together, even temporarily. Finally, it is important to ship the sample off to the lab *promptly*—especially if it is moist. Otherwise, fungi may begin to grow, using modern carbon from the air for their metabolism.

Badly deteriorated materials should *not* be coated with preservative, if the intention is to submit them as radiocarbon samples. While some chemicals can be removed, failure to do so can halve the date. In the case of some Colorado mammoth bones, contaminated samples dated to only 5240 BP. Chemical cleaning of the material permitted a new date of 9240 years to be obtained.³³

All of these problems have been discovered through unfortunate experiences. Porous samples of charcoal were indeed collected in used coffee cups, giving erroneous dates that—if not immediately rejected—entered the literature to be listed again and again. Today, most people in the profession know better, but through carelessness or unwillingness to discard a risky sample, unnecessarily erroneous dates are still being obtained.

The Laboratories

Since the beginning of radiocarbon dating at the University of Chicago, dozens of labs have sprung up across the United States and around the world. For a number of years, the solid-carbon method was the only one available. Sample materials of all kinds were burned to charcoal, washed with acids, and placed in a shielded Geiger counter. Unfortunately, charcoal in the lab, as in the ground, is prone to contamination. Some labs in particular lay in the path of radioactive fallout from atomic bomb tests, or suffered from leaks of radioactive sewer gas. For such labs, there were serious problems.

Solid-carbon is also capable of absorbing some of its own beta-rays, by which the radiocarbon is to be detected.³⁴ For still other, *unknown* reasons, solid-carbon dates from arctic and sub-arctic samples "were erratic in distribution, and unsatisfactory, even though occasional dates appeared to be useful."³⁵

In the mid-fifties the gas-counter rapidly replaced the old method. In this procedure, samples were converted to carbon dioxide. The dates thus obtained were thought to be more accurate, but Johnson observed that on northern samples, the new method still "failed to produce a chronology that was unequivocal. . ."

Further advances in technology brought liquid-scintillation counting, which seems to be neither more nor less reliable than gas counting.³⁶ Both are limited to a practical range of 30,000 to 40,000 years, even though theory suggests greater extremes.

And now, we stand on the threshold of a new, totally different kind of technology—one that is expected to routinely date materials 100,000 years old. Minute samples will be specially prepared, then sped past magnetic lenses in a tandem electrostatic accelerator. Different atoms and ions will be deflected according to their atomic properties, and their numbers will be directly determined, rather than inferred from radioactive decay.

Introduction of this high-energy mass spectrometry is delayed by unsolved problems. Apparently, ions having the same magnetic rigidity as carbon-14 can heavily contaminate the prepared samples. Additionally, there is an altogether *unknown* source of carbon-14 somewhere within the equipment.³⁷

Although samples so small as half-a-gram can be dated in conventional counters, much larger samples are preferred by the labs. With 50 or 100 grams (two to four ounces) of charcoal adequate chemical decontamination is feasible. On less concentrated materials such as bone or shell, a much greater quantity is required. It is common practice, nonetheless, for archaeologists and geologists alike to collect insufficient material, and most labs will run the samples through the counter anyway. If the dates are disagreeable, sample size is faulted.

In general, radiocarbon labs seem to do a fair job of determining sample activity. It is said that they make a second run on each sample, a week later, to detect possible radon gas contamination (radon decays swiftly). However, many GSC dates, at least, are based on only one run³⁸. Recounts *usually* coincide, but in a notable

exception, “the determined age of sample M-411 was increased more than 2000 years by extending the time of measurement from the conventional 48 hours to a fortnight”.³⁹ It raises a question about what would result if *all* tests were thus extended.

The Statistics of the Thing

All labs estimate the *statistical* uncertainty of their age determinations, and express it as a plus-or-minus figure, which is appended to each date. They do *not* take into account the age of a tree when it died, or from what part of a large-diameter trunk the sample came. Neither do they concern themselves with the *extent* of contamination. Their sole concern in this matter is the amount of error involved in laboratory measurement. This *standard error*, as it is called, is *not* intended to bracket the possible range of the date, but is instead a measure of *probability*. It indicates, to the informed, that there are two chances in three of the date falling within the indicated spread, and one out of three that it actually lies *outside*.

When two dates are compared, the statistics of the thing dictate that there is a fifty-fifty chance of at least one of them lying outside its own standard error. If *four* dates are being compared, you may reasonably expect one or more to exceed its own plus-or-minus figures—the probability is four out of five.

In applied statistics, however, use of what amounts to a 68% confidence-interval is virtually unknown. By *doubling* the standard-error figure, a more acceptable 95% interval is obtained. *Now*, when two dates are compared, the chances of one of them lying outside the interval are only *one in ten*. If, however, *ten* dates are to be compared, the odds once more approach fifty-fifty.⁴⁰

Although cross-checking of specially prepared standards in eight different labs did yield “impressively close” results⁴¹, the practical side of radiocarbon dating tells *another* story. When one lab dates tree rings of a given period, the results ought to coincide with the dates obtained in another lab, or in *all* labs—within the limits of standard error.⁴² Instead, Clark⁴³ found that the actual variability was “far in excess” of what should be expected.

Pardi and Marcus⁴⁴ calculated that the actual error was more than *four times as great* as that shown in the standard error. Both for individual dates and for the tree-ring calibration curves, Pilcher and Baillie⁴⁵ felt compelled to assign a *minimum* of 100 years as the proper standard error for any date. To achieve an acceptable level of 95% confidence, this figure had to be doubled to 200 years. *Any* calibrated date, they pointed out, must combine both its own confidence interval and that of the calibration curve. This gives a plus-or-minus spread of 800 years for the *best* of radiocarbon determinations, after calibration.

Proper use of radiocarbon dates really does require an education in statistics. In a hypothetical situation, suppose that one has to work with two old dates from published sources, 3000 ± 150 and 3500 ± 150 (Fig. 3). They appear to suggest a good separation for the two samples, but there is some degree of risk that one might lie outside its standard-error limits. Better to double

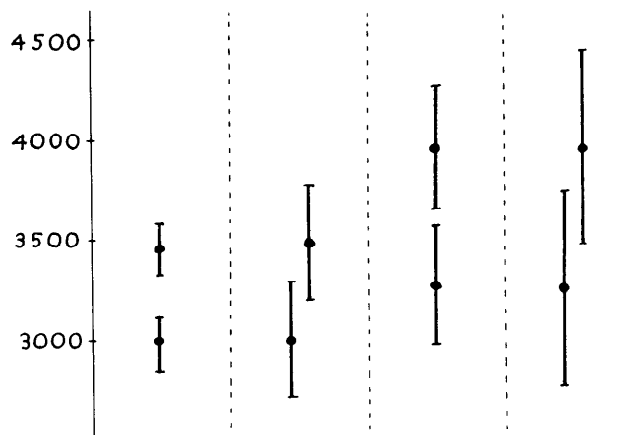


Figure 3. Step by step, the same pair of radiocarbon dates is transformed by better statistical treatment. From left to right: Uncalibrated, 68% confidence interval; uncalibrated, 95% confidence interval; calibrated, 95% confidence interval; and calibrated, combined confidence intervals. Do these two dates really represent different ages?

those limits and obtain a 95% level of confidence. Now, however, the dates *overlap*. But wait—there is more. Neither one of the dates was ever corrected on a bristlecone calibration curve! Try the famous curve of Dr. H. Suess—and delight in the fact that the gap between the dates widens to 700 years, making them 3310 ± 300 and 4000 ± 300 ! *Now* they can be claimed as proof of different levels—or *can they?* Whispering in the back of one’s mind are the words of the statisticians, who say that the standard error has to be *added* to that of the calibration curve, for each date. Once more, study the results, and try to figure out your chances of being wrong—in the final analysis, the dates are 3310 ± 500 and 4000 ± 500 . The standard errors overlap even *more* than before! Shakes you a bit, *doesn’t* it?

Actually, the fact that the standard errors overlap a little is not sufficient reason to rule out separation of the dates. It all comes back to *probability*, for the greater the overlap, the more *likely* it is that the dates really apply to the same event. The lesson in this is that “there will be situations where conclusions drawn by the archaeologist from a given radiocarbon date will depend critically on which formula is used to estimate the accuracy of the date after calibration”⁴⁶. Working out the probability associated with the varying degrees of overlap is no easy matter, but Carl Hubbs and Alfred Perlmutter⁴⁷ did set forth general guidelines.

The Part Played by the User

The collector of a sample—and he *alone* is familiar with the circumstances on the site—must exercise a comprehensive knowledge of the problems involved in radiocarbon dating. Proper handling of the material in the field is essential, together with competent evaluation of possible contamination. Later, when a date has been determined, he should act responsibly in using it.

A sample that is not associated with the culture of particular interest is quite useless, as some have learned after spending their money.⁴⁸ It took two tries on sample M-1530 to persuade one archaeologist to check his *own*

records, and lo!—the carbon was thus belatedly discovered to have been separated from the major cultural component by *six inches of sterile soil*!⁴⁹ A discrepancy of 1000 years had resulted.

Although there *are* means for clearing samples of their contamination, the collector has to *ask* for special pre-treatment. Otherwise, it will not be done. The resulting poor dates have to be explained away—perhaps by noting somewhat tardily that the sample material had been “saturated by solution from [an] overlying bed of manure”⁵⁰ Much more commonly cited as contaminants are plant roots. These were blamed by Martijn as an infestation giving rise to the troubling rejuvenation of one of his dates to nearly modern levels⁵¹. Such poor samples as these should never have been submitted at all, for dating.

Remembering Ogden’s stunning observation that collectors come to reject *more than half* of all dates obtained for them⁵², one surely must wonder how they can presume to know age *better* than the sophisticated technology picked to measure it. They *do*, though, as attested by the astonishing frequency of their comments in radiocarbon date lists: “apparently too old”, or “100 years too late”, or “5000 years too late”, or “impossible,” and “also impossible”—to give just a few examples from an enormous body of them.

As Sanger innocently expressed it⁵³, “Chronology constitutes a problem if all the radiocarbon dates are used”. Some dates, evidently, just have to be *eliminated*, if others are to become “plausible”. Internal consistency in a series of dates is popularly taken as a sure sign of accuracy—but the date must also fall into line with *accepted beliefs*. One author managed to meet both criteria by rejecting *one-third* of his dates, making it possible to “erect a chronology which is compatible with the known late Pleistocene and Recent history.”⁵⁴

Sometimes it seems imperative that even lone dates must be tossed aside, as when “acceptance of [McGhee’s] date would place Canadian Thule culture earlier in time than [its own ancestors]”⁵⁵ Yet, so entranced were professional people, the authorities, with their new toy that such bizarre results, somehow, were taken in stride, and such a careful scientist as Antevs was could be scornfully rejected, ignored, forgotten.

Occasionally, imperfect dates are *adjusted*, rather than rejected. In this way, they can be pushed toward what the user *thinks* they ought to be. In one instance, “the date is acceptable, but [Taylor] prefers to add 120 years of range to obtain [a] date of about A.D. 1125.”⁵⁶

Another date, $14,200 \pm 1150$ BP, which Bryan thought⁵⁷ was *too daring* for the age of Early Man in Brazil, was “used with great caution, tripling the range of error and conservatively assigning a ‘date’ of 10,750 BP to level 10.” That bit of arithmetic brought it safely into the time of Clovis man, making it acceptable to the Establishment. *Surely* the standard-error figure was never intended for this kind of abuse? It is, after all, an indication of *probability*.

Full acceptance of a date, on the other hand, can be based on nothing more substantial than finding “no compelling reasons for rejecting it”. That does *not* mean that it is right. At other times a date like Wright’s

GaK-1267 is accepted largely because it “reinforces [the] apparent association” of artifacts.⁵⁸

Armed with one or more of these *selected* dates, the collector will naturally attempt to draw some conclusions from them. Believing, as Johnson did,⁵⁹ that “without exception, they are directly comparable”, many authors make unjustifiable and even ludicrous use of the dates. Two geographically separated dates, for instance, fell so nearly alike in age that Ritchie⁶⁰ was led to speculate on the course of a single canoe voyage some 3000 years ago! Hough⁶¹ went farther, if such were possible, in reversing the known *sequence* of some post-glacial lakes on the basis of just two dates, even though there was considerable overlap between them!

When using published dates, one must rely somewhat blindly on the care and knowledgeability of other investigators. As de Laguna observed,⁶² “both authors [Borden and Byers] seem ready to accept dates published . . . for my Pacific Eskimo materials . . . even though [they] were from samples suspected of contamination”. She went on to point out that the deposits had been saturated by seawater, and that the samples were washed in seawater; that the wooden objects were treated with paraffin, while the bone and antler material was soaked in a solution of shellac and wood alcohol; and that everything sat gathering dust for a quarter-century, prior to dating. Unbelievably, these were the samples held by Borden⁶³ to be “sufficient to demonstrate that the ground slate industry . . . could not possibly have been derived from Eskimo culture”!!

The First Radiocarbon Revolution

In the light of what is known about the radiocarbon method and the way it is used, it is truly astonishing that many authors will cite agreeable determinations as “*proof*” for their beliefs. Such blind faith in radiocarbon was more characteristic of the beginning years for the method, when the first dates encouraged wholesale abandonment of the existing age estimates, and open ridicule of dedicated men who had spent their lives in building up meaningful relationships.⁶⁴ There was an enormous gap between the new magic numbers and the old chronologies—a *gap much wider than we now have*, following corrections and improvements in C-14 methods.

One of those now-forgotten chronologies was based on the counting of clay varves in the ancient beds of glacial lakes. Using the annually-deposited layers as one would tree rings, Ernst Antevs⁶⁵ painstakingly arrived at conservative estimates for the deglaciation of eastern North America. He had placed the last major ice advance—other than Cochrane—at 19,000 years, and the end of *main* Lake Algonquin at 16,300 years ago.⁶⁶ Then came radiocarbon, Krieger announcing⁶⁷ that the whole of the Wisconsin period *began* “not more than 25,000 to 30,000 years ago”. Today, one may well gasp in disbelief at such naivete!

An embattled Antevs argued in vain, while exhibiting a rare understanding of the problems involved in radiocarbon dating.⁶⁸ He discussed modern-carbon contamination and chemical exchange, isotope fractionation, and variation in carbon-14 concentrations, *before*

these things were even measured! The great thrust of his argument concerned the implications of those radiocarbon dates then being accepted by "authorities", right and left. Some of the dates, he observed, were impossible on *stratigraphic* grounds. No one was listening—he was just a doddering old fool.

The correlation of Two Creeks with the Champlain Sea,⁶⁹ for instance, was in Antevs' opinion untenable because "1) the Two Creeks forest is older than 2) Valders till which is older than 3) Lake Algonquin which is older than 4) post-Algonquin lakes (Wyebridge through Korah), some of which drained into the arm of 5) the Champlain Sea".⁷⁰

Other radiocarbon dates implied wildly improbable behavior on the part of the retreating ice sheet, he argued. Johnson,⁷¹ however, ridiculed Antevs' meticulous and serious approach as "unprovable opinion" and "absurdity". Rapidly, radiocarbon dates that cut Antevs' estimates in half replaced his chronology, and it became unpopular even to mention him. The new order, which somehow had gotten hold of God's Truth in a laboratory, remains entrenched to this day—for it is not the way of "science" either to acknowledge or dwell upon its embarrassing mistakes.⁷²

Although our present understanding of glacial chronology is indeed dependent on radiocarbon dating, the ages *we* know and are using are *not* the ages that were first announced. Were Antevs alive now, he would be amused at the performance of his detractors, upon seeing some of those extremely young dates being pushed back to what he said they should be in the first place. It is true that certain dates are still only halfway there, or are in some cases static. But increasingly, there has been a tendency for the first determinations to be superseded by much older dates (Table 1). Additionally, re-study by Terasmae and Hughes⁷³ "confirms Antevs' counting of the varves and his calculations of the rate of retreat of the ice sheet". (italics mine).⁷⁴

The varve chronology established by Antevs was not alone in being discredited, nor is it the only one now partly verified. Far distant from our glacial lakes, new radiocarbon dates *also* have come to approximate the old and rejected archaeological synchronisms for the Aegean Bronze Age.⁷⁵ For the most part, though, the systems of dating used formerly are still scorned—if indeed anyone remembers them at all.

What we believe we know is very much based on radiocarbon dating; that is, on radiocarbon dates that were *selected* to fit other, earlier determinations. Traced back through the literature, it would appear that

those early and often erroneous radiocarbon determinations were *accepted without question*, at a time when the many problems were scarcely even recognized.

Implications

When radiocarbon dating was introduced on a *wide* scale, back in the early fifties, it quickly replaced the older methods of estimating ages. Thus it was freed from any embarrassing checks on its accuracy. Instead, adjustments were made to achieve *internal* order in the radiocarbon chronology! Once that comforting operation was completed, a feeling of security enveloped the exponents and their faithful followers. As Flint and Rubin⁸⁰ viewed it, "the consistency of the group of dates under consideration is such as to justify the assumption that all are accurate."

Even so, there were problems. Lee,⁸¹ who had heard it parroted over and over on the Sheguiandah site that "*radiocarbon dates are consistent*", observed that "an immediate result of the acceptance of the C-14 datings is the squeezing of tremendous cultural developments into an unreasonably short time span". To relieve this extreme compression of events and time, there was constant tinkering, whereby, for instance, the date of 3656 BP for Lake Algonquin was transferred to Great Lakes Nipissing, and the Nipissing date of 2619 BP was reassigned to a still more recent lake level, called Algoma! We should take note, too, that the Wisconsin is no longer just 25,000 years old, but is now permitted to occupy a niche at more than 60,000 years, as we may see in Minshall.⁸² The ages past, we might say, are being *stretched* a little! "Improvements" are piling up, and we still have some little distance to go. But as Antevs might have said with his wry humor, "We're getting there!"

Many authors, Flint and Rubin included, took special pains to report their dates in terms of radiocarbon years, determined ages, and apparent ages. Curiously, while *individual* dates were recognized as being inaccurate, radiocarbon chronologies as a whole were *not*. Yet it is really a *relative* chronology, in which dates tend to be too young, but are *assumed* to be in correct sequence.

In similar fashion, the necessity for calibration over the last 7000 years is well recognized and attended to, while the probable error in older dates receives no practical consideration at all. At a range of 20,000 to 30,000 years, it is true, one can only guess at the full extent of the problem. But one can be reasonably sure about its trend: *too young*.

First of all, we know that dates immediately beyond the range of the bristlecone curves must *also* be about a thousand years too recent, as a result of changing carbon-14 concentrations. Similar work on varved clay suggests a continuation of that trend to at least 10,000 B.P. For more ancient dates, the gap between radiocarbon and *real* ages may be still wider, as indicated by comparisons with uranium-series dating.

Those bristlecone dates, however, were special determinations, obtained from *uniform* wood samples. Excavated materials such as bone, shell and charcoal, on the other hand, all suffer from contamination—both in the ground and in the hands of careless or ignorant col-

Table 1. Changes in Age Estimates

	Antevs	Early C-14	Current C-14
Duration of Great Lakes Nipissing	4500-3500	2619-3400	5500-3700
End of main Lake Algonquin	16,300	3656	10,500
References	73	74	75 & 76

lectors. With peat, other types of soil, and bone, there is apparently no way to completely remove contaminants. Even *fully* treated samples give dates that are too young. Lamented Goh *et al.* "That contamination increases in significance with age is well established . . . and yet [C-14] dates 20,000-40,000 years BP derived from peats and organic silts and wood remains . . . are still cited in the literature without any consideration given".⁸³ They also observed that an orderly succession of dates in a deposit is often—and *wrongly*—argued as evidence of insignificant contamination.

