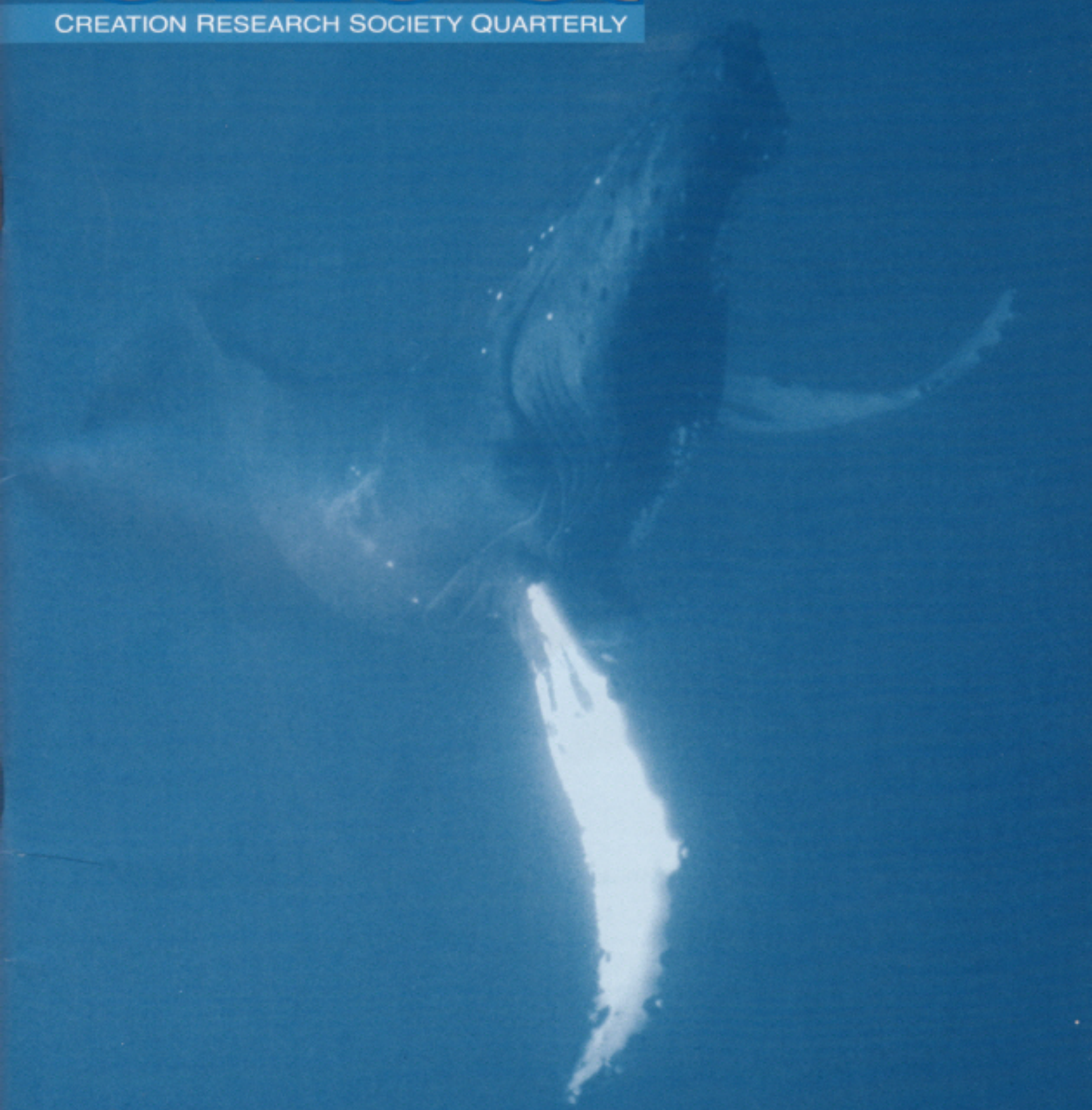


CRSQ

CREATION RESEARCH SOCIETY QUARTERLY



Volume 39

March 2003

Number 4

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The *Creation Research Society Quarterly* is published by the Creation Research Society, P. O. Box 8263, St. Joseph, MO 64508, and it is indexed in the *Christian Periodical Index* and the *Zoological Record*.

Send papers on all subjects to the Editor: Emmett L. Williams, P.O. Box 2006, Alpharetta, GA 30023.

Send book reviews to the Book Review Editor: Don B. DeYoung, 200 Seminary Dr., Winona Lake IN 46590.

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ISSN 0092-9166

Published with Corel Ventura

Printed in the United States of America

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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh.—Exodus 20:11

Whales Still Have No Ancestor

Patrick H. Young*

Abstract

Recent scientific publications have reported the excavation of fossilized anklebones from the perceived whale ancestors, *Pakicetus* and *Rodhocetus*. While previous evolutionary opinions have erroneously concluded that mesonychids are the terrestrial whale ancestor, these new discoveries along with past molecular data, are being used to claim a different ancestral origin for cetaceans. Information about the dental and auditory morphology as

well as molecular biology was presented to justify the theory that artiodactyls are the newest terrestrial relative of whales. It is evident from evaluating the available details that there is no convincing argument to conclude that artiodactyls and cetaceans are related via anklebones. Therefore, the scientific data supports the conclusion that cetaceans are not related through evolution to extinct terrestrial creatures such as artiodactyls or mesonychids.