Ultimately, we must question the reliability of radiocarbon dating—even for use as a *relative* chronology. For one thing, we are trying to compare dates obtained on *different* materials, some of which are more prone to contamination than others. Even where the material is of only one kind, as in the case of peat, dates from just *above* an impermeable zone will date younger than the more recent deposits nearer the surface, because modern-carbon contaminants *accumulate* in just such places.⁸⁴

Difference in environment, too, would influence the degree of contamination—and hence, the error—from one region to another. Hunt⁸⁵ commented on the fact that samples from eastern North America yielded dates only half as great as those from drier climates in the West: "It is possible to select a long or short timetable depending on one's choice". He suggested that the eastern dates were strongly affected by the more abundant decomposition products of a moist environment.

If we are trying to make comparisons with dates already reported in the literature, then we must surely wonder how those dates and samples were handled. Were the samples *large* enough? Were they collected *meticulously*? Was special *pre-treatment* used to attempt decontamination—and was it successful? Did the lab correct for *fractionation*, or in the case of shell, was that simply *assumed* to cancel the estimated reservoir effect? Were those dates calibrated *at all*, and if so, was the curve *smooth* or *irregular*? Did the collector accept the standard error assigned by the lab, or did he follow the advice of the statisticians? Were the dates *manipulated* in any way? In short—*what assurance do we have that the dates are correct*? After all, acceptance by the collector merely tells us of his belief that *he* was right!

Additionally, we will have to acknowledge the fact that the radiocarbon time scale is not *evenly* foreshortened. Fairly young dates can be calibrated to compensate for variation in past carbon-14 levels, but not the older dates. And yet it is the older dates that may have been affected by *extreme* changes in the carbon-14 supply, depending on the severity of ancient magnetic-pole reversals. Then, too, the more ancient samples are all the more sensitive to modern-carbon contamination, such as atomic fallout, and are likely to be disproportionately young.

Conclusion

Radiocarbon dating has somehow avoided collapse onto its own battered foundation, and now lurches onward with feigned consistency. The implications of per-

vasive contamination and ancient variations in carbon-14 levels are steadfastly ignored by those who base their argument upon the dates.

The early authorities began the charade by stressing that they were "not aware of a single significant disagreement" on any sample that had been dated at different labs.^{86,87} Such enthusiasts continue to claim, incredible though it may seem, that "no gross discrepancies are apparent",^{88,89} Surely 15,000 years of difference on a single block of soil is indeed a *gross* discrepancy! And how could the excessive disagreement between the labs be called insignificant, when it has been the basis for the reappraisal of the standard error associated with each and every date in existence?

Why do geologists and archaeologists still spend their scarce money on costly radiocarbon determinations? They do so because occasional dates *appear* to be useful. While the method cannot be counted on to give good, unequivocal results, the numbers do impress people, and save them the trouble of thinking excessively. Expressed in what *look* like precise calendar years, figures *seem* somehow better—both to layman and professional not versed in statistics—than complex stratigraphic or cultural correlations, and are more easily retained in one's memory, "Absolute" dates determined by a laboratory carry a lot of weight, and are extremely helpful in bolstering weak arguments. If they are sufficiently numerous to "cluster at A.D. 1000", as is erroneously claimed for L'Anse aux Meadows in Newfoundland, they can be presented as "overwhelming evidence" to sweep aside any dissenting voices.⁹⁰

No matter how "useful" it is, though, the radiocarbon method is still not capable of yielding accurate and reliable results. There *are* gross discrepancies, the chronology is *uneven* and *relative*, and the accepted dates are actually *selected* dates. "This whole blessed thing is nothing but 13th-century alchemy, and it all depends upon which funny paper you read."⁹¹ Is it, then, time for the *final* radiocarbon revolution?

It may be possible to save radiocarbon from the fate that unjustly befell its old rivals, such as time scales of Antevs. Sometimes, it seems to be the *only* clue an investigator has. But it must be understood that a radiocarbon date is nothing more than just exactly *that*—a clue. It has to be used accordingly, and as just *one* piece of evidence leading to an informed age estimate.

As a mere piece of evidence, of course, each date will have to be reported in full, answering all of the questions that might arise. In this way, its background will be out in the open, where it can be scrutinized and evaluated. The figure finally presented to the reader, as an informed age estimate, should make pretense of no greater degree of precision than befits *any* estimate.

Radiocarbon, I suggest, *can* have a future. But if no radical changes in *attitude* are forthcoming, that future can hardly be an illustrious one. Let it be "a useful tool"—but not a death warrant for all powers of observation and reasoning. As the great teacher L'Abbe Breuil advised, let us observe and *think*!

References

¹In 1947, at a University of Chicago "round table", I first learned of

the new "wonder-tool", described as a by-product of the atomic bomb research, which had been carried out in the football stadium of their Stagg Field. The results had been tested against Egyptian materials of known age, and found to tally very closely. It was declared capable of precise dating on charcoal, wood, bone, and shell. Other materials were being tested. TEL. (Notes marked "TEL" were added by Thomas E. Lee, Editor of the *Anthropological Journal of Canada*.)

²Vividly I recall the shock and excitement among archaeologists at the University of Michigan, as they hurried from door to door with the news that C-14 had proven Hopewell older than Adena! TEL.

³Libby, Willard F., 1963. Accuracy of radiocarbon dates. *Science* 140(3564):278-280.

⁴Gladwin, Harold S., 1976. Dendrochronology, radiocarbon, and bristlecones. *Anthropological Journal of Canada*. 14(4):2-7.

⁵Barbetti, M., and K. Flude, 1979. Geomagnetic variation during the late Pleistocene period and changes in the radiocarbon time scale. *Nature* 279(5710):202-205.

⁶Clark, R.M., 1975. A calibration curve for radiocarbon dates. *Antiquity* 49(196):196-266. See especially p. 251

⁷Stuckenrath, Robert, 1977. Radiocarbon: some notes from Merlin's diary. *Annals of the New York Academy of Science* 288, 181-188.

⁸Stuiver, M., 1970. Tree ring, varve, and carbon-14 chronologies. *Nature* 228 (5270):454-456.

⁹Davis, Emma Lou, George Jefferson, and Curtis McKinney, 1981. Man-made flakes with a dated mammoth tooth at China Lake, California. *Anthropological Journal of Canada* 19(2):2-7. See especially p. 6.

¹⁰Stuiver, M., 1978. Radiocarbon timescale tested against magnetic and other dating methods. *Nature* 273(5660):271-274.

¹¹Reference 5, p. 205.

¹²Saupe, F., O. Strappa, R. Coppins, B. Guillet, and R. Jaegy, 1980. A possible source of error in ¹⁴C dates: volcanic emanations. *Radiocarbon* 22(2):525-531. See especially p. 528.

¹³Jardine, W.G., 1978. Radiocarbon ages of raised-beach shells from Oronsay, Inner Hebrides, Scotland: a lesson in interpretation and deduction. *Boreas* 7(4):183-196. See especially p. 189.

¹⁴Mangerud, J., and S. Gulliksen, 1975. Apparent radiocarbon ages of recent marine shells from Norway, Spitsbergen, and Arctic Canada. *Quaternary Researches* 5(2):263-273.

¹⁵In classrooms prior to 1950, both at U. of Chicago and U. of Michigan, I heard it stated that modern shells picked up on the beach would date to as much as 3000 years. It seems very odd to me that, in all the years since, I have seen no mention of this in archaeological site reports dealing with the dating of shells, and no allowance for it in connection with the dates obtained on ancient shells. TEL.

¹⁶Reference 7, p. 186.

¹⁷It has long been my opinion—perhaps under the influence of Ernst Antevs, who told me in 1955 that such was his belief—that older carbon can be moved upward by circulating groundwater, to impregnate a younger sample, thereby diluting the carbon-14 in the sample. The actual process may be a replacement of the younger carbon by the older carbon—thus providing a date that is too old, a date that is false. TEL.

¹⁸de Atley, S.P., 1980. Radiocarbon dating of ceramic materials. *Radiocarbon* 22(3): 987-993. See especially p. 988.

¹⁹Taylor, R.E., 1980. Radiocarbon dating of Pleistocene bone: toward criteria for the selection of samples. *Radiocarbon* 22(3):969-979. See especially p. 971.

²⁰Reference 7, p. 183.

²¹Wise, E.N., and D. Shutler, Jr., 1958. University of Arizona radiocarbon dates. *Science* 127(3289):72-74.

²²Lee, Thomas E., 1971. How old is "definite"? *Anthropological Journal of Canada* 9(2):14.

²³The consistency of these results was indeed only fair. In the early fifties, J. Normal Emerson, University of Toronto, reported to me that a stunning discrepancy of 3000 years (34%) had been obtained on one of these samples. Because this result made the fine particles older, instead of younger, Libby had to try again before achieving the consistency he sought. TEL.

²⁴Matson, F.R., 1955. Charcoal concentration from early sites for radiocarbon dating. *American Antiquity* 21(2):162-169.

²⁵Goh, K.M., P.J. Tonkin, and T.A. Rafter, 1978. Implications of improved radiocarbon dates of Timaru peats on Quaternary loess stratigraphy. *New Zealand Journal of Geology and Geophysics* 21(4):463-466. See especially p. 464.

²⁶Gilet-Blein, N., M. Gerard, and J. Evin, 1980. Unreliability of ¹⁴C dates from organic matter of soils. *Radiocarbon* 22(3):919-929.

²⁷Hassan, A.A., and D.J. Ortner, 1977. Inclusions in bone material as a source of error in radiocarbon dating. *Archaeometry* 19(2):131-135.

²⁸Tamers, M.A., and F.J. Pearson, 1965. Validity of radiocarbon dates on bone. *Nature* 208(5015):1053-1055.

²⁹Silar, Jan, 1980. Radiocarbon activity measurements of oolitic sediments from the Persian Gulf. *Radiocarbon* 22(3):655-661. See especially p. 659.

³⁰Wendorf, F., R. Schild, and R. Said, 1970. Problems of dating the late Paleolithic age in Egypt. (In) Radiocarbon variations and absolute chronology, 12th Nobel Symposium, Uppsala, ed. I.U. Olsson. Pp. 57-77. See especially p. 60.

³¹Reference 13, pp. 188-190.

³²Ogden, J., III, 1977. The use and abuse of radiocarbon. *Annals of the New York Academy of Science* 288, 167-173.

³³Agogino, G.A., 1968. The experimental removal of preservatives from radiocarbon samples. *Plains Anthropologist* 13(40):146-147.

³⁴Ralph, E.K., and N.H. Michael, 1974. Twenty-five years of radiocarbon dating. *American Scientist* 62(5):553-560.

³⁵Johnson, F., 1967. Radiocarbon dating and archaeology in North America. *Science* 155(3759):165-169.

³⁶Re-runs on solid-carbon samples W-76, W-77, and W-174 (14,000 BP) by the gas-counting method yielded new dates of greater than 36,000 years. See Karlstrom, Thor N.V., 1957. Tentative correlation of Alaskan glacial sequences. *Science* 125(3237):73-74.

Again samples of wood from a single source have been dated at 11,050 ± 400BP (L-190A), older than 30,840 (Y-242), and older than 40,000 (W-189)—all by solid carbon. Later, scintillation-counting gave a date of 20,000 ± 800. See Pringle, R.W., W. Turchintez, B.L. Funt, and S.S. Danyluk, 1957. Radiocarbon age estimates obtained by an improved liquid scintillation technique. *Science* 125(3237):69-70.

³⁷Grootes, P.M., 1980. Discussion of paper by Gove *et al.* *Radiocarbon* 22(3):793.

³⁸Lowden, J.A., R. Wilmeth, and W. Blake, Jr., 1970. Geological Survey of Canada Radiocarbon Dates X. Dept. of Energy, Mines, and Resources. Ottawa, Ontario, Canada.

³⁹Stearns, C.E., 1956. Review: The Midland Discovery. *American Antiquity* 22(2):198.

⁴⁰Reference 6, p. 265.

⁴¹Ollet, R.L., A.J. Walker, A.D. Hewson, and R. Burleigh, 1980. ¹⁴C interlaboratory comparison in the UK: experimental design, preparation, and preliminary results. *Radiocarbon* 22(3):936-946.

⁴²Almost in a state of limbo now is the fact that in the early years, one was required to declare, when submitting a sample for radiocarbon testing, that it had not been sent to any other lab. So late as the mid-fifties, Fredrick J. Pohl (1955) was strongly protesting this requirement, and pointing out that it made a mockery of the scientific method. Quite justifiably, he further protested being asked by the lab to state what date he would accept. In his opinion (and in mine) the testing, if a valid method in the first place, should provide that information, not the collector. TEL.

⁴³Reference 6, p. 252.

⁴⁴Pardi, R., and L. Marcus, 1977. Non-counting errors in ¹⁴C dating. *Annals of the New York Academy of Science* 288, 174-180.

⁴⁵Pilcher, R.J., and M.G.L. Baillie, 1978. Implications of a European radiocarbon calibration. *Antiquity* 52(206):217-222.

⁴⁶Reference 6, p. 258.

⁴⁷Hubbs, Carl L., and A. Perlmutter, 1942. Biometric comparison of several samples, with particular reference to racial investigations. *American Naturalist* LXXVI(767):582-592.

⁴⁸At U. of Chicago in 1947 I was told that a test would cost \$1500, but that the cost would come down as increasing use was made of the method. Such has been the case. In the late sixties I had tests done at \$110 each. Today, allowing for variations from lab to lab, the cost is around \$140 to \$160 per test. TEL.

⁴⁹Wilmeth, R., 1969. Canadian archaeological radiocarbon dates. National Museum of Canada Bulletin 232, pp. 68-127. See especially p. 73.

⁵⁰*Ibid.*, p. 98.

⁵¹*Ibid.*, p. 112.

⁵²Reference 32, p. 173.

⁵³Sanger, David, 1973. Cow Point: an archaic cemetery in New Brunswick. National Museum of Man, Mercury Series 12. Ottawa, Ontario, Canada.

- ⁵⁴Colinvaux, P.A., 1964. The environment of the Bering land bridge. *Ecological Monographs* 34, 297-329. See especially p. 314.
- ⁵⁵Reference 49, p. 83.
- ⁵⁶*Ibid.*, p. 78.
- ⁵⁷Bryan, A.L., 1978. An early stratified sequence near Rio Claro, East Central Sao Paulo State, Brazil. (In) *Early Man in America* ed. A.L. Bryan, Arch. Res. Int'l. Edmonton, Alberta, Canada. Pp. 303-305.
- ⁵⁸Reference 49, p. 101.
- ⁵⁹Johnson, F., 1958. Reflections upon the significance of radiocarbon dates (In) *Radiocarbon Dating*, by W.F. Libby, University of Chicago Press, 1967, pp. 141-161.
- ⁶⁰Ritchie, W.A., 1965. The archaeology of New York State. The Natural History Press, Garden City, New York. P. 171.
- ⁶¹Hough, J.L., 1953. Revision of the Nipissing stage of the Great Lakes. *Illinois Academy of Sciences Transactions* 46, 133-141. 1958. The geology of the Great Lakes. University of Illinois Press.
- ⁶²deLaguna, Frederica, 1962. Intemperate reflections on Arctic and Subarctic archaeology (In) *Arctic Institute of North America Technical Paper No. 11*, ed. J.M. Campbell, pp. 164-169. See especially p. 166.
- ⁶³Borden, C.E., 1962. West coast crossies with Alaska. (In) *Arctic Institute of North American Technical Paper No. 11*, ed. J.M. Campbell, Pp. 9-19. See especially p. 14.
- ⁶⁴At the Early Man site, Sheguiandah, a visitor responded again and again to my criticisms of radiocarbon dating: "Radiocarbon dates are consistent!" On that ground it was argued that Lake Algonquin had fallen from its maximum to the low point, the waters rising again to 71 feet above present Lake Huron to form Great Lakes Nipissing—all in the space of 200 years. Such was the madness that swept Antevs under the rug, such was the blind faith in radiocarbon. TEL.
- ⁶⁵This almost forgotten man (see obituary, 1974, *Anthropological Journal of Canada* 12(3): 18-20) did his tremendous field studies in Northern Ontario on foot, by horseback, and with railroad handcars—the "hard way". Almost no money was available in the twenties for scientific work. In the early fifties, there were still "Old-Timers" in the Geological Survey of Canada who remembered seeing this wiry and tough little man clinging to the nearly vertical railway cuts, patiently counting and measuring the layers of clay put down in ancient lake bottoms. TEL.
- ⁶⁶Antevs, Ernst, 1957. Geological tests on the varve and radiocarbon chronologies. *The Journal of Geology* 65(2):129-148. See also Antevs, Ernst, 1955. Varve and radiocarbon chronologies appraised by pollen data. *The Journal of Geology* 63(5):495-499.
- ⁶⁷Krieger, Alex D., 1957. News and notes, early man. Ed. Clement Meighan. *American Antiquity* 22(3):321-323. See especially p. 322.
- ⁶⁸It is only fair, in view of the painful castigation and rejection to which this great and kindly man was subjected in his declining years, and the scorn and contempt with which he is dismissed even now, that I mention a letter which Ernst showed me. It read, in part: "It is a well known fact that you never attend conferences, yet you continue to criticize radiocarbon, about which you know nothing." In his reply Antevs said: "In the first place, I was not invited to the Conference. In the second, I didn't know there was a Conference. And in the third place, now that I know there was a Conference, I see that you had only people there who were favorable to radiocarbon, and none of its critics. As for your charge that I know nothing about radiocarbon, I would like you to consider the following eight points." He then proceeded to list his objections.—to my great delight, including some that I too had arrived at when excavating the Sheguiandah site. TEL.
- ⁶⁹Reference 61. (Geology of the Great Lakes.)
- ⁷⁰Broecker, W.S., and W.R. Farrand, 1963. Radiocarbon age of the Two Creeks forest bed, Wisconsin. *Bulletin of the Geological Society of America* 74(6):795-802.
- ⁷¹Reference 59.
- ⁷²In my experience, very few professional men take kindly to being reminded of their early enthusiasm for radiocarbon dates that were only a small fraction of the currently acknowledged ages. "Oh, but those dates were from the block carbon method—we've improved the methods now, and there is little if any error." The improvements I recognize—they are getting close to the dates set by Antevs 50 years ago. But let me remind them that their scorn for Antevs was based on those now-rejected and never-mentioned dates. TEL.
- ⁷³Reference 66, p. 141.
- ⁷⁴Flint, R.F., 1953. Probable Wisconsin substages and late-Wisconsin events in northeastern United States and southeastern Canada. *Bulletin of the Geological Society of America* 64(2):897-920.
- ⁷⁵Cowan, W.R., 1978. Radiocarbon dating of Nipissing Great Lakes events near Sault Ste. Marie, Ontario. *Canadian Journal of Earth Science* 15(12):2026-2030.
- ⁷⁶Dreimanis, A., 1977. Late Wisconsin glacial retreat in the Great Lakes region. *Annals of the New York Academy of Science* 288, 70-89.
- ⁷⁷Terasmae, J., and O.L. Hughes, 1960. Glacial retreat in the North Bay area, Ontario. *Science* 131(3411):1444-1446.
- ⁷⁸When an extremely important book was published . . . Antevs wrote a Commentary for publication. Back it came, with a letter . . . "— is very highly regarded here . . . and we would not wish to publish anything that might seem to detract from his reputation and the quality of his work." TEL.
- ⁷⁹Cadogan, G., 1978. Dating the Aegean Bronze Age without radiocarbon. *Archaeometry* 20(2):209-214. See especially p. 212.
- ⁸⁰Flint, R.F., and M. Rubin, 1955. Radiocarbon dates of pre-Mankato events in eastern and central North America. *Science* 121(3149):649-658.
- ⁸¹Lee, Thomas E., 1968. (Review) *Archaeology of New York State*, by Wm. A. Ritchie. *Anthropological Journal of Canada* 6(1):21-31.
- ⁸²Minshall, Herbert L., 1981. A stratified early man site at San Diego: tentatively early Wisconsin. *Anthropological Journal of Canada* 19(1):13-17. See especially p. 16.
- ⁸³Reference 25, p. 464.
- ⁸⁴Kigoshi, K., N. Suzuki, and M. Shiraki, 1980. Soil dating by fractional extraction of humic acid. *Radiocarbon* 22(3):853-857 See especially p. 855.
- ⁸⁵Hunt, Charles, B., 1955. Radiocarbon dating in the light of stratigraphy and weathering processes. *Scientific Monthly* 81(5):240-247. See especially p. 244.
- ⁸⁶Reference 59, p. 142.
- ⁸⁷A rather astonishing statement. The 5000-year discrepancy in five samples from one small Paleo-Indian hearth at depth on the Lehner Kill site, collected in 1955, should have been known . . . even if not yet in print. TEL.
- ⁸⁸Reference 32, p. 172.
- ⁸⁹No gross discrepancies? . . . I submitted . . . a large block of peat from the bottom of a five-foot profile on the Sheguiandah site. See Lee, T.E., 1956. The position and meaning of the radiocarbon sample from the Sheguiandah Site, Ontario. *American Antiquity* 22(2):79 . . . Later, another letter enthused over the importance of the date, 9130 ± 250 years—at that time by far the oldest C-14 date for man in Canada. The enthusiasm stemmed from the fact that the profile registered the Cochrane glacial advance, at a higher level, and my date "proved" Antevs wrong. But then someone . . . noticed that the peat was necessarily post-Algonquin. Since Algonquin's maximum was at that time carbon-14-dated at 3,600 years, my date was in direct conflict—and silence descended . . . TEL.
- ⁹⁰The 16 radiocarbon dates (or is it 21, as stated by Anne Ingstad?) range all the way from A.D. 630 to A.D. 1080, and the weighted mean is A.D. 920—not A.D. 1000. The early dates are explained away as being from charcoal that was derived from centuries-old driftwood—totally ignoring the fact that one of them was made from turf from a "longhouse wall". Other dates on turf were thought by Henningsmoen to be too young—and this was blamed on recent rootlet contamination. See Ingstad, Anne, 1969. The discovery of a Norse settlement in North America, volume 1.
- ⁹¹Reference 7, p. 188.

PANORAMA OF SCIENCE

The Velocity of Light and the Age of the Universe

A comprehensive theory of a changing speed of light has been advanced by Mr. Barry Setterfield of Australia. A high initial speed for the propagation of light near the time of creation would explain why we are now able to see distant galaxies, since if c , the speed of light, were constant, the light from these objects should not have reached us as yet. He goes on to examine the implications of a changing c for other physical quantities. He finds that not only do some physical "constants" vary with time, but that among other effects the half lives of radioactive nuclides have been decreasing since creation, causing radiometrically determined ages to be far too large. This is a summary of the first two articles originally printed in the Australian journal *Ex Nihilo*.^{1,2}

If the creation event took place only about 6000 years ago, how is it now possible for us to see objects farther away than 6000 light years? Some have suggested that light was created en route from the emitting objects, just as if they had existed for long periods of time. But this means we are observing events that never really happened. Another suggestion has been that light travels analogously to along curved surfaces (Reimannian Space concept) and that light takes only 16 years to cross the universe. Though this is a fascinating concept, it lacks confirming evidence. A third possibility, and one not much explored, is that the speed of light has changed, decreasing exponentially (e.g.) since creation or shortly thereafter. Though the speed of light is considered one of the really fundamental constants of nature, there is evidence that it has indeed changed in the more than 300 years since the first measurement was made.³ Table 1 lists a number of light-speed measurements grouped according to the experimental method.

The drop in c , in the last 300 years amounts to 1507 km/sec, considerably larger than even the largest experimental error. It is also evident that the rate of decrease in c has been tapering off. DeBray observed it to be about 4 km/sec/year between 1870 and 1920, while Tolles noted it at about 0.3 km/sec/year in 1950.

A large number of possible curves were tried in attempting to fit the observations of velocity vs. time. Exponential functions, power curves, polynomials, logarithmic and hyperbolic functions all failed to fit the data satisfactorily. Only one curve was found to fit the data, a log sine curve with a logarithmic vertical axis, which fits the data exactly. The general equation is $\log c = A + B(\log \sin(T))$ where A and B are constants with values of 5.47682068 and -1.94665385 respectively. Here T is a time function. The 6000 years since creation are taken to be 90 degrees of the log sine scale. Then $T = t(90/6000)$ where t is in years. This follows from the curve-fitting; it is not an assumption.

The decay curve is quite sensitive to its date of origin. If this is set too early, the curve falls below the early clusters of points. If too late, it lies above the data. The best date of origin as determined from the curve is 4040 B.C. ± 20 years. Similarly, it appears that from about

Table 1. Values of c : Units Km/sec Optical Methods

Romer	1675	301,300 $\pm$ 200
Bradley	1728	301,000
	1871	300,400 $\pm$ 200
Cornu-Helmert	1874.8	299,990
Michelson	1879.5	299,910 $\pm$ 50
Newcomb	1882.7	299,860 $\pm$ 30
Michelson	1882.8	299,853 $\pm$ 60
	1885	299,940
Perrotin	1902.4	299,901 $\pm$ 84
	1902.8	299,895
	1906	299,880
	1924	299,802 $\pm$ 30
Michelson	1926.5	299,796 $\pm$ 4
Mittelstaedt	1982.0	299,778 $\pm$ 10
Pease-Pearson	1932.5	299,774 $\pm$ 11
	1933	299,774 $\pm$ 2
Anderson	1937-41	299,771 $\pm$ 12
Huttel	1940	299,768 $\pm$ 10
Values of c—Cavity Resonators		
Essen	1947	299,797 $\pm$ 3
Essen	1950	299,792 $\pm$ 3
Hansen	1951	299,789 $\pm$ 1
Values of c—Geodimeter		
Bergstrand	1949	299,796 $\pm$ 2
Bergstrand	1951	299,793.1 $\pm$ 2.5
Scholdstrom	1955	299,792.4 $\pm$ 0.4
Edge	1956	299,792.4 $\pm$ 0.11
Values of c—Radio Interferometer		
Florman	1954	299,795.1 $\pm$ 3.1
Froome	1958	99,792.5 $\pm$ 0.1
Values of c—Tellurometer		
Wadley	1956	299,792.9 $\pm$ 2
Wadley	1957	299,792.6 $\pm$ 1.2
Values of c—Radio		
Kraus	1953	299,800
Corson & Lorraine	1962	299,790
I.T.T. Staff	1970	299,793
	1972	299,792.5
Bay, Luther, White	1972	299,792.462 $\pm$ 0.018
		"Nature" 8/9/72, pps 65-66
	1976	299,792.456

1960 the speed of light has remained constant. It may be asked whether this effect could be produced simply by improved measuring techniques. Nearly all measurements fall within the experimental error of the curve. A more detailed analysis is provided in appendix three of the first article.

The speed of light did not change by a large factor in the recent past; in 1 A.D. it was 391,966 km/sec. At the time of the flood (2384 B.C.) it was 1,621,908 km/sec. Before this the rise is steep. In 3540 B.C. it was 15,783,104 km/sec and in 3940 B.C. it was 360,146,768 km/sec. An estimate of the initial value is given by the value of the curve at 1 to 1½ days from the origin, being about 1.5×10^{17} km/sec. Setterfield assumes that this held during creation week since the Creator would not allow decay during His initial work. Integrating the curve to determine the distance which light has traveled since creation shows that it has allowed light from even the most distant observable objects to reach the earth. The total distance amounts to 12×10^9 light years. The latest determination of Hubble's con-

Table 2. Electron Rest Mass ($\times 10^{31}$ Kg.)

Authority	Date	Value		Reference
Prof. R.T. Birge	1929	8.994	$\pm .014$	Rev. Mod. Phys. 1:1
R.T. Birge	1932	9.035		Science 75:383
F.C. Dunnington	1939	9.1070		Rev. Mod. Phys. 11:70
R.T. Birge	1941	9.1064		Phys. Rev. 60:785
Dr. J.D. Ryder	1947	9.1060		Electronic Eng. Princ. p. 3.
G.I. Brown	1953	9.1066		Mod. Valence Theory p. 167.
Prof. W.J. Moore	1950-56	9.1068		Physical Chemistry p. 209.
Dr. H. H. Sisler	1949-59	9.1070		General Chemistry p. 121.
Prof. A. J. Woodall	1955	9.1078		Physics p. 1239.
E. R. Cohen et. al.	1955	9.1083	± 0003	Rev. Mod. Phys. 27:363
Prof. W. J. Moore	1957	9.1085		Physical Chemistry p. 618.
Prof. A.P. French	1958	9.1085		Princ. Mod. Physics p. 109.
Drs. Wehr & Richards	1960	9.1084	± 0004	Phy. of the Atom p. 41.
Cohen & DuMond	1963	9.1091	± 0004	Proc. 2nd Int. Conf. Nuc. Mass.

tant implies a radius of the observable universe of 7.9×10^9 light years, impressively close to the derived value.

A great deal of insight into the effects of this change in c on other physical "constants" can be derived from examining some common formulas. First we must recognize that the value of the elementary charge, q , has remained constant over time. Measurements of this quantity since 1911 show no statistically significant change in its value. We can then note that the energy expended in moving a particle to a distance r away from an oppositely charged particle is given by: $q^2/r\pi\epsilon_0$ where ϵ_0 is the permittivity of free space. Assuming that the same amount of energy will be expended if the experiment is done at a different time and that q is constant, then $q^2/\epsilon_0 = \text{CONSTANT}$: implying that ϵ_0 is constant. Since, from Maxwell's equations, $c = (\mu_0\epsilon_0)^{-1/2}$ where μ_0 is the magnetic permeability of free space, we get $\mu_0 \propto 1/c^2$. This suggests that the change in c with time can be regarded as due to the change in the magnetic permeability of free space over time. This may be due to a change in the physical character of the universe over time, possibly due to expansion or contraction.

From the well-known formula $E = mc^2$ (also derivable independently of relativity theory) we can immediately see that $m \propto 1/c^2$. This is a startling result, but is rendered less unacceptable by thinking of it not so much

as the amount of stuff present but rather as a property describing how a particle will react and behave generally, and especially its inertial properties. Setterfield also derives this result independent of the assumption of conservation of energy.

Without experimental verification, however, this is still a large pill to swallow. Table 2 shows the measurements of the electron rest mass since 1929. A clear trend for the electron's mass to increase with time can be seen. In a more detailed analysis, Setterfield shows that the trend is consistent with a $1/c^2$ dependence as required by the formula.

It is significant to note that the reaction energies of chemical or nuclear reactions remain independent of the speed of light. Since energy released (or consumed) in a reaction is proportional to the change in mass according to $E = mc^2$ and $m \propto 1/c^2$, the c^2 factors just cancel. Therefore despite changes in c and m , the energy given off in any reaction will be constant throughout time and independent of c . The laws of chemistry should therefore apply unchanged.

In an atom, the "centrifugal force" on the electron must be balanced by the electrical attraction from the nucleus, thus: $mv^2/a = q^2/(4\pi\epsilon_0 a^2)$ or $\frac{1}{2}mv^2 = E_k = q^2/(8\pi\epsilon_0 a)$. Applying the first law of thermodynamics implies that a , the Bohr radius, is constant.

In the Bohr model of the atom, an electron in a permitted orbit has angular momentum $mva = nh/2\pi$.

Table 4. Planck's Constant $\times 10^{-27}$ erg-sec

Planck quoted by				
J.W. Nicholson	1912	6.548		R.A.S., Mon. Not. Vol. 72 -. 677 & 729
Ryerson Labs.	1904-15	6.260		"Electrons" R.A. Millikan p. 242.
Dr. L.P. Seig	1914	6.415		Sc. Am. Supp. 78:46-48, July 18th
Prof. R.T. Birge	1929	6.547	± 008	Rev. Mod. Phys. 1:1
R.A. Millikan quoted by Prof. G.P. Thompson	1930	6.550		Sc. Am. 143:38-41, July '30
F.G. Dunnington	1939	6.610		Ref. Mod. Phys. 11:70
R.T. Birge	1941	6.624	± 006	Phys. Rev. 60:785
R.A. Millikan	1946	6.560		"Electrons" p. 242.
Drs. Martin/Connor	1951	6.622		"Basic Physics" p. 929.
G.I. Brown	1953	6.624		"Modern Valence Theory" p. 16, 23
E.R. Cohen et. al.	1955	6.62517	± 00023	Rev. Mod. Phys. 27:363
Prof. W.J. Moore	1957	6.6252	± 0005	"Physical Chemistry" p. 618.
Prof. A.P. French	1958	6.6252		"Principals of Modern Physics" p. 109.
Drs. Wehr & Richards	1960	6.6253	± 0003	"Physics of the Atom" p. 65.
Cohen & DuMond	1963	6.6256	± 0005	Proc. 2nd Int. Conf. on Nuc. Mass
Prof T. Barnes	1980	6.6261964		C.R.S. Quarterly, Vol. 17 p. 46. Je'80

Since a is constant, $m \propto 1/c^2$ and $v \propto c$, Planck's constant $h \propto 1/c$. Angular momentum appears not to be conserved, perhaps a disturbing situation. But Setterfield says that angular momentum is indeed conserved via orbital precession. By way of confirmation, Table 4 (Setterfield's Table 3 is not included here) shows measurements of Planck's constant since 1912. A definite trend toward increasing value of h is evident.

Through similar arguments Setterfield is able to show that Boltzmann's constant k , the gas constant R , the wavelength of maximum intensity emitted by a blackbody as given by Wein's displacement law, and the Rydberg constant are all true constants, independent of the speed of light. An important result is that the wavelengths of photons resulting from atomic transitions are also independent of the speed of light. Other true constants include the deBroglie wavelength, the Compton wavelength, the classical electron radius, the Zeeman displacement per gauss and the Bohr magneton. One quantity which is predicted to be dependent on c is the gyromagnetic ratio, $\gamma = q/(2mc)$. This implies that $\gamma \propto c$ (since $m \propto 1/c^2$). Measurements of this quantity, although first measured in 1946, are accurate enough so that even in this short time a trend toward decreasing γ is evident, as shown by one of Setterfield's tables (not reproduced). In all there are over a dozen physical quantities and constants which behave as predicted; a very powerful argument for this theory.

One of the most significant applications of this theory is in the behavior of the atomic nucleus and the resulting effects on the decay rates of radioactive nuclides. Always assuming conservation of energy (which, aside from Setterfield's formulas is also consistent with a cessation of creation acts after the first week), the speed of nucleons moving in an atomic nucleus is proportional to the speed of light (from $E = \frac{1}{2}mv^2$ or other arguments). Many radioactive nuclides decay by emitting an alpha particle (helium nucleus). Consider such an alpha particle moving in an orbit within a radioactive nucleus. The approximate value of the frequency with which alpha particles reach the exterior surface of the nucleus and escape can be obtained by dividing the speed of the alpha particle, v , by the radius of the nucleus r . If this frequency, expressed as the number per second, is multiplied by the probability of escape P , by the tunneling process, the result will be the actual frequency with which the alpha particles escape. This frequency is equal to λ^* , the decay constant linked to the half-life, τ , by $\tau = (1/\ln 2)/\lambda^*$. Now $\lambda = Pv/r$, so $\tau \propto 1/c$. Setterfield also shows that the same relationship holds for decay by electron capture.

Another way to approach this is to consider the binding energy per nucleon. In the spontaneous decay of a nucleus, energy is released as the total energy of the two fragments is less than that of the original nucleus. The greater the energy available for disruption, the shorter will be the half-life. From earlier discussion, the mass of each nucleon was smaller in the past, thus, in a way, distributing the same binding energy over the same number of less massive objects. For those elements which are stable, a greater binding energy per nucleon would thus have caused such nuclei to be even more

stable in the past. But for those which are not stable there was, in the past, even more energy available per nucleon mass to cause disruption. Hence decay would have occurred more rapidly in the past.

These results are for comparison for any given nucleus and for a change in c . They do not apply to making comparisons between one element and another with different binding energies.

Experimental verification of this change in half-life is not possible for most nuclides since the change in half-life in the few decades over which measurements have been made is smaller than the experimental error. Setterfield examined 39 isotopes all of which, except carbon-14, are from the uranium, actinium and thorium decay sequences. The result is that 30 show no change in half-life values and 9 show increasing half-lives. Unfortunately the accuracy of all such measurements is poor.

The result of the change in half-lives with c is dramatic. For uranium-238, whose half-life is about 4,500 million years (at present) the half-life at the time of creation (when c was 5×10^{11} times faster) was 3.29 days. For radioactive potassium it was 22.79 hours. To give an order of magnitude estimate of the apparent age of an element created on the first day, Setterfield assumes that the speed of light was unchanged during the seven days of the creation week at 500 billion times its present value. Thus since $\tau \propto 1/c$ during each day of the creation an equivalent of 500 billion days worth of decay would have occurred, or 35×10^{11} days, or 9.6×10^9 years. This is very close to the age assigned to the elements by Burbidge of 10×10^9 years.

Analysis.

Setterfield's is one of the most far-reaching creationist theories there is, solving two major problems (light travel time and radiometric ages) and rewriting much of physics at the same time. His promised third article will cover cosmological redshift and, I believe, other important topics. His reasoning is fairly straightforward. In some places he appeals to classical intuition where a slightly more rigorous treatment may be called for. But in most cases his logic is unassailable. If his theory should prove correct its power in providing a paradigm for further creationist theories and, in fact, proving the youth of the universe will be unparalleled in the history of scientific creationism.

My only reservation comes from the speed of light data themselves. I once compiled a list of light-speed measurements dating from Roemer to the present in order to establish whether or not such a change as Setterfield suggests had really happened. I concluded that though the data implied that it had, the results were not statistically convincing. My list differs substantially from Setterfield's. For example, my source showed Roemer's value of c to be 292,000 km/sec in 1676², while Setterfield's is 301,300 km/sec. (Setterfield, however, used results later than 1870, not Roemer's original ones.) All these old measurements have been reworked in recent years and the result stated probably depends upon the reworker's evaluation of the original experiment. There may be a question, too, whether the

quoted precision was optimistic in some of these figures, and about the risk in extrapolating back in time by a factor of more than twenty.