Introduction

Gingerich *et al.* (1983) published an article describing the discovery of an extinct creature proposed to be an ancestor to modern whales. The creature, labeled *Pakicetus* (Figure 1), was excavated in terrestrial deposits of the early Eocene in Pakistan. This disclosure led Gingerich (1983) to publish drawings representing a fully preserved *Pakicetus* as a partially aquatic and partially terrestrial animal. Although the primary remains discovered were cranium fragments including a few teeth, portions of the upper and lower jawbone, and other various skull remnants (Gingerich, *et al.*, 1983), the detail and completeness of the drawings were remarkable and demonstrated the presence of an overactive imagination with little adherence to scientific principles (Sarfati, 1999, p. 77).

The excavation of *Pakicetus* provided evolutionists with fresh evidence to justify the perceived evolutionary transition of whales from fully terrestrial creatures to being fully aquatic mammals. Subsequently, several authors introduced supposed transitional forms in other publications concluding that *Pakicetus* was the intermediate between completely terrestrial wolf-like mesonychids and partially to fully aquatic mammals (Berta, 1995; Bajpai and Gingerich, 1998).

The latest proposal for whale evolution is shown in Table I. Certain militant evolutionists continue to promote these creatures as “indisputably recognizable” intermediates of cetaceans, saying they are “large nail(s) in the coffin of creationism” (Domning, 2001, pp. 38, 41).

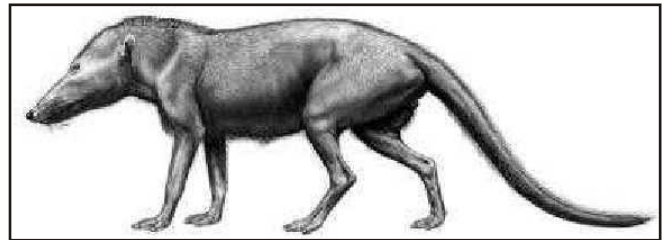


Figure 1: An artist's rendering of the perceived wolf-sized terrestrial ancestor to whales called *Pakicetus*. Illustration by Carl Buell, and taken from <http://neoucom.edu/Depts/Anat/Pakicetid.htm>

However, the scientific validity of these perceived ancient “walking whales” and their relationships to modern cetaceans have been expertly refuted by creationists in the past and there has been little new evidence to question their previous conclusions (Camp, 1998; Gish, 1995, pp. 198–208; Ham and Weiland, 2001; Sarfati, 1999, pp. 69–78; Sherwin, 1998; and Weiland, 1990). These researchers have pointed to: (1) the lack of time required for evolution to occur due to the closeness of fossil

Table I. The Perceived Evolutionary Timeline for Transitions by Fully Terrestrial Mammals to Modern Whales

Proposed Transitional Form	Perceived Time Scale (MYA*)	
Mesonychids or Artiodactyls	Terrestrial	55
<i>Pakicetus</i>	Terrestrial	52
<i>Ambulocetus</i>	Partly Aquatic	48
<i>Rodhocetus</i>	Partly Aquatic	44
<i>Basilosaurus</i>	Fully Aquatic	40

*Millions of years ago

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Received 4 March, 2002; Revised 1 September, 2002.

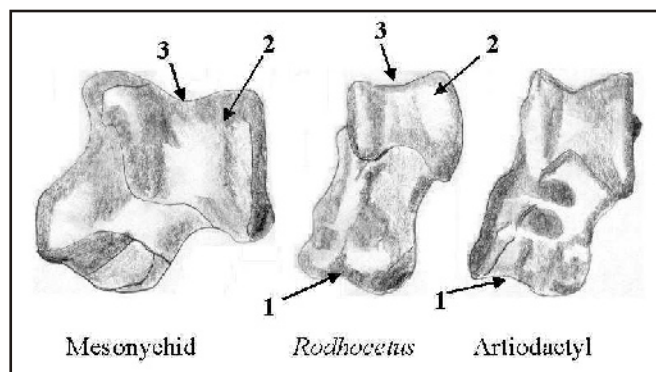


Figure 2: Ankle bone astragali comparison of mesonychids, *Rodhocetus* and artiodactyl. Diagnostic traits consistent with both *Rodhocetus* and artiodactyls is (1) the shape and orientation of the articular surface connecting the astragalus to the calcaneus. Diagnostic traits inconsistent with both *Rodhocetus* and artiodactyls but consistent with mesonychids are (2) a shallower tibial trochea with more rounded trochlear ridges and (3) similar astragalar foramen. (Redrawn from Gingerich, *et al.*, 2001)

appearance in the geologic time scale (Eldridge, 1991, p. 168), (2) the fact that *Basilosaurus* is approximately 70 feet long while the other proposed ancestors range from wolf to walrus size (Stahl, 1974, p. 489), and (3) the use of conjecture to interpolate critical missing remains in the fossil evidence (Sarfati, 1999, p. 74). Gish (1995, p. 207) philosophically challenges the transitional conclusion of these creatures by stating:

It requires an enormous faith in miracles, where materialist philosophy actually forbids them, to believe some hairy, four legged mammal crawled into the water and gradually, over eons of time, gave rise to whales....

Similarities which resulted in several researchers giving transitional status to *Pakicetus* in the past converged on dental and auditory characteristics. Gingerich *et al.* (1983 p. 404) reported, "The tympanic bulla may have been used to some limited extent in *Pakicetus* in the reception of water-borne sound". Others noted a resemblance in the teeth of *Pakicetus* to those of other archeocetes such as *Protocetus* and *Indocetus* (Berta, 1995; Bajpai and Gingerich, 1998). These dental and auditory standards have been referenced for years as intermediary criteria and consequently prepare the way for *Pakicetus* to achieve the transitional rank necessary to validate whale evolution. Several articles were also published proclaiming the conclusion that wolf-like mesonychids are the ancestor to *Pakicetus* via similarities in dentition (Zimmer, 1995; O'Leary and Rose, 1995; Zhou, *et al.*, 1995).