Also, one cannot help but note that only now, in the last few decades, has the speed of light settled down to an almost constant value. During this time both the experimental errors and the difference between the measured value and the currently accepted value have decreased together. Is it too much of a coincidence that this should occur as our measuring tools are becoming spectacularly precise? (Part 3 of the series is to give an additional reason for this behaviour.) If the speed of light really is only now reaching a constant value, there is nothing we can do about it but accept it and rejoice in the fact that our measurements started in time to catch what was happening. The trends of the changes in other physical constants which Setterfield predicts seem to be according to prediction, so perhaps this really is the case.

Though perhaps a further evaluation of the data

themselves is in order, there is no doubt of the consequences of a real change in the speed of light. Setterfield's theory is both appealing and convincing. It should have a large impact upon creation science.⁴

—Contributed by Mr. Paul M. Steidl

References

¹Setterfield, Barry, 1981 The velocity of light and the age of the universe. *Ex Nihilo* 4(1):38-48 & (3):56-81.

²Since this is a summary of two articles, both with many footnotes, it has been impracticable selectively to reproduce those footnotes which apply to what is given here. Further information can be obtained from the author, Mr. Barry Setterfield, whose address is Box 318, Blackwood, S.A., 5051, Australia.

³Cohen, B., 1944. Romer and the first determination of the velocity of light. The Burndy Library, Inc., New York, P. 33.

⁴Morton, Glenn R., 1982. Electromagnetics and the appearance of age. *Creation Research Society Quarterly* 18(4):227-232, and Harris, David M., 1978. A solution to seeing stars. *Creation Research Society Quarterly* 15(2):112-115, have both proposed ideas which have some resemblance to some of Setterfield's. I do not doubt that these men all arrived at their ideas independently. (Editor)

BOOK REVIEWS

Biology for Christian Schools, by William S. Pinkston, Jr., 1980. Bob Jones University Press, Inc., Greenville, South Carolina. 741 pages. \$23.20.

Reviewed by Wayne Frair*

This is the type of book I would want used were I still teaching high school biology in a Christian school or if I were parent of a high school student in such a school—a book dealing with the *real world* and issues the Christian must face while serving God in *this world*—creation, evolution, drugs, hypnosis, drinking alcohol, tobacco use, euthanasia, test tube babies, abortion, sex and genetic engineering. All of these subjects are handled appropriately and discussed within a biological framework in the light of the Word of God. For instance,

Some Christians condemn genetic engineering, cloning, and the like because they consider these techniques “unnatural.” But like X-rays, surgery, and all of modern medicine, these genetic techniques are simply tools in man's hands that God can use. If used within the bounds of Scripture, if used to correct deformities or for currently accepted therapeutic purposes, these tools would find few opponents. But, just like any other tool, these genetic practices can be misused. (p. 173)

The book was authored by an experienced Christian teacher and is authoritative, complete and beautifully illustrated with photographic reproductions and many original drawings. At the end of each chapter is a list of Biology Terms used; some Review Questions; and helpful Thought Questions, many of which deal with understanding the subject as related to the Bible. Scripture references and discussions of them are scattered

through the text at appropriate places so that a felicitous balance exists between the well-covered subject matter of biology and its importance for a Christian life. I think that one of the best chapters is 7C “Diseases and Disorders” because of the way Scripture and scientific data are brought together.

The book opens with an “Introduction for the Student”, this being followed by three units. The first of these consists of 218 pages and covers chemistry, cells, genetics, creation, and evolution. The second unit is 340 pages long and deals with taxonomy, survey of living forms and ecology. Unit 3 has 156 pages and presents human anatomy and physiology, concluding with a 9-page chapter on “A Christian Perspective of Human Relationships”.

Following this there is a 3-page Appendix containing English and metric values, a creationist bibliography and the major divisions of a 5-kingdom classification system as used in the text. The Appendix is followed by a 15-page Glossary (with a few plurals and abbreviations) and a 9-page Index.

Although this first edition is well produced and should, I expect, have an enthusiastic reception in a wide spectrum of Christian schools, it does have some rough edges which should be smoothed in subsequent editions. With appropriate refinement and updating in future years, as the Lord tarries, the work can be expected to have extensive long-range usage.

The first chapter on “God and Science” has science defined as “man's attempts to observe and describe the natural processes God established to govern the universe.” (p. 11) But the glossary definition is “a body of facts that man has repeatedly observed about the physical universe around him.” (p. 728) People have different understandings of science, and the two given by Pinkston could go together. Another definition I par-

*Dr. Wayne Frair is Professor and Chairman of the Department of Biology, The King's College, Briarcliff Manor, New York 10510.

ticularly like is by L.A. Higley in *Science and Truth* (Revell, 1940):

Science is knowledge of God's creation, its phenomena and laws, fully tested by adequate observation and interpreted by accurate thinking. (p. 279)

Higley also says:

Inasmuch as everything that science treats came originally from the Creator, no definition of science is satisfactory that leaves God's name out of consideration. (p. 279)

Presently I am tending more toward stressing science as a methodology, for thus I think we are less likely to exclude God from appropriate relationship with His creation.

Though there may be some truth in Pinkston's somewhat anti-clerical sentiment expressed on p. 18, it may be wise to soften this in future editions in the light of the book's overall purpose. On the whole, the first chapter does deal with the scope of science in a very fair way and ends with:

True scientific knowledge can enhance your worship by giving you more insight into the wonders of God's creation. (p. 28)

In special chapters starting on p. 176 the book treats evolution and creation along with various concordistic concepts. The age of the earth and radiometric procedures are considered, and a case is made for a young earth and flood geology. In the creation section as well as the chapter on vertebrates I was pleased to see a correct modern treatment on the evolutionary idea of embryonic recapitulation where Pinkston clearly indicates that human embryos (and other nonaquatic vertebrates) have pharyngeal pouches and not gill slits. The anthropology material is attractively presented (p. 212-213), but this needs revision and scientific updating.

Pinkston recognizes that mutations, though virtually all harmful, have caused some aspects of present phenotypes (p. 161-162), but for diversification as among "Darwin's finches", there was distribution of existing genes or isolation of "only 'puddles of the gene pool'". (p. 207)

Some miscellaneous suggestions for users of the text and those responsible for its revision follow:

On p. 26 I suggest including Romans 1:20 or possibly replacing Psalm 19:1 with it. Contrary to what is said on p. 63, the insulins of animals are not exactly like human. Beef insulin, for instance, which has been utilized in treatment of human diabetes mellitus, has 51 residues as does human, but the amino acids used in forming the two compounds differ at three positions.

The cell reproduction section (p. 121 ff.) I think more clearly could explain that cell division has two aspects: (1) nuclear division (mitosis or karyokinesis) and (2) cytoplasmic division (cytokinesis). There appears to be a discrepancy between Table 4A-7 (p. 125) where the Irish potato is listed as a 24-chromosome diploid and p. 152 where we learn that it is a 48-chromosome tetraploid. Then I wondered if something were missing on p. 139 to go with the "HH, HS, and SS". On p. 140 "homologue" can be simplified to "homolog". Proof

reading of the manuscript was meticulous, but an "s" is missing on "put", p. 203, par. 2, line 5; and on p. 230, par. 2, line 1, "who" might better be "which". For the Glossary I think the age of human embryos (to eight weeks) should be included under "embryo", and the definition of "thylakoid", for instance, could be improved by transposing a few words (flattened discs forming grana in a chloroplast).

At present it is urgent that the concept of "kind" be spelled out scientifically in more detail, and until this is done by the scientific community, caution must be exercised in associating kind with any present taxonomic categories. Author Pinkston has indicated to me by personal letter that he thinks it is possible but not probable that since creation "there are still the same number of kinds existing on the earth." (p. 232) I misunderstood his statement on my first reading of p. 232 and think that possibly the sentence containing the above quotation (line 11ff) could be clarified.

On p. 238 under "Making Vinegar" the last line should be made more clear, as should the sentence p. 241, par. 2, lines 6-7, ("Soon living cells in the center are . . ."). On p. 356, par. 2, line 1, it is redundant to say "physiological processes". It should be "physiology" or "processes". In the treatment on aspirin (p. 669) possibly more could be included regarding its potential dangers (as possible damage to mucous membranes).

On p. 407 Pinkston in discussing "Crustacea" says that "the open circulatory system is not as efficient as the closed circulatory system." I question this idea because one must appraise any organ or system within the context of the organism. An open system may be less efficient in a vertebrate where completely different hemodynamic conditions exist, but in an arthropod it likely is best as part of the total design of the organism.

Regarding the taxonomic order of turtles, the term "Testudines" (Batsch, 1788) has priority over "Testudinate" (Oppel, 1811) (p. 471, 477, 716) even though the latter term may appear to fit our current system better. Also in the United States it is most common for the word "turtle" to be used for *all* members of the order, not just aquatic forms.

On p. 231 and 233 Pinkston refers to Linnaeus' belief in fixity of species. This was true in 1735 when in *Classes Plantarum* he wrote, "There are as many species as there are originally created forms." But later he recognized that some changes had occurred, for in his 1774 book, *Systema Vegetabilium*, he says:

Let us suppose that the Divine Being in the beginning progressed from the simpler to the complex; from few to many; similarly that He in the beginning of the plant kingdom created as many plants as there were natural orders. These plant orders He himself, therefrom producing, mixed among themselves until from them originated those plants which today exist as genera.

Nature then mixed up these plant genera among themselves through generations of double origin [= hybrids] and multiplied them into the existing species, as many as possible (whereby the flower structures were not changed), excluding from the number of species the almost sterile hybrids, which

are produced by the same mode of origin. Therefore, on the basis of this later published information, we can recognize that Linnaeus expressed thoughts which could be considered consistent with a creationist position.

Some drawings in the text are superbly done, for instance, those presenting cellular anatomy and physiology; and I especially like the cartoons demonstrating catalysis (p. 55). The book contains a number of comic drawings and I think perhaps a few more could enhance the work. The representations of Redi's spontaneous generation disproof (p. 20), however, are not as clear as they could be with more labels (such as "maggots" or "drying"); or, alternately, more detail could be added to the text. The diffusion and osmosis drawings (p. 52-53) need improvement. Fig. 3A-14, p. 81, is not clear. Labels may help. On p. 394 (11E-3) there are a number of structures not clearly labeled (muscle layers, for instance). Here a plural word "ganglia" is used with a line going to only a single structure. This is true for "intestines" and "gills" (p. 398), "eyes" (p. 415) and "bronchioles" (p. 594). There probably are others because I have not made an exhaustive check of all figures. The Fig. 17A-5 (p. 594) drawing of erythrocytes unloading CO₂ and picking up O₂ should have direction of flow arrows, "alveolus" (not "alveoli") and better would show dark red to light red rather than blue to red.

There is a trend now toward Anglicizing Latin words and using descriptive rather than commemorative terms. Descriptive terms clarify the subject. The book wisely uses "oviduct" in preference to "Fallopian tube". Future advisable changes, for example, could include "vas deferens" to "deferent duct", "corpus luteum" to "white body", "Eustachian" to "tympanic" or "pharyngotympanic", "Bowman's" to "glomerular", "loop of Henle" to "loop of tubule" and "islets of Langerhans" to "pancreatic islets". In time of transition from one terminology to another authors can use the preferable terms and include alternate names in parentheses.

Another trend toward language simplification involves forming plurals with "s" or "es" rather than using Latin plurals, as "formulas" rather than "formulae". The book now has antennas, bursas, lacunas and lamellas; so why not vertebrae? It has both "ganglia" (p. 395) and "ganglions" (p. 407). I think we biologists are being rather elitist in perpetuating our "mitochondria" instead of "mitochondrions", "atria" rather than "atriums" and "epididymides" rather than "epididymises".

For the teacher utilizing *Biology for Christian Schools* there is available a looseleaf teacher's edition (\$29.50). It contains all pages of the student text with helpful teaching notes printed in brown on various pages. Following this there are 210 pages of teaching aids including sections corresponding to each chapter in the student text. There are lists of chapter objectives, introductions to content and philosophy of each chapter, selected references, answers to questions in the student edition and more teaching notes. Sources of visual aids, rate of coverage, assignments, etc., also are here.

Pinkson's accompanying 1981 200-page laboratory manual (\$6.00) has a relatively standard coverage—microscope (I wish they would use "turret" rather than "nosepiece"), osmosis, cells, mitosis, heredity, plants and animals, ecology, human anatomy and physiology, and frog. Exercises require filling in blanks and tables along with some drawing. There is available a looseleaf teacher's edition (\$12.00) containing the student manual with answers included, this section followed by 91 pages on needed laboratory materials and sources of them, references and specifics for each exercise.

Though some sections in the lab manual and particularly the text may be controversial even among Christians, I expect that most Bible believers will favor the basic creation approach and high spiritual and moral standards presented. The text and lab manual probably could be utilized in most beginning courses in high school biology; and all biology teachers in Christian schools should give them their serious consideration.

A Christian Manifesto, by Francis A. Schaeffer, Crossway Books, Westchester, IL., 1981, \$5.95, 157 pages.

Reviewed by M.A. Cutchins

This book should be read by all those interested in the creation/evolution issue. Dr. Schaeffer uses the terms, "the material-energy-chance concept" to describe the present evolutionary-dominated world view and documents how it ties in to the natural scheme of the Humanists. (The *Humanist Manifesto*, I and II are referenced. The reader should be familiar with these sinister documents.)

A Christian Manifesto is an outgrowth of a talk by Dr. Schaeffer given before the Christian Legal Society in South Bend in April, 1981. It is a well documented call to realize the magnitude and the ramifications of the battle which exists at present and what needs to be done, as educators, as lawyers, as open minded scientists, and as Christians. He deals with truth and morality, faith and freedom, and related topics in the contexts of history, law, government, schools, and court cases (including the recent Arkansas creation case). Most significantly, he postulates that there is now a "window" for a possible turnaround of the trends of the past 40 years, a window that will soon close if the humanists have their way (possibly assisted by many non-humanist scientists who do not realize the role played by evolution in the Humanist religion?).

Creationists who have been actively crusading for the end of the dominance of the poorly supported evolutionary view will be especially encouraged by the summary points of Dr. Schaeffer, several of which are indicated below:

"The world view which produced the founding of the United States in the first place is increasingly now not allowed to exert its influence in government, in the schools, or in the public means of information. The result of the original base in the United

*M.A. Cutchins, Ph.D., is Professor of Engineering, Auburn University, Auburn, AL. His mailing address is 701 Sanders St., Auburn, AL 36830.

States . . . (was) liberty . . . (which) included liberty to those who hold other views—views which would not give the freedom (to begin with). The material-energy-chance view has taken advantage of that liberty, supplanted the consensus, and resulted in an intolerance that gives less and less freedom in courts and schools for the view which originally gave the freedoms. Having no base for law, those who hold the humanist view make binding law whatever they personally think is good for society at the moment. This leads increasingly to arbitrary law and rulings which produce chaos in society . . . What is now needed is to stand against that other total world view . . . to take the steps necessary to break the authoritarian hold which the material-energy-chance concept of final reality has on government and law."

Hopefully, this book will encourage a stronger effort and especially encourage those who are not "in the battle" to realize its importance and to "enlist!"

Man, a Unity of Matter and Spirit, by J. Schroeder, 1981. Published by the author, P.O. Box 729 Waterloo, Ontario, Canada, N2J 4C2. 47 pp. \$2.50.

Reviewed by Douglas E. Cox.*

This little book examines the question "what is man?" from the point of view of a Christian in a materialistic world.

The author contends that man's body and spirit are inseparable. The spiritual faculty imparts such capacities as free will, thought, faith, charity, intuition. In contrast, modern psychology attempts to reduce man to a unit of organic matter, a view "which results in a pestilent perversion of man's spirit to an invisible but deterministic property of matter."

Professor Schroeder undermines this materialistic view of man by questioning the supposed potential of science to lead to truth. He questions whether creation, or even the true reality of the existing material world, can be understood by man, and concludes that, (contrary to prevailing opinion in today's science-dominated world,) man cannot even recognize the truth.

Professor Schroeder follows French philosopher and scientist Pierre Duhem by defining science as follows: it consists of natural phenomena as perceived by the senses, hypotheses based on man's intuition, and experimental validation, the sole criterion for acceptance of any scientific hypotheses.

This definition would effectively exclude past and future events. Also, it leads to questions about the "true reality" of even so well established and respectable a science as mechanics, which utilizes several abstract mathematical concepts such as fixed origins and unobservable force and mass. Professor Schroeder characterizes the idea of fixed origins, from the point of view of demonstrability, as absurd.

Evolution disqualified as science since it cannot be observed, and cannot be validated by experiment because of the vast time-spans postulated for it. Pro-

fessor Schroeder contends that the hypothesis has survived "mainly, because it evolved into a man-made secular religion as contemporary evolutionists conjecture it to be true without any possibility of ever proving it."

It is suggested that physical science represents rather than explains the true reality underlying a phenomenon, and that, for example, both atoms and energy are merely symbolic, mathematical concepts representing properties of matter.

"Science," writes Dr Schroeder, "like all human endeavors, is based on arbitrary human propositions which cannot be verified (as truth) by experience."

The materialistic view of man presented by the behavioral and psychological sciences is contrasted with the teachings of Christ. The denial of the existence of man's immaterial spirit in contemporary sociology and psychology leads, for example, to the denial of man's capacity for free will, which cannot be quantified for a scientific study. Man's capacity to choose, to obey, or disobey God is shown, for example, in Matthew 7:24-26.

Professor Schroeder contends that man can accept the truth, revealed in scripture, by faith only. He writes: "Christianity depends on God-given faith. The realization that man can neither reveal the underlying reality of nature nor the real nature of man renders faith and man-made thought independent. Faith in Christ depends on concepts revealed by God to man, whereas science depends on concepts imagined by man. Since no experiment in the universe can prove that God exists or that any science can reveal a true reality, man has a free choice: accept by faith the part of Truth revealed by God through Christ or adapt to man-made ideas."

This reviewer has some reservations about the need for a choice between science and faith. Certainly a selection from various scientific concepts is necessary, but may not one seek, discover and develop concepts that are compatible with faith, and with revelation?

Scripture seems to encourage this. Christ expected his contemporaries to draw conclusion from their observations of the clouds, for instance, and Paul wrote in Romans 1 that the study of nature can even reveal certain truths about God.

However, the topic will interest many readers, who will find the work stimulating and refreshing.

Bibliography of the Grand Canyon and the lower Colorado River, 1549-1980, compiled by Earle E. Spamer and others. Available from The Grand Canyon Natural History Association, Post Office Box 399, Grand Canyon, Arizona 86023. \$7.00 plus \$1.00 for postage and handling.

Reviewed by John R. Meyer*

This review of the scientific literature, both technical and popular, relating to the Grand Canyon provides an in-depth look at the studies that have been performed on its many facets. The bibliography contains just over 4000 references taken from over 350 periodicals and nearly 75 non-periodic serials. The references are

*Mr. Douglas E. Cox's address is P.O. Box 18, Petersburg, Ontario, Canada.

*John R. Meyer, Ph.D, lives at 27117 Langside Avenue, Canyon County, California 91351.

grouped under the following headings with the approximate number of entries shown at the right:

Popular Works on The Grand Canyon and the Colorado River Including Accounts of the Early Spanish Expeditions	708
The Lower Colorado River: Geography, Geology, Hydrology and Diversion Projects, Lake Mead to the Colorado Delta	393
Geology of The Grand Canyon; Its Palaeozoic Strata Exposed Elsewhere, and The Regional Tectonic Setting	1722
Biology and Ecology of The Grand Canyon	495
Archaeology of The Grand Canyon	67
History of Grand Canyon National Park	133
Native Americans of the Grand Canyon Region	104
Maps and Charts Encompassing the Grand Canyon (Excluding Geologic and Topographic Maps)	16
Grand Canyon Articles and Reports in <i>The New York Times</i>	285
Miscellaneous	84
Total	4007

Several of the above sections will be of great interest to creationists. The material on "geology of The Grand Canyon" provides a number of references not only to fossils, but also to fossil tracks and trackways. Caves in general appear to have received considerable attention with the Giant Sloth caves being of particular interest. The stratigraphy of the area has, of course, received extensive attention along with tectonics and geophysics. Many studies have also involved attempts to understand Pleistocene climates.

At first, the section on "Biology and Ecology" appears disappointing. The paucity of references in this area is underscored in that over 200 of the nearly 500 entries are from *Grand Canyon Nature Notes* published in the 1920's and 1930's, apparently primarily as an in-house information organ for park personnel. These *Notes*, while providing helpful information, are primarily anecdotal in nature and provide little in-depth analysis. Thus, the number of substantive reports in this section is well under 300. This disappointment in the number of studies in the life sciences indicated in the bibliography points out the opportunity that biologists, particularly those of the creationist viewpoint, have in making a significant contribution not only to Grand Canyon natural history in general but to the creationist interpretation of the area in particular.

The Grand Canyon provides one of the most dramatic and sharply delineated barriers to terrestrial animal distribution in the world. Its influence on the biology of the area has, with a few exceptions, been largely neglected by both creationists and evolutionists.

This section on the biology of the areas contains references to a number of guide-books and check-lists of the flora and fauna of the area. The disasters relating to the mismanagement of the Kaibab deer herd are well documented and some information is provided with reference to geographic isolation of the Kaibab squirrel on the north rim. Students of palynology will find a number of important articles on pollen in the Grand

Canyon area. A fairly large number of ornithological observation notes are also reported.

The section on "Grand Canyon Articles and Reports in *The New York Times*" provides references to disasters in the canyon including plane crashes, lost or missing individuals and Risdon's hoax regarding the death of all Powell expedition members. Also covered are the usual news-making controversies surrounding management of various aspects of The Grand Canyon National Park. Of special interest to creationists is a number of articles appearing throughout 1937, relating to the expedition to Shiva Temple by Harold Anthony of the American Museum of Natural History, whereby he hoped to find evidence of evolution on top of the isolated "sky island." Few scientific enterprises have started with such a "bang" and ended with such a "whimper."

I have collected a number of papers relating to the Grand Canyon and have not found any omissions in the bibliography with the exception of failure to reference material in the *Creation Research Society Quarterly*. Thus, the bibliography appears to be reasonably thorough, though making no claim to be exhaustive. Current plans are to keep the bibliography updated and the author welcomes corrections and additions.

In general, it is clear that the *Bibliography of the Grand Canyon and the Lower Colorado River, 1549-1980* should be considered an indispensable tool for anyone seriously interested in the natural history of the Grand Canyon.

Earlier Than You Think, A Personal View of Man in America, by George F. Carter, Texas A & M University Press, College Station 1980, 348 pages, including glossary, bibliography and index.

Reviewed by Chris C. Hummer*

"Science and scholarship are carried on not by bloodless automatons but by very real people, brimming with passions, psychologically patterned, and scholastically warped."

—George F. Carter (321)

According to the archaeological establishment in North America the first American to leave behind a distinctive technology was Clovis man. In the *Odyssey* TV program "Seeking the First Americans" a debate was carried on between Vance Haynes and Dennis Stanford, prominent American archaeologists. They addressed the question, "Was the sophisticated Clovis technology indigenous or imported?" Their divergent views are in evidence in this exchange:

Vance Haynes: "Clovis is from the Old World, central Europe and the Russian plain. It came from people who were oriented to hunting megafauna."

Dennis Stanford: "We have no idea where it came from. The Old World and Siberian cultures are no closer to Clovis than to other cultures."

Clovis technology is found across all of North America. Not only was its appearance sudden but it spread very rapidly, probably in not more than 1000

*Mr. Chris C. Hummer's address is 1211 Rose Lane, Berwyn, Pennsylvania 19312.

years. How can we account for the spread of Clovis?

Vance Haynes: "The hunters spread across the continent, multiplying and killing the many animals. I have no trouble with the idea that they spread from Canada to the tip of South America in less than 1000 years."

Dennis Stanford: "For Clovis to have spread as fast as Haynes suggests the men would have to be running. I believe instead that America was widely peopled before Clovis. Then someone invented the Clovis point 12,000 years ago. The idea spread through resident populations."

With the publication of this book George Carter (re-)enters the debate. He, too, believes that America was widely populated before Clovis—but for more than 60,000 years before the earliest date (40,000 BP) that some recent publications reticently recite.

George Carter: "I simply mean to point out that the foundations of the recency-of-man-in-America school stand on quicksand (320) . . . The lithic industries that appear in America are all in Asia, and men in America came from Asia (313) . . . Initial occupation of America, via Bering Strait was by longheaded people of at least three types, probably coming in separate waves. One was Neanderthaloid, One Negritoid, and the other Australoid . . . the first movements quite clearly were on the 100,000-year scale." (297)

Stanford said the problem could be couched in two hypotheses: A) Clovis was the first man here, B) man was here before Clovis. The test for either hypothesis is to look for archaeological traces of earlier man. This is what George Carter's book is all about. Carter offers more than 300 pages of evidence—artifactual, stratigraphical, geomorphological and skeletal—in arguing for a pre-Clovis appearance of man in America. And, if you paid attention to the time scale in the quotation above, that appearance pre-dates Clovis man by a whopping 88,000 years!

For George Carter, who says he is "more identified with this controversy than anyone else in America" (12), this book is his latest major effort at explaining his views on the earliest Americans. Carter's perspective is archaeological, anthropological, geographical, geological and geomorphological, and in these latter two areas he brings an expertise to his studies that many American archaeologists lack. Through all of his studies he admits that his interest "has centered on the question of time" (xi). He defends use of such European terms as Neolithic, Upper Paleolithic and Lower Paleolithic to represent similar cultural stages in America (though not necessarily similar times). Carter believes that the peopling of America was begun by people of a Lower Paleolithic culture at about 100,000 years ago. The problem of time, of course, raises another interesting, and almost as difficult, problem: race. If man came into America at only 12,000 years ago then we could expect that those who crossed the Bering Strait were modern Asiatics. But with the greater antiquity proposed by Carter there is time enough for different kinds of men and different kinds of cultures to have entered the New World. The Cedar County, Nebraska and the Brazil "neanderthaloid" skull cap, among others, are offered

as evidence of non-Mongoloid people in ancient America.

Carter's problem has been in getting his colleagues to accept the broken stones that he and others have found on a number of sites as genuine human artifacts (and not "cartifacts"). All kinds of alternative hypotheses have been offered by Carter's detractors: the glaciers-break-rocks, streams-break-rocks, surf-breaks-rocks, etc., theses. Carter's answers to these "excuses" are at once thorough and decisive. The stones in question are broken to distinct patterns familiar to stone workers, there is selectivity of raw material involved, and, after thorough observation and field investigation, no known natural force could be found that could account for the breakage. As an indication of the narrowness of the establishment in North American archaeology it is interesting to note that the *Odyssey* documentary (referred to earlier in this review) did not examine any of Carter's sites or evidence. As Carter says, "you cannot find what you will not look for and cannot or will not recognize when you stumble over it."

Dennis Stanford said that to test the hypothesis for the existence of pre-Clovis man in America you have to look for earlier sites. Two chapters of the book are devoted to ancient sites possessing the evidence that Carter believes supports his views of pre-Clovis man in North America. Dee Simpson's deep Calico site in the Mojave Desert has yielded blade and core work—and some fun. The question here is, do trained archaeologists recognize stone tools when they see them? To quote Carter:

The most interesting test is to hand an archaeologist a Calico tool without telling him where it is from. 'Well, that is an artifact. No one will deny that. Where is it from?' was a recent exclamation. When I replied 'Calico', the victim of my duplicity was astonished, for his professors who had been to Calico had told him that there were not artifacts there. Among others, Vance Haynes was so victimized. . . (35)

Carter's theme in this discussion, and one amusingly demonstrated several times, is that "our preconceptions always color our views." When hand axes were first discovered a hundred years ago they were not accepted as human artifacts. There was no precedent for them, and they turned up in gravels containing bones of extinct animals. Before 1930 it was believed that man came to America no more than 500 years ago and that he arrived *with* the bow and arrow. By 1960 American scholars recognized much older pre-bow and arrow cultures in America. The problem today is recognizing even older technologies and the sites that contain them. In Carter's view ancient sites like Calico, Texas Street, Truckhaven, Yuha Desert, and Buchanan Canyon are yielding stone tools that point to a long series of cultural stages that pre-date Clovis:

1. Pebble tool stage.
The earliest stage. 100,000+ years.
2. Heavy blade stage.
Split off blades, heavy and thick, are ready-made knives. 80,000 years.
3. Ovate biface stage.
Bifacial flaking corresponding to hand axe stage of the old World. 80,000-60,000 years.

4. Unifacial flaking stage.
Blows all struck in one direction, resulting in thick and often steep-edged adzes, scrapers, skinning tools, etc. 60,000-12,000 years.
5. Fine bifacial stage.
Finely flaked points characteristic of Clovis, Folsom and subsequent projectile point traditions. 12,000-recent times.

Carter says,

In America we are still struggling with the problem of recognizing blade and core work—obviously the work of man, once you have learned its diagnostic traits, but work that American archaeologists tend to reject when it turns up in ancient river gravels (or other sites, we may add) that are too old for man in America. (12)

Age-old anthropological problems surface in this book: diffusion vs. independent acquisition, uniraical vs. multi-racial origins, recent vs. ancient entry, and the validity of various types of dating processes such as radiocarbon and racemization. Not everyone will be satisfied with Carter's theoretical position, or that he has done much to solve the problems. But they need to be solved, and if Carter is right we may be standing at the threshold of another "revolution" in our thinking about man in the New World.

The book, written for the educated layman, contains a helpful glossary with only 30 entries. Expected words like "Clovis" or "graver" do not appear in it. There is an index and a bibliography. I was disappointed in the illustrations. They are not as plentiful as I would like (only a line drawing of a single artifact from Calico is all that is given for an important site in Carter's scenario), and they vary in quality. Photographs often appear without a scale so necessary for ascertaining the size of depicted artifacts.

Young-earth creationists will have difficulty, of course, with the dating system used by Carter and North American archaeologists in general. But creationists may find Carter's scenario of cultures and races and technology to be stimulating. Feeling his way in an unsettled natural world post-diluvian man in the New World, like post-diluvian man elsewhere, may have indeed taken time to improvise, invent and improve his stone tool kits. Carter's multiracial peopling of America can be interestingly compared to Arthur Custance's scenario for post-diluvian Hamitic migrations.

American archaeology is a field relatively untouched by creationist scholars. If we are not satisfied with the establishment views, or with Carter's time scale and geomorphological calculations regarding ancient beaches, deeply buried manos, metates, fire pits and a Pleistocene horse with charcoal, then we must analyze the material ourselves. We must also excavate. It is insufficient for PhDs in other fields or even amateur creationists to read the archaeological literature and look for inconsistencies that "prove" the evolutionary approach to be wrong. We need PhD's who are specialists in North American prehistorical archaeology to excavate, analyze, experiment and publish. We need specialists in paleozoology, paleobotany, geology and geomorphology to work closely with the archaeologists. We need to launch a major multidisciplinary prehistoric study of the Americas.

Entropy: a New World View, by Jeremy Rifkin, 1980. The Viking Press, New York. 305 pages, \$11.95.

Reviewed by Emmett L. Williams*.

The author, embracing many of the concepts of chronological or cultural primitivism, attempts to employ environmental, economic and sociological interpretations of the second law of thermodynamics as major weapons in an attack against the philosophy of progress.

Before proceeding with this review, the two competing philosophies will be defined. (Quotes are taken from *A Glossary of Literary Terms* by Meyer H. Abrams p. 138).

Chronological primitivism signifies the belief that the ideal stage of man's way of life lies in the very distant past, when he lived naturally, simply, and freely, and that the progress of history has been a gradual "decline" from that happy stage into increasing artifice, complexity, inhibitions, and prohibitions in the psychological, social, and cultural order . . .

Primitivism is as old as man's recorded thought, and is reflected in the widespread myths of a vanished golden age and of a lost Garden of Eden . . .

D. II. Lawrence was a recent and powerful instance of a primitivistic thinker in his laudation of the spontaneous instinctual life, his belief in a vanished condition of man's personal and social wholeness, and his attacks on the disintegrative effects of the modern technological economy and culture.

The philosophy of progress is the doctrine that, by virtue of the development and exploitation of man's art, skills, and wisdom, the course of history represents an overall improvement in his lot, morality, and happiness from early barbarity to the present stage of civilization and that this historical progress will continue indefinitely in the future—possibly to end in a final stage of social, rational, and moral perfection.

Although this reviewer agrees that the world view of progress has many defects and its proponents have "created" a man-made "antiparadise", the "new world" offered by Rifkin is probably more horrible. He like so many other humanists fails to cope with the fallen nature of man when building his "dream world".

The author attacks the mechanical world view (the universe operates similar to a machine) and primarily blames Bacon, Descartes, and Newton as the popularizers of the concept. The theory of evolution became the greatest triumph of this world view (p. 29). Using the second law (referred to as the entropy law) Rifkin states that the universe is "grinding down" not becoming more orderly and complex as would be necessary if the progressive-evolutionary-mechanical world view were true. Several anti-evolutionary statements are made but Rifkin believes in evolution and employs several conclusions from the theory to support his case. For instance he states that life exists on free energy mistakenly called negative entropy (p. 52). Evolution to higher and higher

*Emmett L. Williams, Ph.D., is a Scientist-Associate at Lockheed-Georgia Co., Marietta, Georgia.

species has caused increasing disorder since the ordering of evolution was accomplished at the expense of generating "great seas" of disorder elsewhere in the universe—and thus we (man) are in trouble because we are destroying the universe to keep ourselves going. Man must stop this endless energy suction (consumption) to improve his life style.

According to Rifkin each time man moved into a different evolutionary phase such as from hunter-gatherer societies to agricultural stages, it was because the environment was exhausted (called an entropy watershed) and man was forced to change his way of life (p. 65). Likewise, man was forced into an industrial environment after he exhausted his agricultural base. However, man's survival now depends on his willingness to make peace with nature or learn to become one with nature. Near-eastern mysticism and raw pantheism creeps into the "new world" philosophy. Technology has failed man and is producing diminishing returns. Socialism is a result of increasing entropy (p. 89, 90). Of course the U.S. being the most technologically advanced nation, receives the only national reprimand, i.e. Americans are addicted to energy consumption. (p. 99).

A review of future energy and mineral sources is undertaken, recycling and conservation are considered and Rifkin concludes America faces an entropy watershed. Modern energy consumption, industrialization and other consumption-oriented activities are doomed. Modern American farming is the most inefficient form of farming ever devised (p. 136). An organic farmer with his manure, horse, and personal sweat are more efficient!? We are getting to the crux of Rifkin's great society. It will be labor intensive, possibly every man hoeing out his 4 or 5 acres to support his family. (Slavery is labor intensive.) In his brave new world of primitivism we can do without heavy industry, particularly the auto and aircraft industries; transportation over long distances is a no-no.

What's really scary is the recognition that the entropy process often affects activities so far removed from the original energy expenditure that no relationship is even suspected. For example, a man driving an automobile down the highway, no doubt, would be shocked to learn that every time he puts his foot down on the accelerator he is potentially contributing to the brain damage of a five or six year old school child miles away. (p. 146)

Highly urban areas must go, the military machines of all nations must be dismantled. Education must be a process of teaching man to become one with nature. Modern medicine has the wrong approach and does more harm than good.

Of course to replace all of this modern nonsense is a Solar Age (p. 186). Like all modern ecomaniacs, Rifkin feels that the ultimate solution lies in the use of solar power and it will work and be our benefactor because it must. Likewise such pagan societies as Mao's China and Gandhi's India are put forth as ideal examples of third world development. The Marxist views of the author slip forth. Redistribution of wealth will be necessary (p. 195) to enter the primitive new world. Material consumption will become minimal (enforced poverty?). Can you imagine a smiling dictator seeing that all of us

peasants will stay poor! Men must work, work, work, there seems to be almost salvation in work. Land cannot be privately owned but replaced with public guardianship (p. 211). Who is the public? The destruction of any species is a cardinal sin (p. 211). However, population control will be necessary (p. 211). Although Rifkin imagines a decentralized society, can you visualize what may happen when anyone disobeys these humanitarian (?) principles? Destroy the ants in your yard, kill a marauder, etc. and you might possibly have to defend yourself in a public court as an enemy of nature (or society).

Finally the Christian will seek salvation by preserving God's creation (p. 240). A lofty thought but certainly missing the entire point of salvation through Christ's finished work on the cross.

There is much wrong with modern society but to this reviewer a return to the 1800's or even the 1400's is not the answer. The cure is worse than the disease. Man's schemes to create an ideal society on earth, progressive or primitive, are doomed to failure for man's problem is not physical, environmental, or economic, but spiritual, and man continually choses to ignore his only hope, the Lord Jesus Christ.

In the Beginning, by Isaac Asimov, 1981. Crown Publishers, Inc., New York. \$10.95.

Reviewed by Don B. DeYoung.*

Isaac Asimov is the author of more than 220 books, seven of which concern Bible subjects. His latest effort, called *In the Beginning*, has the subtitle: "Science Faces God in the Book of Genesis." It is a treatment of Genesis 1-11, from Adam to Abraham. Asimov is very concerned with current attempts to integrate scripture with modern science theories. Such efforts are typified by Robert Jastrow's popular book *God and the Astronomers*, in which the big bang theory is read into Genesis 1.

Asimov disagrees, writing that "the mere agreement between the Bible and science that there was, in fact, a beginning, loses most of its value" because "the age of the Universe, according to science, is at least two million times the age according to the Bible (p. 10)." He sees apparent similarities between Genesis 1 and modern scientific theories as interesting but entirely coincidental.

At least Asimov is to be commended for rejecting Bible-Science compromises such as day-age and gap theories, if indeed he is familiar with them. However, his real reason for rejecting compromise seems to be a strong anti-scripture and anti-Christian bias. Asimov simply fails to see any reason for Bible-science agreement. He believes that the Bible is based on incorrect science and primitive folktales, "if one can bear to abandon the theory of divine inspiration (p. 77)." While he is at it, Asimov also expresses his doubt about the existence of the soul (p. 83) and the Trinity (p. 59).

Theological Framework

Asimov depends heavily on liberal sources throughout his book. The J-P documentary theory pro-

*Don B. DeYoung, Ph.D., is at Grace College, Winona Lake, Indiana.

vides his outline. According to this theory, based on modern rationalistic skepticism, Genesis 1-11 is a composite of two previous documents. The J source is said to consist of primitive Judean legends. The P source was a later document adopted by Jewish priests from Babylonian myths. For a thorough refutation of this view, see Edward J. Young, *Introduction the Old Testament*, 1949, pp. 183-276.