The immediate discussion will focus on the morphological and molecular characteristics of mesonychids / ar-

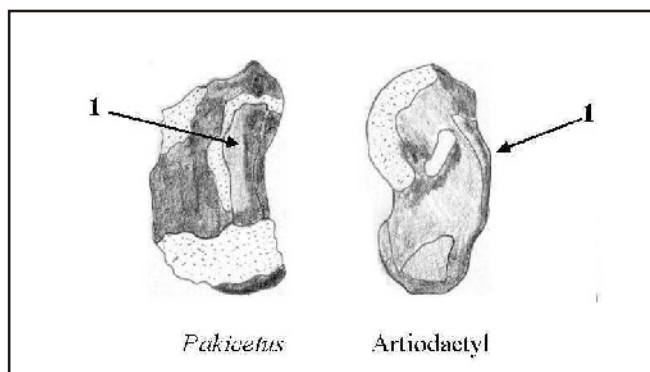


Figure 3: Astralgali of the artiodactyl and *Pakicetus*. (1) is a comparison of the sustentacular facet. (Redrawn from Thewissen, *et al.*, 1998)

tiodactyls and the evolutionary validity of relating them to *Pakicetus* or any other perceived ancient "walking whale."

Discussion

Gingerich *et al.* (2001, p. 2239) reported the discovery of anklebones from a *Rodhocetus* fossil, which they believe demonstrates: "... paleontological evidence showing that whales evolved from artiodactyls rather than mesonychid condylarths." Anklebone morphology is considered by evolutionists to be a primary tool for identifying artiodactyls (Schaeffer, 1947), and these similarities are now proposed to confirm the perceived evolutionary connection of artiodactyls to primitive whales (Harder, 2001). The characteristic in question is a trochlea on the distal part of the astragalus of the artiodactyl. A similar trochleated head on an anklebone is present in the *Rodhocetus* fossil but absent in the mesonychid (Figure 2) (Milinkovitch and Thewissen, 1997).

Later, Thewissen *et al.* (2001) reported similarities of *Pakicetus* to artiodactyls via anklebone affinity. Their conclusions were based on the excavation of four partial *Pakicetus* skulls including 150 isolated post-cranial bones. They stated:

We use these fossils to show (1) that these archaic cetaceans were land mammals; and (2) that cetaceans are more closely related to artiodactyls than to mesonychians (Thewissen, *et al.*, 2001, p. 277).

Although complete pictures of *Pakicetus* have been previously published, post-cranial bone fragments have been nonexistent in the past and therefore this discovery represented some of the first remains available for a true scientific study.

For years, creationists have reported mesonychids could not have been the transitional form for whales since the differences they have with cetaceans by far surpass any similarities (Gish, 1995, pp. 198–207; Ham and

Weiland, 2001; Sherwin, 1998; Weiland, 1990). Originally, evolutionists were convinced that the ancestry of mesonychids was convergent with cetaceans, until a study was done in 1997 suggesting a closer relationship of whales to artiodactyls via molecular phylogeny (Shimamura, *et al.*, 1997). The molecular phylogeny technique was developed to create a pathway to identify the organisms with the closest relationships based on DNA, RNA, or protein sequences, with the primary assumption that all organisms are related via common ancestry.

The biologists have heralded these data from the molecular phylogeny technique as conclusive evidence that artiodactyls are more closely related to whales than mesonychids. Paleontologists were not as quick to embrace these conclusions because the fossil data did not support it (Gibson, 2001). Paleontologists also point out that all the DNA sequence analysis was done on extant animals. Since mesonychids are extinct, there is no sequence data to conclude their relationship to *Pakicetus* by molecular phylogeny (Wong, 1999). Furthermore, the results from both molecular and morphological analysis are not able to account for reversals to ancestral conditions. Matching changes in different lineages (homoplasies), can also result in potentially concealing authentic phylogenetic similarities (Luo, 2000).

Molecular phylogeny experiments using SINE and LINE retroposons are designed to minimize evolutionary reversals and homoplasy because it is believed the mechanism driving replication is irreversible and unlikely to occur independently (Nikaido, *et al.*, 1999; and Hillis, 1999). However, homoplasy can still occur when character traits develop prior to the perceived speciation event (ancestral polymorphism). Since flanking sequences are used to amplify a characteristic SINE event, mutations from the flanking sequence will make it difficult to resolve the lineage in question. This potential problem is key when older SINE insertions are used to determine a lineage. Older SINE insertions mean more mutations in the flanking sequence resulting in a significant loss of critical information and eventually rendering the data useless (Hillis, 1999).

Evolutionists must now live with a conundrum they have created in the legend of whale origins. The past conclusion of mesonychids being ancestors to archaeocetes was based on dental similarity. Dental similarities between archaeocetes and mesonychids have not changed and are also nonexistent in artiodactyls. Gingerich *et al.* (2001, p. 2242) attempted to address the issue by stating:

Although there is a general resemblance of the teeth of archaeocetes to those of mesonychids, such resemblance is sometimes *overstated* and evidently represents evolutionary convergence. (my emphasis)

Thewissen *et al.* (2001, p. 280) attempt their own explanation stating:

Our analysis implies that the relatively primitive dental morphology of archaic artiodactyls is either a reversal (from a more mesonychian-like morphology) or that mesonychians and cetaceans evolved dental similarities independently.