In the Beginning provides no exegetical comments on the Hebrew language. Certainly a grasp of Hebrew should be a prerequisite to authoring a verse-by-verse commentary on Genesis. Text references are limited to popular works such as the Anchor Bible (p. 16). Advertisements for the book promise an "even-handed comparison of the two accounts of creation—the Biblical and the scientific"; but Asimov strongly promotes the mainline evolutionary view of science while showing little respect or understanding of scripture. The measure of "evenhandedness" can be judged by the reader himself after reading a summary of Asimov's statements regarding science and scripture, as found in *In the Beginning*. I will spend no time commenting on the science statements, since we have heard them so many times before.

Asimov on Science

"There may be . . . many arguments over the details of the mechanics of evolution, but none over the fact . . . (p. 1)."

"Biblical statements rest on authority . . . There is no room for disagreement . . . A scientist, on the other hand is committed to accepting nothing that is not backed by acceptable evidence (p. 7)."

" . . . the evidence in favor of evolution is so strong that no reputable biologist doubts the fact . . . (p. 40)."

Asimov on Scripture

1. Asimov describes the Biblical view of heaven as a solid, semicircular dome above the earth. Furthermore, using Job 26:11, he claims that the Bible assumes literal pillars holding up heaven. Then Asimov concludes, "all this is utterly different from the *scientific* view of Earth as a sphere, suspended in emptiness (p. 15)." Why is there no mention of Job 26:7, which clearly states that the earth is indeed suspended in space? Furthermore, Asimov is surely aware of scholarship which has shown Genesis to be a sharp antimythical polemic *against* the contemporary Near Eastern cosmologies having a solid heavenly dome supported by pillars in the sky. For example, see Gerhard F. Hasel, "The Polemic Nature of the Genesis Cosmology," in *The Evangelical Quarterly* 45 (April-June 1974): 81-103.

2. "In short, the Universe is moving from Cosmos to Chaos, from Order to Disorder, in the reverse direction of that imagined by the various mythological accounts—including the Biblical account (p. 24)." Asimov here challenges the creation week establishment of order, but where does *he* propose to get initial order, or low entropy? His appeal is to an oscillating universe with repeated big bangs. "In this case, there is no true beginning or no true ending; the Universe exists forever

. . . (p. 25)." Thus, Asimov has actually turned his back on the problem of initial order, rejecting the *only* credible explanation, that of a Creator; and has adopted a view which only a minority of scientists take seriously.

3. Asimov's weak statements on the Genesis flood are almost humorous. He proposes a local catastrophe which was greatly exaggerated by later Sumerian story tellers. After all, "in a land as flat as Sumeria, it would not take much of a flood to cover large portions of the entire region (p. 153)." In other writings, Asimov proposes that "someone's boat was washed to the foothills of Ararat, thus starting the ark story. "Perhaps a sizeable meteor made an unlucky strike on the waters of the (Persian) Gulf and created a huge splash (p. 162)." That would indeed have been some splash.

4. At times it is evident Asimov has not done his homework; perhaps he was busy writing additional books. Anyway, he takes the *leviathan* in scripture to be a crocodile (p. 52), contrary to the description of Job 41. Regarding the interesting verse Genesis 9:27, Asimov concludes that "no one has been able to explain this verse . . . something may have been left out or distorted in the copying, and it may be hopeless to puzzle out the meaning (p. 188)." Surely Asimov could have looked up pp. 352-3 of H. C. Leupold's *Exposition of Genesis*, Vol. 1, 1942. A full analysis of the verse is given by Leupold, complete with its background and historical fulfillment.

5. The view expressed concerning the seven day creation week is pathetic. There is no mention of God's clear time pattern for man as stated in Exodus 20:11. Instead, the seven day week is said to derive from Babylonian astrological objects: the sun, moon, Mercury, Venus, Mars, Jupiter, and Saturn (p. 74). P-document writers "kept the Babylonian week but sanitized it and tied it in with the tale of Creation," making it "inevitable that we continue to use an unnecessarily clumsy and inconvenient calendar. (p. 76)."

Conclusion

The book *In the Beginning* presents the standard evolutionary view of science, and an extremely critical view of scripture. Creationists who are on the firing line of faith should be familiar with the arguments presented. As for Asimov, he seems to be so busy trying to unravel the artificial J and P parts of Genesis that he completely misses the creation and the curse, the judgements and the promises of Genesis. Asimov surely needs to again start "in the beginning" with scripture, laying aside the outdated tenets of liberal theology. He is a prolific author; but as for *In the Beginning* he is in danger of being an author of confusion. He has yet to meet the great Author of Genesis and Finisher of our faith.

The Tigris Expedition, by Thor Heyerdahl. 1981. Double day and Co., Inc., Garden City, New York. 349 pages.

Reviewed by H.L. Armstrong.*

This work describes, at first hand, the voyage of the

*H.L. Armstrong's address is 4 Couper Street, Kingston, Ontario, Canada.

reed boat Tigris, in 1977 and 1978, from the Euphrates and Tigris Rivers first to Pakistan, then to the entrance to the Red Sea.

This is not at all a Creationist book. But the information and suggestions about ancient civilizations will be useful; and the fact that extensive navigation was practised so early could have important implications for the dispersion of mankind after the Flood and the tower of

Babel. Also, the high degree of ancient civilization, which is revealed in many ways in Heyerdahl's investigations, is reason for taking their records, especially those contained in Scripture, seriously.

Besides, everyone likes an adventure; and it is right that we read about, and honour, a man who was not afraid to put himself to considerable personal risk in order to check out his theories.

LETTERS TO THE EDITOR

No Chance for Chance

I read with delight and interest Randall Hedtke's *The Episteme is the Theory*.¹ We increasingly discover how deeply human thought rests on pre-suppositions. Science which is outside extensional verification must, in the nature of things, become deductive. The level at which primary deductions such as positivism/creationism are made is highly personal and profoundly central to all human action. "Keep thy heart with all diligence for out of it are the issues of life." (Proverbs 4:23)

Having chosen to remove their hearts (which means "Minds") from the Lord, modern scientists have chosen Bertrand Russell's despair to place at the heart of their deductions. How profoundly despairing for the highly articulate, rational scientist to explain his brain as the product of some ill-defined "force" called chance. The Random House Dictionary defines "chance" as "the absence of any cause or series of causes of events as they actually happen than can be predicted, understood, or controlled." If the origin of all things, including the brain, be in such a "state of affairs" why is it understandable now? If chance cannot be predicted, understood or controlled, why the massive efforts to search out the origins of life?

It appears that the word "chance" is a "Cover" word to replace YHWH whose thoughts are not our thoughts. Chance explains nothing, being by definition the "unexplainable." Chance is the true ghost in the machine of evolutionary thought—a most insubstantial form. The real scenario is a take-over of the attributes of God by Mankind, especially *Homo Scientiae*. When he can produce life, then the term "chance" will be discarded.

The use of "chance" and "luck" in our culture seems to also indicate a projecting backward into origins of the actual progressive breakdown of systems and organisms with time. As this breakdown is usually not calculated or "supposed-to" happen according to human thought and occurs unexpectedly this "chance" happening is retroflected into the time of origins.

Reference

¹Hedtke, Randall, 1981. The episteme is the theory. *Creation Research Society Quarterly* 18(1):8-13 & 26.

Lawrence McGhee, M.A.
14019 S.E. Market
Portland, Oregon
Received 5 January, 1982

Mortality Among Deer in Winter

Having read Mr. Guenter's recent article with much interest, I find that there is one point on which my observations have differed from his. I refer to his statement "In several years of hunting in Saskatchewan and Nigeria, both of which are fine deer zones, I have never seen a dead deer (let alone an edible one) that had not been shot or struck by highway traffic."¹

Along the northern tier of states just south of the Canadian border, from Maine through Minnesota, white-tailed deer concentrate in "yarding" areas during the winter months. These are normally located in coniferous growth. No winter passes in which there is not some mortality in these areas, the extent of it being directly correlated with the length of time each winter that snows remain 18 inches or more in depth.

The New Hampshire Game Division established a series of permanent parallel census lines through such yarding areas. Each year, in early May, Fish and Game Dept. personnel walk out these lines and count the deer carcasses. One dead deer per fifty acres, for instance, indicates above-average winter mortality. This is then taken into consideration for harvest recommendations the following fall.

Due to its long-standing buck law, the neighboring state of Vermont has one of the largest deer populations per unit area, in the United States. Wildlife biologists in that State have estimated a mortality of over 20,000 deer in one winter, after particularly deep snows and low temperatures. Here it is easy to find many carcasses during late winter and early spring.

May I add that these remarks in no way detract from the Creationist argument that, since no fossils are being formed today, the ones which do exist must have been formed in a catastrophe? Even though many deer may die in the winter, the carcasses are soon all destroyed by scavengers, usually by late spring.

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¹Guenter, Ken, 1981. Implications of Palaeolithic stratigraphy for Creationist models of prehistory. *Creation Research Society Quarterly* 18(3):168-170.

Hilbert R. Siegler
Box 241, Bangor, Wisconsin
54614.
Received 9 March, 1982.

Not all Footprints Should be Dismissed Lightly

Recently it has come to my attention through correspondence with a retired evolutionary zoologist that various geologists have questioned the authenticity of the Meister "shod print" found in a trilobite bed at Antelope Springs, Utah.¹ In a letter one such worker stated, "The most unfortunate aspect of this particular story is that it is not a hoax, but a case of blatant, unreasoned ignorance"; and continued, "To my knowledge, there is no published scientific reference to the fossil, only the pitiful creationist trash that surfaces from time to time." Concerning studies in the area where the supposed sandal-print was found, one university professor wrote, "... none of my students, nor Mr. _____'s diggers, nor I have ever seen any fossil footprints of man (of any other vertebrate for that matter) in these rocks. I am aware of the reported 'tracks' to which you refer and am convinced that they represent an oddity of weathering which uninformed people mistakenly interpret for fossil forms."

Another geologist wrote, "I have indeed been involved with this matter and am glad to know the details. Although I could possibly discuss the thing scientifically I doubt it is worth it . . . Like so much creationism it is a mixture of fact and a large dose of bias."

C.R.S.Q. reader will be interested to note an article in the journal, *Dialogue*.² In this article Stokes related how he had spoken with Meister, telling him that he could not accept this footprint as such because it failed to show squeezing or displacement aside of the soft material where the supposed track would have been made. Also Stokes felt it significant that no matching prints had been reported from nearby rocks. He asserted that this track is not a footprint but a result instead of "spalling"—a process in which rock patches of various shapes and sizes may form as a result of erosion, heating, cooling, and such. A "spall" may "... literally pop out of the confining rocks . . ." according to Stokes. He dealt with the presence of a trilobite as follows: "If anything interrupts the uniformity of the rock so as to create a spot or plane of weakness within it, the break will tend to pass into or through these areas. This explains why a trilobite fossil should be seen in the Meister specimen. I have observed this type of breakage numerous times in the process of collecting fossils." Concerning C.R.S. Stokes said, "I hope any apprehensions are without foundation but I fear that readers of the newspapers and the *Creation Research Society Quarterly* will get the impression that we geologists deny the genuineness of such specimens because to accept them would be to admit that the basis of geology is a delusion and a fraud."

Evidently Dr. Stokes did not himself read the original C.R.S.Q. report very closely since he did not point out in his critique that on p. 102 of the Meister article an alternative view of the supposed foottrack was clearly promulgated. An entire newspaper account was reprinted in which Dr. Jesse Jennings of University of Utah had theorized that this "print" was merely the result of some other natural occurrence rather than an actual human impression. Jennings' criticisms were printed without rebuttal.

Again, Stokes seems not to have read the original account very closely or he would not have written that "It is most significant that no other matching prints were obtained." Stokes failed to state in his critical paper that in the original report Meister mentioned other prints—"On this visit Dr. Burdick found a footprint of a barefoot child in the same location as my discovery. He showed this footprint August 18. The day before, my family and I had met Dr. Burdick at Antelope Springs. While there we found another sandal print. Dr. Burdick continued, and on Monday, August 19, he informed me by letter that he had found a second child's footprint." p. 100.

The earlier comment by one of the letter writers ("To my knowledge, there is no published scientific reference to the fossil . . .") is false; but if it were not for the Creation Research Society and other creationist organizations, this important discovery probably would have been denied space in the supposedly objective pages of "respectable" geological journals. Reluctance to give this sort of disturbing evidence a fair hearing is quite obvious in Dr. Stokes' paper and in the letters I previously quoted. One can only try to guess just how many other items that posed a threat to the cherished uniformitarian geologic column were either ignored or rejected by workers who would rather not discuss data of this type. One correspondent already admitted that he did not think it was worth his time to deal with matters like this!

Aside from their unwarranted anti-creationist rhetoric, however, these megaevolutionists have raised a valid point. If creationists wish to list and discuss this phenomenon from Antelope Springs, Utah, they should indicate the distinct possibility that it might have been a spall, as Stokes asserted. Such caution and fullness of reporting is essential if we wish to criticize megaevolutionists who fail to acknowledge alternative explanations for phenomena which they preempt as evidence favoring evolution and evolution only.

It would be likewise well if this letter would stir some renewed interest in resolving the true nature of the Meister discovery. Perhaps an update can be prepared to include more detail concerning the other "prints" found nearby and cross-sectional analyses indicating whether or not compression is found near the edges. If the original investigators are unable or not inclined to undertake such an update, perhaps the print itself can be made available to geologists (both creation and megaevolution geologists) for analysis. Until such a report appears, it is wise for both sides to admit that two plausible explanations exist.

Even if this particular Meister "print" is ultimately explained as a spall, what will orthodox geologists say about human-like impressions found in large number, in stride, within Cretaceous beds along the Paluxy River, Glen Rose, Texas? When faced with this question, my retired zoologist correspondent wrote to an evolutionary paleontologist who manifested the following adamant refusal to examine the evidence: "I know of no competent scientist who takes these reports seriously. Some of the alleged man tracks are fakes, some are unusual dinosaur tracks, and some are evidently product of limestone erosion." In a different letter, a pro-

fessor of evolutionary biology wrote, "I have not seen the tracks, but two paleontologists from the University of Texas have examined them and found them to be those of three-toed dinosaurs, not human as claimed by the creationists." Such bluffing apparently stems from malice or ignorance and will do nothing but hurt the megaevolutionary argument. Obviously none of these writers has evaluated the printed³ and cinematographic⁴ evidence regarding the juxtaposition of dinosaur and human-like impressions in Cretaceous beds.

Where are letters to our editor from "competent geologists" concerning human fossils in Dakota sandstone⁵ or regarding fossils of fish and various land plants such as ferns in the Cambrian? Soon the day will come when critics of C.R.S. will have to stop bluffing and will be forced to deal with the arguments raised in these pages. When they sit still long enough to do such reading, they will discover that there is an alternative explanation (usually a better explanation) for every data-item claimed as a support for megaevolution.

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Sincerely,
George F. Howe
Professor and Chairman,
Division of Natural Sciences
and Mathematics, Los Angeles
Baptist College, P.O. Box
878, Newhall, California 91322.
Received 16 March, 1982

Microevolution no Threat

The increasing realization among Darwinians that the lack of transitional forms in the fossil record cannot be ignored has resulted in proposals of rapid or "saltatory" evolution. Stephen Jay Gould, who is the foremost advocate of neo-saltationism, considers alterations in embryonic growth rates to be the major cause of large-scale evolution.¹ How rapidly can such a mechanism of biological change produce truly unique organisms? Did certain forms of fish transform themselves into amphibians in one generation? Gould answers these crucial questions:

I do not refer to the saltational origin of entire new designs, complete in all their complex and in-

tegrated features—a fantasy that would be truly anti-Darwinian in denying any creativity to selection . . . I envisage a potential saltational origin for the essential features of key adaptations.²

Numerous salamanders provide an apparent demonstration of the importance of developmental variation. Certain salamanders retain particular larval features, including gills, in the adult stage.³ If these "neotenic" salamanders were developed through ontogenetic deviations, then this falls short of valid macroevolution. In addition, embryological experiments indicate the retinoic acid causes the formation of feathers on the foot scales of chick embryos.⁴ This is clearly a case of microevolution since there are birds which normally possess feathered feet.⁵

Special creationists should not fear the reality of significant organic modification within limits. As Frank L. Marsh contends, "In the realm of semantics, all you need to do to become a microevolutionist is to recognize that variation has been and is going on within basic types . . ." ⁶ Thus, we can refer to ourselves as "microevolutionary special creationists" without qualms!

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In Christ's love,
Jay Hall
Box 19434, Oklahoma City,
Oklahoma 73144.
Received 16 March, 1982.

Comments on Neanderthals and Chronology

I read with great interest the model of prehistory as proposed by Guenter¹ from his studies in Palaeolithic Stratigraphy. It may be of interest to critics that Neanderthal was indeed post-Noah; for recent research on a La Chapelle aux Saints adult by Dr. John W. Cuozzo.² D.D.S., indicates that Neanderthal lived to around 200 years of age, verifying the decreasing, yet increased longevity after the cataclysm.

It seems that careful scrutiny of the scientific and Biblical data is leading Creationists to a somewhat different, and hopefully more accurate, understanding of the time that has passed since the Creation and Flood. Guenter's 5000BC estimate of the Flood seems to find verification from other sources such as the dating of cataclysm-produced oil;³ glacial wood;⁴ and the increasing postflood levels of radiocarbon.⁵ I wonder if Guenter has any knowledge of the dates the Biblical calendar of history⁶ gives for the Flood (4990BC) and Babel (3153BC-2914BC); for they are exactly the same!

Camping has also pointed out the similarities between the archaeological birth-date of the first great cities in Mesopotamia (3700BC) and the calendar's date for its builder, Nimrod (4050BC-3617BC).

In light of the above, perhaps Creationists should consider the calendar's chronology of time more seriously and also the use of at least 10,000 in T_0 calculations rather than 6,000.

The proposed time scale with consideration of initial conditions is described here for further studies as follows:

Creation	c. 11,000BC
Sun's diameter	929,870 mi.
Sun's temperature	7979 °K
Earth's magnetic moment	380 G
Jubal; Tubal-cain	c. 8,000BC
Flood	c. 5,000BC
Palaeolithic	
Neolithic	
Babel	c. 3,000BC
Abraham	c. 2,100BC

It is admitted that a field strength of 380 gauss is quite high, although not impossible. If the Earth did indeed expand in 5000BC due to a change in the electric force⁷, that a corresponding change in the magnetic field's decay rate may have also occurred (aside from the earth's rotation rate). This however, is independent of the above.

In summary, similarities between scientific and calendar derived dates have been noted, suggesting that further study may be beneficial.

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- ⁷Morton, Glenn Robert, 1981. Reply to Fox. *Creation Research Society Quarterly* 18(2):131. It is intended to present Morton's ideas at greater length later.

Sincerely,
Wayne A. Mitchell
8 Shady Lane, Bound Brook,
New Jersey 08805.
Received 22 April, 1982.

The Present Position on Pre-Cambrian Pollen

When I received the current copy of the *Origins* the other day, I read with great interest and little enthusiasm the article by Dr. Chadwick on the matter of the pre-Cambrian pollen grains and Mr. Burdick (Vol. 8, #1, pp. 7-12). I say with little enthusiasm, because of the facts which led to the *Origins* article.