In other words, they needed a fully terrestrial ancestor of *Pakicetus* to demonstrate their mythical evolutionary pathway to modern whales. Mesonychids were the best guess at the time and the details were exaggerated to prove it. Now they think *Pakicetus* evolved from artiodactyls and they are not exaggerating now!

Evolutionists have also stated that certain portions of the *Pakicetus* auditory system confirms its transitional status to whales and whale ancestors. However, Thewissen *et al.* (2001, p. 278) reported that:

The Pakicetid middle ear was highly specialized and included pachy osteosclerotic ossicles, an involucrum and a plate like sigmoid process. These features have been interpreted as adaptations for underwater hearing, and it has been suggested that the presence of an involucrum facilitates underwater high frequency transmission in modern odontocetes even though the involucrum is also present in low frequency mysticetes. In the case of pakicetid, the absence of air sinuses insulating the ears, the firm fusion of the periotic to the surrounding bones, and the presence of a flat tympanic membrane suggest that reception of airborne sound is well developed, but are *inconsistent* with good underwater hearing. It is most likely that the specialization's of the Pakicetid middle ear are analogous to those of some subterranean mammals... Some features of the sense organs of Pakicetids are also found in aquatic mammals, but they do not necessarily imply life in water. (my emphasis)

This type of hearing in *Pakicetus* clearly establishes it as a fully terrestrial animal without any of the sensitive auditory components present in modern whales. One small bone in the ear of *Pakicetus* has been hailed as the transitional element to modern whale's ears. This claim however, could easily be construed as "overstatements" or an example of "evolutionary convergence."

Today's whales contain several unique characteristics including the following: a highly vascularized sinus to sustain pressure when diving to great depths (Gish, 1995, p. 206), a complex directional auditory system, and the ability to echolocate underwater (Meyer, 1997). Studies also confirm the existence of a heat exchanger type thermoregulation system in the tongue of grey whales that allows them to feed in very cold waters without significant heat loss (Heyning and Mead, 1997). These types of features are not observed in any of the proposed whale ancestors to date, nor is there any proposed transitional pathway to achieve this type of complexity.

In the past, any transitional status of *Pakicetus* to whales was linked via dental similarities. These similarities have now been proven false or have at least been demoted. There is also no evidence of any evolutionary pattern remotely suggesting *Pakicetus* is an ancestral relative to either ancient or modern cetaceans when comparing their post-cranial remains (Woodmorappe, 2002). Although there has been no change in the similarities in the dentition of *Pakicetus* and the mesonychids, evolutionists now allege their earlier mistaken evaluations were the result of overstatements, evolutionary convergence, or independent evolution.

Ear bone similarities have also been a past fundamental characteristic supposedly demonstrating the ancestral tie of *Pakicetus* to primitive whales. This also appears to have been an embellishment and downgraded to secondary or tertiary status (Woodmorappe, 2002).

Thewissen *et al.* (2001), and Gingerich *et al.* (2001) presently report that resemblance's of the anklebones are the principal elements linking artiodactyls to *Pakicetus* and subsequently to *Rodhocetus*. Curiously, Thewissen *et al.* (1998, pp. 452–453) appear to contradict this claim, having stated in a previous article that:

The cetacean astragalar head is wide and nearly flat both mediolaterally and dorsoplantarly. This is *unlike* the condyle of mesonychians, but is also *unlike* the convex trochleated head of artiodactyls. This important feature, often cited as the main defining character of artiodactyls, is *inconsistent* with the hypothesis that cetaceans should be included in the artiodactyls. The cetacean sustentacular facet resembles that of artiodactyls in being long, but *unlike* that of artiodactyls it is narrow. (my emphasis)

These statements by Thewissen *et al.* (1998) are in direct opposition to the conclusions in the Thewissen *et al.* (2001, p. 279) article where they state that:

Our new fossils show that these defining characteristics do not only occur in all artiodactyls, but are also present in basal cetaceans. These ankle characters (deeply grooved proximal trochlea, dorso-plantar rotation plane of trochleated head, rectangular and wide sustentacular facet....) have high consistency indices (1.0).

In the same article, Thewissen *et al.* (2001, p. 280) attempted to justify their contradiction by stating: "This bears out the prediction that widespread homoplasy occurred in one organ system in the early evolution of the clades in question." It appears that every problem can be explained by homoplasy!

Gingerich *et al.* (2001, p. 2242) attempt to minimize the dilemma remarking as follows:

Inferences that astragali of pakicetidae and ambulocetidae are artiodactyl-like have been questioned

because the bones involved are fragmentary and not associated with diagnostic cetacean material.

While Gingerich was accurate in concluding that the remains were fragmentary, critical anklebone areas such as the sustentacular facet shown in Figure 3, are well preserved (Thewissen, *et al.*, 1998). Furthermore, if the bone fragmentations were this disastrous, it would have been irresponsible for Thewissen, *et al.*, (1998) to propose a conclusion at all.

Although there are some similarities in anklebones of artiodactyls and *Rodhocetus*, there are also several crucial differences (Figure 2). Rose (2001, p. 2216) states that:

Primitive mesonychid-like traits present in ancient whales, but not in any known artiodactyl, include a shallower tibial trochlea with more rounded trochlear ridges and retention of a remnant of the astragalar foramen, the opening of a canal through which a nerve and vessels pass in primitive mammals.

Noting the complete lack of transitional evidence in the fossil record, University of Michigan paleontologist William J. Sanders stated that:

The earliest known fossil branching of hippos (artiodactyls) was 15 to 1 million years ago and the earliest whales more than 50 million years ago in the Eocene epoch. Thus, if whales and hippos shared a common ancestor, it would have to have persisted for at least 32 million years—but there is no fossil evidence for such a creature spanning that immensity of time (Wong, 1999, p. 27).

Conclusion

From an evaluation of the available data, it is evident that a relationship between artiodactyls and cetaceans based on anklebones is not a convincing argument. Furthermore, the molecular data suggesting that cetaceans descended from artiodactyls was not convincing to the morphologists until anklebones were discovered.

Homoplasy, evolutionary reversals, and ancestral polymorphism appears to be used abundantly as a crutch to justify numerous "walking whale" character traits that do not follow traditional evolutionary dogma. The dentition similarities of *Pakicetus* and mesonychids were once primary criteria used to conclude they were evolutionary relatives. Now these same characteristics are considered irrelevant homoplasy for no good scientific reason.

Genesis 1:21 says: "And God created great whales, and every living creature that moveth, which the waters brought forth abundantly, after their kind..." After evaluating all the pertinent information, one can only conclude there are both similarities and significant differences in the

dental, auditory and anklebone data for whales and their proposed ancestors.

Therefore, the morphological and molecular pathway for perceived whale evolution continues to be in turmoil and the latest research has done little to resolve the confusion. On this basis, the biblical conclusion that whales and their supposed evolutionary ancestors were divinely created as separate kinds is still the most valid scientific theory.

Acknowledgments

I would like to thank Dr. George Howe, Dr. Wayne Frair and one anonymous referee for their comments in a previous version of this paper. A special thanks to Dr. Frair for his recommendations on further references that were used in this paper.

Definitions

Archeocetes: primitive whale.

Artiodactyls: Even toed ungulates (hoofed) with a double pulley ankle e.g. sheep, cows, hippos.

Astragalar foramen: the opening of a canal through which a nerve and vessels pass in primitive mammals.

Astragalus: the bone of the ankle that articulates with the bones of the leg

Condyle: A rounded bone prominence that functions in articulation

Dorsoplantarly: transverse plane of the foot

Flanking sequence: The immediate or neighboring upstream or downstream sequence from a designated structure such as a SINE or LINE.

Homoplasy: character state that rose independently in several different taxa

Involucrum: a new bone formation.

LINEs: Long interdispersed elements.

Mediolaterally: Sagittal plane of the ankle

Mesonychids: Even toed ungulates (hoofed) without a double pulley ankle but adapted for running

Mysticetes: toothless whales.

Odontocetes: toothed whales.

Pachy-osteosclerotic ossicles: middle ear.

Periotic: bones immediately around the inner ear.

Retroposon: A DNA segment carried within chromosomes capable of copying itself to RNA and then synthesizing DNA via reverse transcriptase.

SINEs: Short interdispersed elements.

Sustentacular facet: supporting face of the astragalus

Tympanic bulla: inner ear bone.

Trochlea: pulley-like anatomical structure.

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Book Review

How The Universe Got Its Spots by Janna Levin

Princeton University Press, Princeton, NJ. 2002, 208 pages, \$22.95

Janna Levin is an Advanced Fellow in the Department of Applied Mathematics and Theoretical Physics at Cambridge University. She received her Ph.D. in physics from Massachusetts Institute of Technology. It is obvious she is a second generation Big Bang believer. Her only departure from the mainline standard theory is that she believes the universe is finite. This belief, I assume, is largely driven by her mathematical specialty of topology. Topology is the study of surfaces and if the universe is infinite it will have no surface for her to theorize about. She is a devout evolutionist, even offering the question, “Could there be Darwinian explanations for our size in the cosmos?” (p. 159). The closest she comes to recognizing creation is the anthropic principle (p. 160), the idea that there is innate design in the universe found in the values of fundamental constants. However in several places (pp. 49, 70, 74, 159) she personifies nature and the universe as having the necessary creative and design capabilities to accomplish evolution. She even makes the statement, “Maybe on one [planet] with optimal conditions, complex molecules form and an inanimate broth waits for the sparks to generate organic life. *Voila*. A few hundred million years later, Africa blooms and here we are” (p. 71).

The book subtitle is “Diary of a Finite Time in a Finite Space”. This is appropriate because the book is written in diary format over a period of 28 months during 1998-2001. Actually it is a compilation of letters Levin wrote to her mother while on assignment with Cambridge University’s Cosmology Group whose leader is Steven Hawking. In this format Levin makes a successful attempt to write about complex mathematical subjects in terms a layman can understand. She also includes personal information not relevant to the subject throughout the book, and readers may be interested in how a theoretical physicist lives in the real world and our modern society.

The first half of the book is a review of the standard Big Bang theory starting with topics like infinity, relativity, gravity, quantum mechanics, black holes, and the pillars of the Big Bang (universal expansion-redshift, cosmic background radiation, nucleosynthesis of hydrogen and helium, and formation of galaxies and large-scale structure). In chapter 9 titled Beyond Einstein she introduces the new material that her work is developing. She starts by describing how the theory of general relativity inevitably leads to an initial singularity which limits application of the theory itself. Only with the integration of quantum

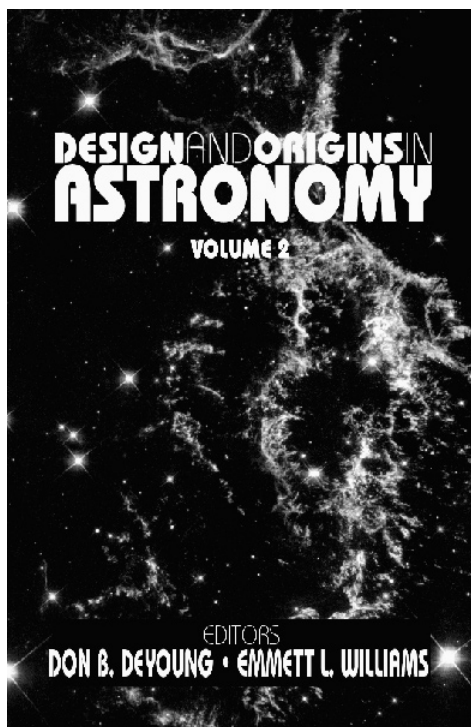
phenomena can the current theory of gravity survive in the vicinity of a singularity. Where this new integrated theory will lead is not obvious as she writes, "Theorists, observers, and experimentalists disperse like headless chickens, or scattered ants to do what they can" (p. 100). Then she introduces topology's role in the efforts to come up with a unification theory of the universe. As gravity is associated with geometry of space, topology is associated with the outer form and connectivity of the universe.