I became a bit involved in this matter of pollen grains being present in too early a strata some years ago. At the time, a Mr. Waisgerber (Feb. 1973 *Geotimes*) had challenged geologists to check out the material in a CRSQ article in 1966 3(1) entitled *Microflora in the Grand Canyon*. Drs. Allen Solomon and Ralph Morgan took up the challenge and reported their findings in the June 1973 *Geotimes*. The pertinent quotes from the report were as follows:

Burdick asked one of us to accompany him to the canyon, collect at Burdick's direction, and to extract those collections, in order to prove or disprove his thesis. The trip could not be made at that time, so Burdick found someone else to do the collecting and upon his return asked to have the samples extracted for pollen with safeguards against contamination. The extractions were done as requested. The results were total palynological sterility; i.e., no pollen grains or land plant spores of any kind were seen.

The implication was that the spurious results were due to contamination, and the reported pollen grains were current ones. I felt that this matter called for an answer of at least of some sort. Hence I addressed the following letter to the *Geotimes* editors:

Having taken due note of the letter entitled "Challenge Taken Up" in *Geotimes* of June 1973, pp 9-10, I find it necessary to draw some items to your attention. The matter under discussion was the thesis that some plant forms are far too modern for the strata in which they are found. It follows that this can be interpreted as evidence favoring a creation origin over against an evolutionary origin of life. This was the thrust of Burdick's article, the evidence of which was questioned.

However, Burdick's information is not needed for support of the thesis since Axelrod (*Evolution*, 13:264-275) and Leclercq (*Evolution*, 10:109-113) over 15 years ago had already reported the finding in Cambrian of the microspores of vascular plants as well as tracheids possessing bordered pits. Neither are these isolated instances, since several workers in India, Australia, and the U.S.S.R. have reported these findings. At this point I would ask, "How is it that after more than 15 years this information is still buried?"

Was it this information along with others that caused E. J. Corner to state in his essay entitled "Evolution" (which appeared as chapter 3 in MacLeod and Cobley, *Contemporary Botanical Thought*;) "Much evidence can be adduced in favor of evolution . . . from biology, biogeography, and paleontology, but I still think that to the unprejudiced, the fossil record of the plants is in favor of special creation."

For discussion and references see Rusch, W. H., *The Revelation of Palynology*, CRSQ 5(3) pp. 103-105.

I addressed carbon copies of my *Geotimes* letter to the two gentlemen. Solomon and Morgan, who had questioned Burdick's evidence. Interestingly enough, neither ever replied in any way. At that time, I wondered why *Geotimes* editors saw fit to eliminate the last two

paragraphs of my letter when they printed it in *Geotimes* September, 1973! At that same time, I also sent copies to Mr. Burdick of all of the material, both the original letters as well as all the responses, without ever receiving any response as I recall.

I suspect that since this Burdick pollen grain material has been used in 'creation vs. evolution' lectures and articles in recent times, the Chadwick article became really a necessity. It is unfortunate if poor technique invalidated Burdick's findings. But certainly the findings of Axelrod and Leclercq leave the major thesis intact. Of recent times, the use of this material as it appeared in my article, has caused evolutionists to raise the question of contamination in the findings of both Axelrod and Leclercq in an attempt to minimize the effect. It would seem a reasonable question, particularly on the basis of the Burdick experience, if it were just a matter of pollen grains. But it certainly would seem to be the height of naivete for any reputable scientist to seriously question the evidence of the tracheids on the basis that they are contaminants. Do those individuals seriously wish to postulate that tracheids with bordered pits are flying around loose in the atmosphere as possible contaminants? Oh come now.

W. H. Rusch, Sr.
Professor Emeritus of
Biology and Geology
2717 Cranbrook Road
Ann Arbor, Michigan 48104.
Received 14 June 1982

Reply to Rusch

I was rather surprised to see the matter of pollen in the Grand Canyon taken up in the journal *Origins*, although about ten years have elapsed and no new work was presented. I was more surprised to learn that a letter was to be published in the *Quarterly*, in effect conceding the implication in *Origins* that my work was faulty. It is surely not enough to say that one piece of work is faulty just because it disagrees with another; some fault should be pointed out. Of course, the evolutionary establishment would automatically say that any work which found pollen in the Cambrian or Precambrian was faulty; but no progress can be made by taking such an attitude.

My work, which is described in the *Quarterly*,^{1,2} was done in the University of Arizona laboratories, which are designed to avoid all contamination. It was under the direct supervision of one of the world's most famous palynologists, Dr. Gerhard Kremp, from Germany. If the results were unreliable, so, I believe, will all others be. One difference in my results, I believe, was that Dr. Kremp was using a new and superior technique. Incidentally, Dr. Kremp chose me to do this work because he considered that the work which I had done in the Petrified Forest was good. I worked with samples which Dr. Kremp himself had cut in the Grand Canyon, from fresh surfaces. He then put the samples into sterile plastic bags, and took them himself to the sealed laboratories.

Chadwick, I understand, collected his samples him-

self. About six months later, he asked me to help him and others to set up a laboratory at Loma Linda. I spent a week there.

I saw slides of the work, which seemed to me to parallel the ones which I had obtained in Tucson. Later Chadwick seems to have changed his mind, and doubted that any ancient spores had actually been found; although I do not believe that all workers at Loma Linda share that view.

As for the failure of Morgan, and perhaps Solomon, to duplicate my work, their slides, which I saw, were clouded, apparently with undissolved silica. So if there were spores present, I doubt that they could have been seen.

May I reiterate that the University of Arizona has a complete library of current spores of Arizona plants and trees. The spores which I observed do not match any current plants. Also, I am not persuaded that the red coloring of the spores does not mean that they were embedded in the red rock for a considerable time, even geologically speaking.

While Chadwick does mention the findings in India, which lead to similar conclusions to mine, I wonder that he did not also mention those (even more significant, in my opinion) from Venezuela,³ and others, too,⁴ which have been reported.

References

- ¹Burdick, Clifford, 1966. Microflora of the Grand Canyon. *Creation Research Society 1966 Annual* 3(1):38-50. Incidentally, see my remark on p. 47 that not every attempt yields spores, so some negative results may prove nothing.
- ²Burdick, Clifford L., 1972. Progress report on Grand Canyon palynology. *Creation Research Society Quarterly* 9(1):25-30.
- ³Burdick, C.L., 1974. More Precambrian pollen. (In *Panorama of Science*) *Creation Research Society Quarterly* 11(2):122 & 123.
- ⁴Burdick, Clifford L., 1975. Cambrian and other early pollen in the literature. (In *Panorama of Science*.) *Creation Research Society Quarterly* 12(3):175 & 176.

Sincerely,
C.L. Burdick D.Sc.
219½ E. 2nd St., Tucson,
Arizona 85705
Received 22 July, 1982

QUOTABLE QUOTE

Lyell is most firmly convinced that he has shaken the faith in the Deluge far more efficiently by never having said a word against the Bible, than if he had acted otherwise . . .

I have lately read Morley's *Life of Voltaire* and he insists strongly that direct attacks on Christianity (even when written with the wonderful force and vigor of Voltaire) produce little permanent effect: real good seems only to follow the slow and silent side attacks.

—Charles Darwin, Oct. 22, 24, 1873

Quoted in Gertrude Himmelfarb, *Darwin and the Darwinian Revolution* (New York: W. W. Norton & Co., 1962), p. 387.

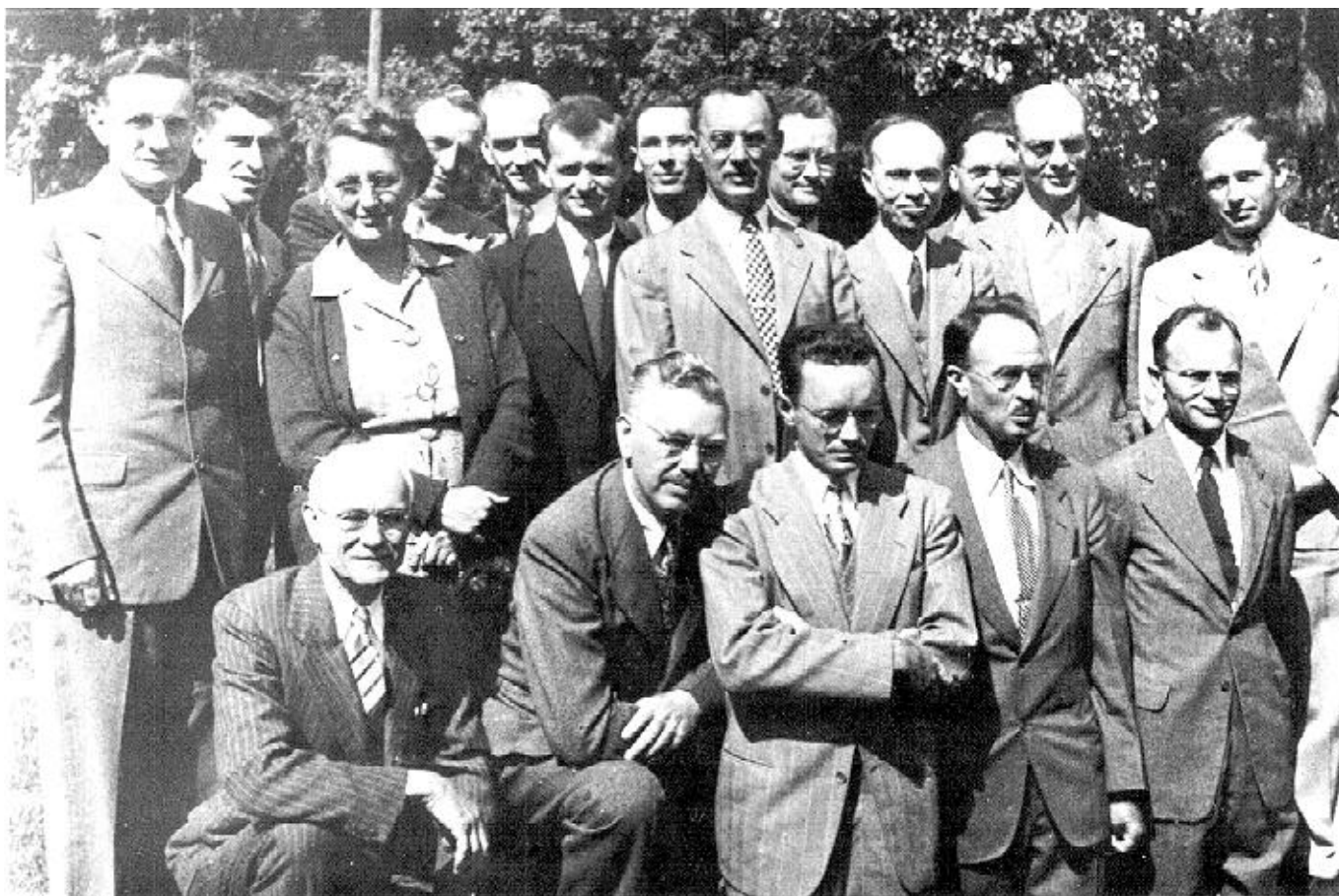
—Suggested by Mr. Robert Harris

IN MEMORY OF WILLIAM JOHN TINKLE

William John Tinkle, or "Will" as we called him during our board meetings, was one of the original "Team of Ten" who organized the Creation Research Society. In fact, as I recall it, he initiated the correspondence by writing to me about his increasing dissatisfaction with the American Scientific Affiliation of which we were both members. This was in the latter part of 1962. As may be seen by the picture of the people attending the first convention of the A.S.A. in August of 1946, he was a member already then. Actually this society was formed at a meeting held September 2-5, 1941. When I was asked to join by Alton F. Everest in 1944 he assured me that the stance of the society would be anti-evolutionary. This position is clearly shown in the first book published by the A.S.A. in 1948 entitled *"Modern Science and Christian Faith"*. The chapter on "Biology and Christian Faith," written by Tinkle and me, presented many genetic reasons for not accepting any sort of "evolutionary" explanation of the origin of species.

By 1951 the A.S.A. had over 220 members; but the form of the statement of belief allowed many who inclined to theistic evolution to join. The thinking and especially the editorial policy of the organization began to reflect this. Yet many dedicated creationists still were members in 1962. These included Arthur Custance, R. Laird Harris, John R. Howitt, John W. Klotz, Frank L. Marsh, Henry M. Morris, William J. Tinkle, Wilbert H. Rusch, Sr. and myself. The "Team of Ten" included all the above men except Custance and Howitt. In their place were John J. Grebe, Duane Gish, and Edwin Monsma. Grebe, then with the Dow Chemical Company, and Gish of Upjohn Chemical Company were particularly helpful and encouraging. These men were the ones with whom I corresponded in 1963 with the idea of forming a new society dedicated to creation concepts.

At a meeting of the A.S.A. with the Evangelical Theological Society held at Asbury College in Wilmore, Kentucky June 19-21, 1963 several of the "Team of



This picture was taken at the first convention of the A.S.A., August, 1946. Those shown are the following: kneeling: Taylor, Monsma, Barnes, MacRae, Mixer. Standing: Tinkle, Horner (v), Mrs. Monsma (v), Karsten (v), B.P. Sutherland, Hartzler, Harris, Nystrom, Parker, Cooke (v), DeKoning, Voskuyl (v), Cowperthwaite.

Here (v) indicates visitors. Horner and Voskuyl have become members.

Others attending but not shown here include: C. C. Brooks (v), Gathercoal, Miss Soldner (v), Bender, Bechtel (v), Bauman, Wilson, Oorthuys (v), Mack (v), Mrs. Karsten (v).

Ten" presented papers. I decided to go to this meeting also. At that meeting the first draft of the present Creation Research Society (C.R.S.) statement of belief was made. As I recall it, William Tinkle, Henry Morris, Wilbert H. Rusch, Sr., Frank Marsh, R. Laird Harris, and John Grebe were at this meeting. Only Tinkle, Rusch, and I were able to drive with John Grebe to his home in Midland, Michigan, where we were joined by Duane Gish, David Warriner, John Moore, Frank Marsh, Karl Linsenman, and John Klotz. The first draft of the statement of belief was then "tightened up" to the present form. Tinkle was our first secretary and continued in this position until 1974.

The June 1967 Annual was dedicated to Will Tinkle, and in the article of dedication I find that he was born in a log cabin in Indiana in 1892.

He lost his father at a very early age and was reared by his mother and maternal grandparents, who took him to Sunday School and church regularly. He showed an early interest in gardening and learned all the names of the species of trees in the neighborhood. He was awarded the degree of bachelor of arts by Manchester College in 1916, having majored in biology. He wrote a thesis on "The Darwinian Theory in the Light of Later Research." He taught school for several years in a district school having all the grades. As was the custom in the Church of the Brethren he was elected to the ministry by a vote of the congregation. He then spent a year in the Bethany Biblical Seminary in Chicago. The Ohio State University conferred the degrees of Master of Arts and Doctor of Philosophy, his field of specialization being zoology. His M.A. thesis was on "The Inheritance of Habitual Wandering"; and to his surprise it was condensed and published in the Literary Digest. His Ph.D. thesis was on "Deafness as a Eugenic Problem." Tinkle is listed in *American Men of Science and Leaders in American Education*.

Dr. Tinkle married Lula Rensch who passed away in 1966, leaving a daughter, a son, and three grandsons. While a member of the American Scientific Affiliation he wrote a series of articles, some of which are listed later. His most interesting one to me is the "Role of Segregation in the Theory of Creation." A modification of this concept might well help to explain the very great diversity of species which arose from the relatively few which survived the great world wide flood. As far as I can determine he wrote 8 articles in the various A.S.A. journals.

His many articles in the Creation Research Society Quarterly are listed later.

His study of the extra- or three-cotyledon tomato plant is most interesting. As he points out, one would suppose that an extra cotyledon would give a seedling considerable advantage due to the extra surface for photosynthetic activity. Instead he found that this plant grew more slowly, was smaller as a mature plant, and produced fewer fruit. The pattern of inheritance was not clear-cut. Several years after finding this tri-cotyledonous plant, Tinkle sent me seeds of it, and I also found the same reduction in vigor which he reported. Controlled cross pollination with an unrelated normal strain gave some 3-cotyledon plants but also single-leaved plants such as he illustrated in Figures 1-3 of his

original article. These plants no longer gave any 3-cotyledon types when selfed, so evidently the gene or chromosomal variation which caused the original 3-cotyledon condition can be broken down into other variant types. I was not able to establish any clear-cut pattern of inheritance for either the single leaflet or 3-cotyledon type. Tinkle also found a 3-cotyledon plant in a group of campion, or *Lychnis alba* plants. It, too, showed a marked lack of vigor.

As Tinkle points out, many mutations have occurred, but few have been studied carefully enough to show the extent of the loss of vigor. It is especially important that creationists carefully study those few mutants which have been reported to have advantages. As he suggests, it may well be that even these have a loss of vigor or ability to reproduce in numbers comparable to the normal type.

The articles which Will Tinkle wrote were never long ones—at most they were three pages in length. But he had a faculty for writing in terms that could be easily understood even by those not trained in any field of scientific study. Accordingly his articles were much appreciated by our sustaining members. We need to insure that our quarterlies continue to have some articles such as Tinkle's "Hybrid Corn-Man's Glory and Limitation" in each issue.

Several times in his letters to me he expressed great satisfaction that a younger generation of dedicated creation-oriented-men were carrying on in the place of those who founded our society. Accordingly he was confident that no usurping of our society by a position such as theistic evolution would ever occur.

Tinkle lived at Timbercrest Home, North Manchester, Indiana since about 1975. He died in August 1981 at the age of 89. We will greatly miss his pertinent and interesting little articles. And I will not be getting those letters from Timbercrest any longer.

Publications by William J. Tinkle

In the Journal of the A.S.A.

Why God called His creation good. 2(4):20-22.
Struggle and progress. 3(3): 39-41.
Role of segregation in theory of creation. 4(1):15-16.
The principle of growth as an obsession. 6(4):8-9.
Entropy in relation to genetics. 7(4):17-21.
Crossing in relation to origin of new groups. 9(4):5-6.
The principle of uniformity. 12(4):106-107.
East wind of authority. 15(4):52.

In the Creation Research Society Quarterly

Paradox of a century. 1(2):8-9.
Wild flowers: a problem for evolution. 4(4):125-126.
Ancestry of man. 5(1):42-45.
Immortality in natural selection. 4(4):125-126.
Ancestry of man. 5(1):42-45.
Immortality in natural selection. 5(4):148-150.
Jack in the Pulpit teaches a lesson. 6(1):65-66.
Our position—we are just ourselves. 6(2):9.
Natural selection inadequate. 6(4):102 (With C.H. Mosher.)
Creation outreach. 7(3):159.
Fitness of Earth for life. 8(1):16-18.
Pleiotropy: extra cotyledons in the tomato. 8(3):183-185.
Is nature cruel? 9(1):44-46.
Creationism in the twentieth century. 10(1):44-46.
Hybrid corn: man's glory and limitation. 11(1):37-39.
God's personality revealed by nature. 11(3):139-141.
Further research on reduced vitality of mutant plants. 12(1):52.

The reign of law. 13(1):44-46.
 Selection: artificial and natural. 13(3):131-133.
 Did sex evolve? 14(1):53.
 The difference between acquired characteristics and mutations. 14(2):113.
 Genetics favors creation. 14(3):155-156.
 Assumptions and human nature. 15(1):53-54.
 True creationists. 15(3):138-140.
 Our friends hold back. 16(1):63-65.
 What can mutation and selection accomplish? 16(2):100-101.
 Does an embryo climb its tree? 16(3):151-153.
 Belief—and more. 17(1):55-56 & 41.
 Let us reason together. 18(1):25-26.
 Intelligence rather than struggle. 18(3):163 & 167.