In chapters 10-13 Levin discusses topology of one to three dimensional spaces and what each new dimension adds to the possible topology of space. Each new dimension allows more idealized examples of finite spaces with their own topology. With three-dimensional spaces there are three categories of topologies: flat, positively curved and negatively curved. There are only seventeen possible flat spaces, a countable infinity of positively curved spaces, and a larger infinity of negatively curved spaces. A countable infinity means that mathematicians have devised a counting routine or prescription that can generate all the variants. Such a prescription does not exist yet for the negatively curved spaces. Besides cataloging the infinity of possible 3-D spaces, topologists look for ways to identify the curvature of the space we live in by recognizing its unique characteristics. But the possibility of doing this depends on how big the universe really is. As Levin states "If the volume of space is huge, then we won't be able to see far enough into the universe to perceive the topology" (p. 146). But she thinks "space is finite and the perfect poly-

gons are mathematical idealizations that allow us to pursue the implications either to the point of absurdity or to the point of discovery" (p. 147).

The remaining chapters are based on Levin's conjecture that the universe is finite spatially and of a size where someday we will be able to see the characteristics needed to show its actual topology. She writes about how researchers are proceeding in the search for these characteristics. She includes the added dimensions of string theory and shows how they complicate the search. She also discusses the theory of how animals evolved their spots biologically and proposes that the universe got its structure in a parallel way. She does not see the flaw in logic that animal spots (a design) could not evolve without a designer. Levin describes what the discovery of the topology of the universe would mean for mankind and the future of this universe. The last concept she addresses is the fourth dimension of time. She states, "Time can start over again only on a scale set by the largest cosmological forces. Only a universe that can naturally return to its own infancy could be consistent with a closed time loop" (p. 196). This statement demonstrates that even evolutionists that believe the universe is finite in space have to believe it is never ending in time to avoid admitting there was a beginning (creation) and there also will be an end.

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These and other topics are discussed from a creationist worldview. These key articles have been gathered from the *Creation Research Society Quarterly*, now in its 39th year of publication.

Edited by Don B. DeYoung and Emmett L. Williams, the authors of the individual articles include:

Eugene Chaffin	Don DeYoung
Danny Faulkner	Russell Humphreys
David Rush	Paul Steidl
J.K. West	Emmett Williams

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Natural Tunnel, Virginia: Origin Speculations

Emmett L. Williams*

Abstract

A model for the development of Natural Tunnel, Virginia within a young-earth framework is presented. A brief review of conjectures offered to date

on the origin of the tunnel is given. The creationist model employs the action of retreating Floodwater on carbonate strata to form the tunnel.

Introduction

Previously I discussed how a karst feature (Natural Bridge) in the Commonwealth of Virginia could have formed assuming a young earth-Flood model (Williams, 2002). This treatise covers the origin of another karst feature in Virginia—Natural Tunnel. It is located in Scott County near the towns of Clinchport and Duffield in the southwestern corner of Virginia (Figure 1). The tunnel is a part of Natural Tunnel State Park, a short distance east of U. S. Highway 23.

History of Natural Tunnel

Daniel Boone may have been one of the first explorers to see the tunnel. Likely it was well-known to local Indians and hunters prior to that time (Natural Tunnel State Park Trail Guide). The arch was named Natural Tunnel by Lt. Col. Stephen H. Long when he explored the site in 1831 (Virginia Department of Conservation and Recreation). In 1880 an engineer, J. H. McCue, found the tunnel while surveying a route for the South Atlantic and Ohio Railroad (Waltham, 1988, p. 11). Around that time William Jennings Bryan, the famous orator and statesman, declared the tunnel to be the eighth wonder of the world (Natural Tunnel State Park Trail Guide). The South Atlantic and Ohio laid tracks through the tunnel in 1890. Later the Southern Railroad acquired the tracks and started passenger service calling it the Natural Tunnel Line.

When large coal deposits were discovered in the region, trains began hauling the mineral through the tunnel and these operations continue today even though passenger service was discontinued (Virginia Department of Conservation and Recreation).

The Commonwealth of Virginia acquired the tunnel and 100 surrounding acres in 1967 from the Natural Tunnel Chasm and Caverns Corp. to establish Natural Tunnel State Park. Approximately 750 acres were later acquired, and the Park opened in 1971. (Virginia Dept. of Conservation and Recreation).

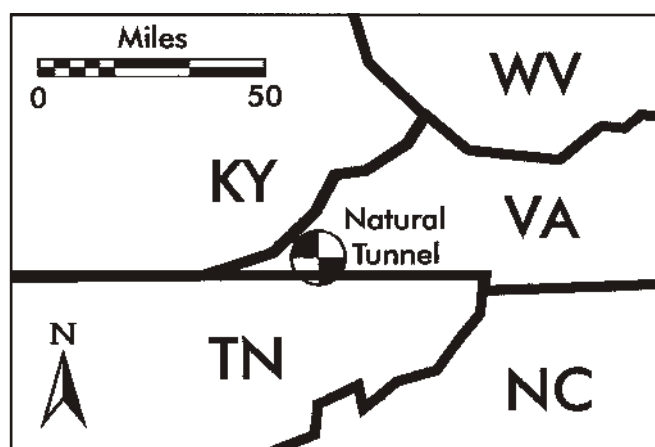


Figure 1. The location of Natural Tunnel in Scott County, Virginia.

Geologic Setting of the Natural Tunnel Region

Natural Tunnel is located in the Appalachian Valley (the portion of which in Virginia is often called the Great Valley of Virginia). "The Appalachian Valley is a subdivision of a larger region called the Appalachian Highlands..." (Butts, 1973, p. 5). Natural Tunnel (Figures 2 and 3) lies in the Valley and Ridge Physiographic Province, "...a region characterized by long, parallel ridges separated by narrow, deep valleys" (Milici, 1990, p. 17). The tunnel is a large solution arch cut into the Cambrian-Ordovician Knox Group dolostones and limestones (Brent, 1963, p. 18; Cooper, 1945, pp. 189–191; Milici, 1990, p. 19). Natural Tunnel is incised into Purchase Ridge (Figure 4), a major topographic feature composed of synclinal dolomite escarpments "oriented NE-SW in line with the Appalachian structural trend" (Waltham, 1988, p. 11).

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Received 25 June 2002; Revised 31 July 2002

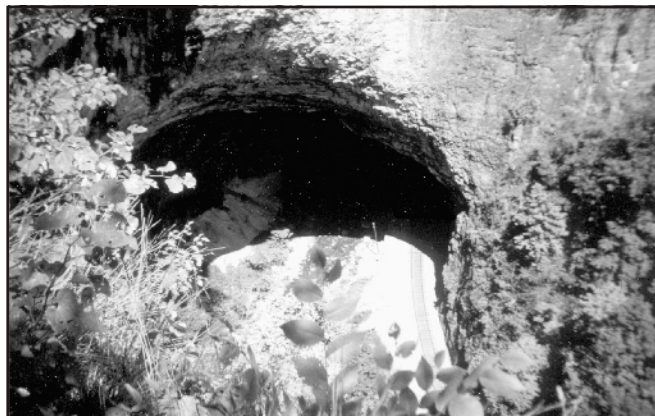


Figure 2. The south portal of Natural Tunnel. The Norfolk-Southern Railroad tracks are seen to the right. Stock Creek is to the left of the tracks. The trace of the Glenita fault is in the lower left of the tunnel. (Photograph taken in 1989)

Underfit Stock Creek and the Norfolk-Southern Railroad (Figures 2 and 3) pass through the tunnel. The dimensions of the tunnel are: length of 900 ft., width of 130 ft., and height of 75 ft. above Stock Creek which is in the Clinch River system. The thickness of the arch is 200 ft. with one large circular dome in the roof (Dietrich, 1990, p. 112; Webb, 1988, p. 23). Beyond the south portal of the tunnel is a spectacular amphitheater (Figures 5 and 6) at the head of a gorge that is approximately 700 ft. deep (Woodward, 1936, p. 611; Webb, 1988, p. 23).

Speculations on the Formation of Natural Tunnel

Woodward (1936) postulated that in the past a higher altitude tributary of the North Fork of the Clinch River flowed somewhat parallel to the Clinch River (Figure 7a). An active smaller tributary of the Clinch began to erode headward toward the higher level stream (Figure 7b). About the same time, a sink developed in the upper stream diverting some of the flow into an underground channel which eventually joined the headward growing tributary (Figure 7c). The sink continued to enlarge, capturing all of the flow from the upper reaches of the high-level tributary forming Stock Creek. The water flowing in the phreatic tube eroded and dissolved the walls until the roof of the underground passage collapsed except at Natural Tunnel (Figure 7d). The roof remains at the tunnel because it is situated near the axis of a broad shallow syncline where the dolomite and limestone strata are nearly horizontal resisting dissolution and erosion. (These horizontal layers being massive and less jointed have greater structural integrity than those layers located farther from the axis of the syncline.)

In presenting another model of tunnel formation, Waltham (1988, pp. 13–14) observed that the Clinch

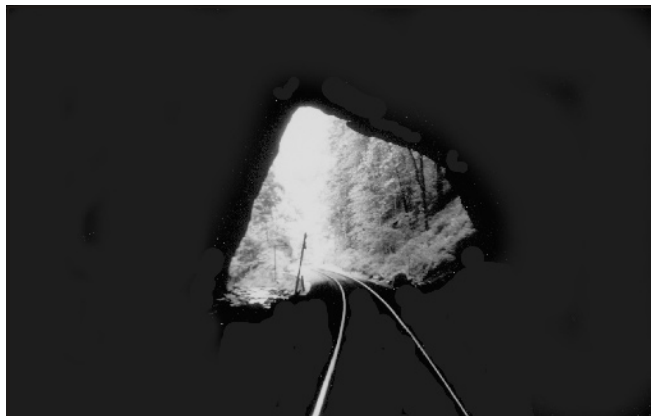


Figure 3. The north portal as viewed from the inside of Natural Tunnel. Stock Creek is seen on the left. This photograph was taken in 1989. Presently no visitors are allowed in the tunnel.