Books

Heredity: a study in science and the Bible. St. Thomas' Press, 1967.
 Fundamentals of zoology.

—Prepared by Walter E. Lammerts

EXCERPTS FROM THE BYLAWS

Article III—Election of Directors

Section 1. The date for the annual election of directors shall be set by the secretary, but in no case shall it be later than March 1.

Section 2. The Board of Directors shall annually nominate at least one candidate for each vacancy on the Board of Directors, said candidate to have agreed to serve on the Board of Directors. The secretary shall report the names of those nominated by the Board of Directors together with the date of the election to all voting members not less than 120 days prior to the election.

Section 3. Any voting member may nominate one candidate for election to the Board of Directors by presenting a petition signed by not less than 25 voting members of the Society, said petition to list the name and address of the candidate, indicate the qualifications of the candidate in not more than 50 words, list the

SPECIAL NOTICE ABOUT ELECTION, 1983

The following candidates have been nominated to the Board of Directors to serve beginning in 1983. The six having the most votes will have three-year terms, and the seventh two years (to fill a place left vacant by a resignation.)

Akridge, Garth R.
 Armstrong, Harold
 Barnes, Thomas G.
 Boylan, David R.
 Gish, Duane T.
 von Fange, Erich A.
 Williams, Emmett, Jr.
 Wolfrom, Glen W.
 Zimmerman, Paul A.

It should be remembered that the elections are staggered, one third of the members of the Board being elected annually. Thus, if a certain member of the Board is not listed here, that does not necessarily mean that he is leaving the Board.

The date of the Annual election is 1 March, 1983. Biographical information on each Nominee will be distributed with the ballots.

name of the individual nominating him, bear the certification of the nominator as to the authenticity of the signatures on the petition, and contain a statement by the nominator that the individual nominated is willing to serve on the Board of Directors. This petition must be mailed to the secretary and must be postmarked not less than 60 days prior to the election. On receipt of the petition, the secretary shall ascertain that at least 25 of the signers of the petition are voting members in good standing.

REPORT OF THE 1982 BOARD OF DIRECTORS MEETING

The annual meeting of the Board of Directors of the Creation Research Society for 1982 was held 23 and 24 April, at Concordia College, Ann Arbor, Michigan. The first session was called to order at 1535 hours, Friday, 23 April, by President Howe, beginning with silent prayer. Present: H. Armstrong, T. Barnes, D. Boylan, C. Burdick, W. Frair, D. Gish, G. Howe, J. Klotz, R. Korthals, J. Meyer, J. Moore, G. Mulfinger, W. Rusch, N. Smith, E. Williams, and P. Zimmerman. Absent: H. Morris and H. Slusher. Several guests were also present, including David Golisch, President of the Creation Science Association of the Greater Detroit Area.

The minutes of the 1981 meeting were read and approved. The secretary reported that in the election of

members, held earlier, 140 votes were cast, and the following persons elected to the C.R.S. Board for a term of three years: John W. Klotz, Richard G. Korthals, Henry M. Morris, Wilbert H. Rusch, Sr., Harold S. Slusher, and E. Norbert Smith.

Treasurer Korthals reported on financial matters. In 1981-82 total expenditures were \$51,217.51, total income \$75,328.84. The total cash assets were \$84,055.97. Persons remitting from abroad are again reminded to send a cheque on a bank in the U.S., or an international money order.

Membership Secretary Rusch reported that for the first time in C.R.S. history the voting membership was over 700. About 100 of these are foreign members.

Total figures were: 701 voting members, 1154 sustaining, 319 student, 118 subscriptions, also 225 library, 26 school, and 8 church subscriptions, for a total of 2551.

Rusch introduced Robert F. Burkette, Editor, Educational Publications, Mott Media, who is supervising the production of the biology textbook. While the directions taken may depend to some extent on forthcoming events, there is good hope of having the book ready for sale by late 1982. More good illustrations can still be used.

Editor Armstrong reported that the *Quarterly* is continuing with about the same policies, and at about the same size, as in recent years. He expressed his satisfaction with the work done by the printer: Stone Printing Co. of Lansing, Michigan.

Barnes reported on the Committee for Openness as a Principle in Science. This group is entirely independent of the C.R.S., having now been incorporated with the following officers: Barnes, President; Klotz, Vice-President; Slusher, Secretary. (While this is not business of the C.R.S., it was reported for information.) Barnes also reported considerable activity on the part of the C.R.S. Student Chapter of the University of Texas.

Mulfinger reported on the C.R.S. Monographs. The one on Astronomy is farthest along; others being worked on or envisaged include: Dating Methods, Vestigial Organs, Mimicry, Symbiosis, Biological Regulatory Systems, Anthropology, Genetics, Homology, Biochemistry, Anatomy, Comparative Enzymology, Botany, Overthrusts, and Paleontology.

Williams reported on sales of C.R.S. books, and pointed out that Variation and Fixity in Nature may be obtained at a reduced price by ordering five copies at once.

As Chairman of the Research Committee, Williams reported that \$29,207 was on hand toward the construction of the projected C.R.S. laboratory. Total receipts and pledges for that purpose amount to \$92,400.

Klotz invited those seeking employment, or knowing of positions available, to contact him at 5 Seminary Terrace North, St. Louis, Missouri 63105. See also the items headed "PLACEMENT SERVICE" in various issues of the *Quarterly*.

At 1900 hours there were two concurrent sessions of 20-minute reports. At the one, chaired by Williams, the following research reports were presented:

Barnes—An Electric Theory of Gravitation

Howe—Postfire Strategies of Two Chaparral Shrubs
Frair—Serological Studies of Turtles

Meyer—Tassel-Eared Squirrels at the Grand Canyon
Ancil—Effective Use of Godel's Theorem

The other session, chaired by Rusch, included the following reports of general interest:

Burdick—History of Recent Creationist Movement

More—Use of Words for Clear Communication in Science

Gish—Creation vs. Evolution in Arkansas

Smith—Principles of Biological Creationism

At the break time during the evening, ladies of the Creation Science Association of the Greater Detroit Area served delicious refreshments. The Board takes this opportunity to thank them for this kindness.

During the business session, on Saturday, the projected C.R.S. laboratory was considered. (See the report by Meyer, pp. 181 & 182 of the *Quarterly* for December, 1981, about the role envisaged for this laboratory.) About financing, churches are encouraged to consider the laboratory as a missionary project; and it was reported that a certain donor will give \$15,000 if four other donors can be found to do likewise. It was decided that anyone donating \$150 or more in a lump sum would receive a free subscription for that year; anyone contributing \$750 or more in a lump would receive a 5-year subscription plus a copy of the most recent book or monograph by the C.R.S. The goal is to have the site established by June, 1983; the first scientist on the site by June, 1984. The region chosen is the Prescott-Flagstaff-Sedona area in northern Arizona.

Other action taken includes:

The C.R.S. reaffirms its position that as a society it does not take part in lobbying for legislative action.

The Board accepts with regret Henry M. Morris' resignation from the Board, due to the pressure of his other duties.

It was moved and passed:

That the candidates, listed elsewhere in this issue, be nominated to the Board of Directors;

That the present officers be reelected;

That the dues be increased by \$1.00 for each category;

That the 1983 meeting of the Board of Directors be held 15 and 16 April, 1983, the headquarters to be Howard Johnson's Motel, Ann Arbor, Michigan.

The meeting was adjourned at 1535 hours.

Wayne Frair, Secretary

A BRIEF STATEMENT OF THE HISTORY AND AIMS OF THE CRS

Wilbert H. Rusch*

(Editor's Note.) This item is published to put on record the answers to questions which are often asked about the Creation Research Society.

Prior to 1963, Dr. Walter E. Lammerts, celebrated rose geneticist of California, had been corresponding for a number of years with like-minded creationists, who became known as the "Team of Ten". These were Duane Gish, John J. Grebe, R. Laird Harris, John W. Klotz, Frank Marsh, Edwin Monsma, Henry M. Morris, Wilbert H. Rusch, Sr., and William J. Tinkle. This correspondence culminated in a meeting at Asbury College, Wilmore, Ky. in June, 1963. The meeting was then adjourned to the home of John Grebe, nuclear physicist in Midland, Mich. Those in attendance at this adjourned meeting were:

Duane Gish, Ph.D. . . . Upjohn Chemical, Kalamazoo
John Grebe, D.Sc. Dow Chemical, Midland
John Klotz, Ph.D. Concordia, Ft. Wayne
Walter Lammerts, Ph.D. Germain's, Livermore
Karl Linsenmann, M.D. Physician, Midland
Frank Marsh, Ph.D. . . . Andrews Univ., Berrien Springs
John N. Moore, M.S., Ed.D. Mich. State Un., E. Lans.
Wilbert Rusch, Sr., M.S. Concordia, Ann Arbor

At this meeting, after a good deal of discussion, the general guiding principles as well as the name of the Creation Research Society were decided. These principles later served as the basis for the constitution of the CRS. The above list of individuals plus Dr. William Tinkle, Ph.D., of Taylor University, made up the first temporary board of directors of the CRS, with Dr. Walter Lammerts as the first president.

From their correspondence with each other, reinforced by their discussion at this and the Wilmore meetings, it became apparent that the group had experienced one common problem. This was that not one of the individuals present seemed to be able to get any articles, that were at all favorable to creation, accepted for publication in a scientific journal. This was true even when the authors were members of the scientific society which published the journal. Therefore the group felt that the only solution to this problem was to publish their own journal. These individuals all believed that they had acquired scientific information that was worthy of publication. They also felt that there were probably others in a like situation. Hence this became the primary aim of the group as well as of the society which they founded. After considerable discussion, "a statement of belief" was adopted by those present. The working and content of the statement was influenced by the previous experience of some of the individuals present with theistic evolutionists in other supposed creation groups. At any rate, for better or for worse, this was how ten men began about twenty years ago what has become known as the *Creation Research Society*. Incorporated

as a non-profit corporation under the laws and in the state of Michigan followed. The granting of IRS recognition as a tax-exempt organization also followed shortly.

From the beginning, two principles were established. Firstly, the CRS would remain completely independent, unaffiliated with any other organization. Above all, there would be no affiliation with any religious group or church body. In any case, the widely diverse church affiliations of the members of the Society would make this impossible, even if some had desired it. Actually, the application blank has no provision for the listing of any denominational affiliation. Neither does the Society in the person of its membership secretary ask for it at any time. Obviously, individual members of the society remain free to become members of any other groups, as well as being free to carry out various activities, but all these on their own initiative. However, regardless of whatever actions members might take, it is understood that these are always taken on their own responsibility, and in no way would such actions commit the Society as a whole in any way.

Secondly, the essential and primary purpose of the CRS was and remains the publication of its journal as a quarterly. This would contain articles of a scientific nature impinging on an alternate view of origins, namely creation. It was later felt that producing several anthologies of its quarterly articles, as well as the production of textbooks in various sciences, would be compatible with the objectives of the Society. To date, the CRS has published three anthologies as well as a high school level biology text. The latter is now in the development stage of a third edition. It is for this reason that the CRS does not engage in any lobbying for any legislation. Nor does it distribute tracts, films, tapes, etc. Neither does it offer institutes or seminars. It is solely a publishing society for its quarterly and the other works previously mentioned.

Already in those early days there was ample evidence, that as far as some quarters were concerned, membership in the Society might be a hindrance to a young member in the pursuit of a career in science, for example, in admission to advanced degree programs in some area of science. There were also reports from members that a belief in creation had served as a possible cause for the denial of tenure or promotion. In some cases the fear of outright dismissal from an institution was expressed. Since there is no evidence of any change in this state of affairs today, the custom of not producing a membership list or directory is a CRS board of director's policy to this day. Certainly the history of the actions of some scientists towards those who held views, contrary to the party line has been amply documented. (see Rusch, Chapter 2 in *CREATION, EVOLUTION AND GOD'S WORD*, P. Zimmerman, editor—The actions of some at the time of the Velikovsky affair would support the wisdom of the board's decision.)

*Wilbert H. Rusch, Sr., is a Founding Member, Fellow, and Membership Secretary, of the Creation Research Society. His address is: 2717 Cranbrook Road, Ann Arbor, Michigan 48104.

At the first beginning meeting, it was decided that, being a scientific society, the government of the CRS should be in the hands of competent scientists. Hence the first category of membership decided upon was that of *voting member*. The primary qualification is the possession of an earned degree in some area of science, at at least the master's level.

Later it was felt that the CRS could be of greater service to the public at large if it also had a general category, that of *sustaining member*. Such members could be scientific laymen, persons with no more than a bachelor's degrees in science, or they might even be persons with advanced degrees in some discipline other than science.

At a later time, the category of *student member* was instituted, to serve secondary and undergraduate level students. This was simply a category at a reduced rate, thus recognizing the possibly less affluent circumstances of many students. It was later also recognized that there was need for still another category of membership, that of *subscriber*. For one thing, institutions can not sign statements of belief, so they would fall into this category. In addition, there were numerous individuals who liked to know what the CRS was doing, but because they did not agree with the objectives of the CRS, or its statement, could not in all conscience sign it. Therefore the membership category of subscriber was instituted to meet these several needs. Finally, last year, the board of directors also instituted the *senior member* category, which is set at the same rate as that of the student category.

The annual report of the membership secretary, showing a steady numerical increase in membership through the years, has provided evidence that the society seems to have met a need. Indeed already at an early date, the CRS enjoyed world-wide geographic coverage. Probably this is because it still would appear to be the only journal of its type in the field.

Through the years of the Society's existence, there have been numerous changes in the membership of the Board. However, the present board of directors is still committed to the continued existence of the Creation Research Society to meet the same needs that the

original "team of ten" saw. The roster of the present board of directors is as follows:

Duane T. Gish, Ph.D.	Biochemistry
Wayne Frair, Ph.D.	Biological Sciences
George F. Howe, Ph.D.	Botany
John R. Meyer, Ph.D.	Biology
Wilbert H. Rusch, Sr., M.S., Sp.S. .	Biology & Geology
E. Norbert Smith, Ph.D.	Zoology
Paul A. Zimmerman, Ph.D.	Chemistry
David R. Boyland, Ph.D.	Engineering
John W. Klotz, Ph.D.	Genetics
Clifford L. Burdick, M.S.	Geology
Harold Slusher, M.S.	Geophysics
Harold Armstrong, M.S.	Physical Science
Thomas G. Barnes, D.Sc.	Physics
Richard G. Korthals, M.S.	Astrophysics
George Mulfinger, M.S.	Physical Science
Emmett L. Williams, Ph.D.	Physical Science
John N. Moore, Ed.D.	Science Education

The present officers are as follows:

President	Dr. George Howe
Vice-president	Dr. Emmett Williams
Recording Secretary	Dr. Wayne Frair
Treasurer	Prof. Emeritus Richard Korthals
Membership Secretary ..	Prof. Emer. Wilbert H. Rusch
Editor	Prof. Harold Armstrong

One third of the board of directors is elected each year by the voting members. At the annual meeting, according to the constitution, the board nominates qualified candidates for the board (voting members in good standing, who have also contributed articles to the quarterly). Additional nominations may be made by any qualified voting member according to procedures in the constitution. The board may (and has) considered such nominations the following year in making its own nominations. Balloting is by mail for all voting members.

The officers are elected annually by the board from among its members. According to the constitution, no board member may be paid but must serve gratis, regardless of the time required in performing his duties. He may only be reimbursed for authorized expenses. Since officers are board members, this also applies to them.

CREATION RESEARCH SOCIETY

History The Creation Research Society was first organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a real need for an association devoted to research and publication in the field of scientific creationism, with a current membership of over 600 voting members (with graduate degrees in science) and over 1800 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as probably the outstanding publication in the field.

Activities The Society is solely a research and publication society. It does not hold meetings or engage in other promotional activities, and has no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund is maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible.

Membership Voting membership is limited to scientists having at least an earned graduate degree in a natural or applied science. Dues are \$13.00 (\$15.00 U.S. for overseas) per year and may be sent to Wilbert H. Rusch, Sr., Membership Secretary, 2717 Cranbrook Road, Ann Arbor, Michigan 48104. Sustaining membership for those who do not meet the criteria for voting membership, and yet who subscribe to the statement of belief, is available at \$13.00 (\$15.00 U.S. for overseas) per year and includes subscription to the Annual Issue and Quarterlies. All others interested in receiving copies of all these publications may do so at the rate of the subscription price for all issues for one year: \$16.00 (\$18.00 U.S. for overseas.)

Statement of Belief Members of the Creation Research Society, which include research scientists representing various fields of successful scientific accomplishment, are committed to full belief in the Biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution), both of the universe and the earth with its complexity of living forms.

We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. In 1970 the Society published a textbook, *Biology: A Search for Order in Complexity*, through Zondervan Publishing House, Grand Rapids, Michigan 49506. Subsequently a Revised Edition (1974), a Teachers' Guide and both Teachers' and Students' Laboratory Manuals have been published by Zondervan Publishing House. All members of the Society subscribe to the following statement of belief:

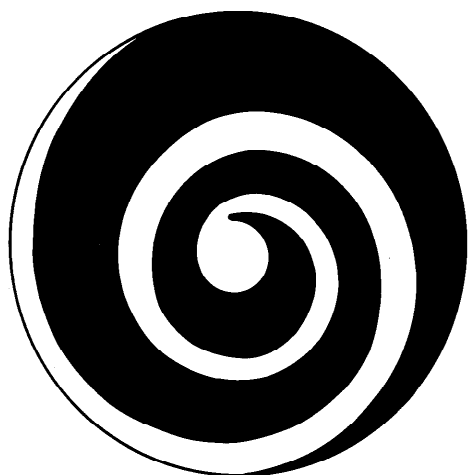
1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.

2. All basic types of living things, including man, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.

3. The great Flood described in Genesis, commonly referred to as the Noachian Flood, was an historic event worldwide in its extent and effect.

4. We are an organization of Christian men of science who accept Jesus Christ as our Lord and Saviour. The account of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Saviour for all mankind. Therefore, salvation can come only through accepting Jesus Christ as our Saviour.

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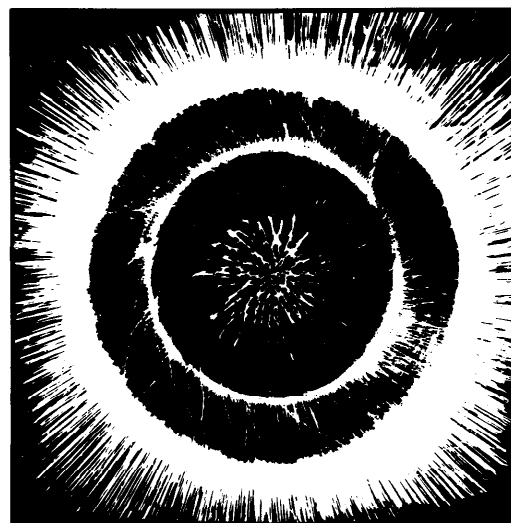


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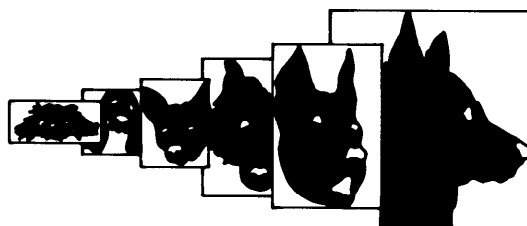
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