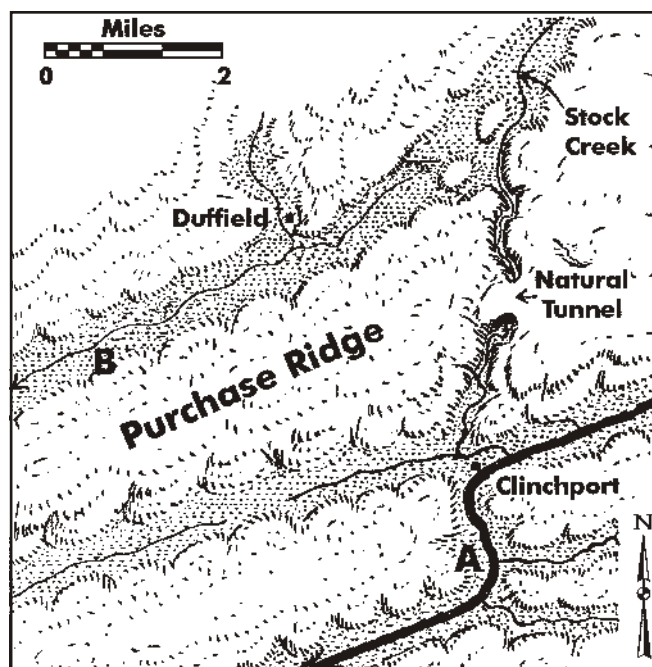


Figure 4. Diagram of Purchase Ridge/Stock Creek/Clinch River (after Woodward, 1936) A: Clinch River; B: North Fork.

River and its North Fork flow in the Valley and Ridge Province generally parallel to the ridges (parallel to structural controls). He conjectured that the headwaters of ancestral Stock Creek drained into the North Fork. A tributary of the Clinch River eroded headward into Purchase Ridge and captured the head of the North Fork to form Stock Creek. The original route of Stock Creek was slightly west of the present location of Natural Tunnel. A sink developed along the route of Stock Creek causing the underground capture of this flow. The water then leaking through the opening of Natural Tunnel developed a phreatic loop.

The original sink into this phreatic loop was very close to the present northern entrance of Natural

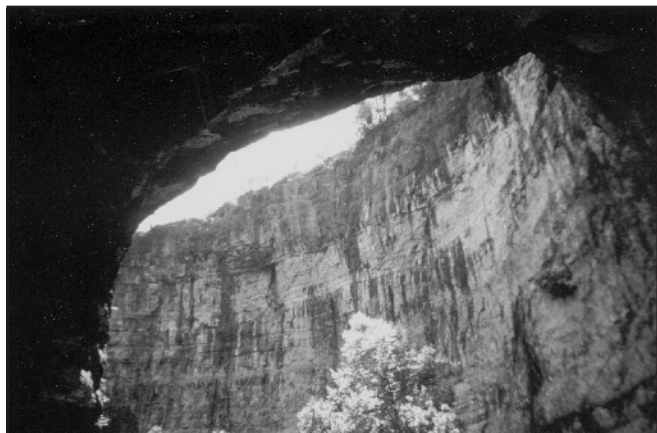


Figure 5. South portal amphitheater as seen from inside of Natural Tunnel. (Photograph taken in 1989)

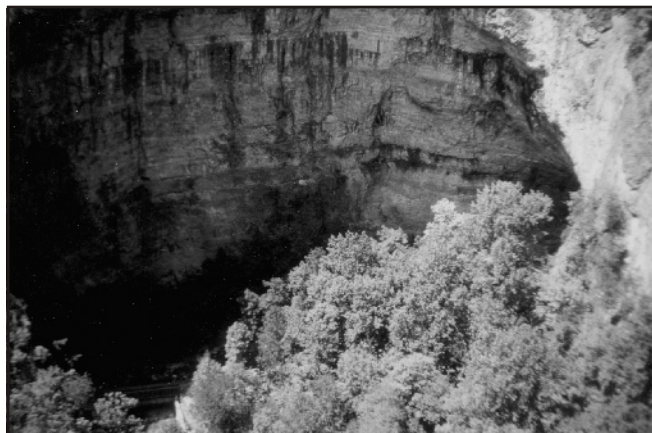


Figure 6. Amphitheater at south portal of Natural Tunnel. Portal is on the right of photograph. (Photograph taken in 1989)

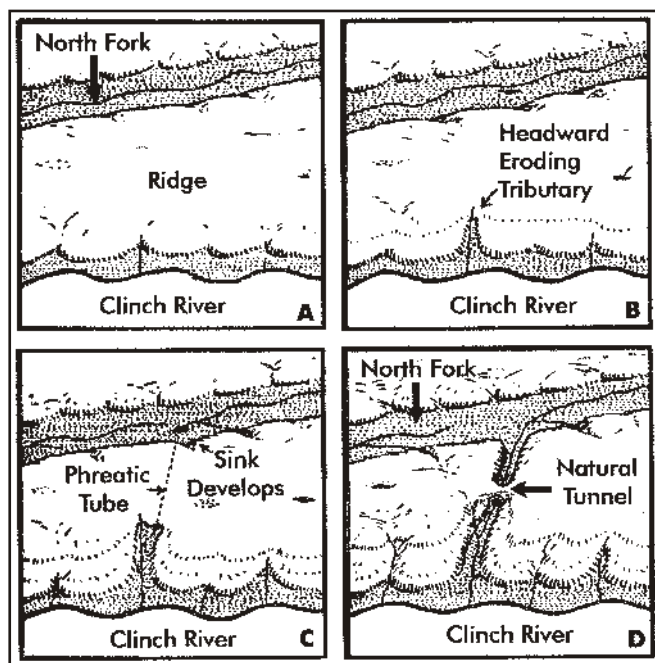


Figure 7. Stages of the Woodward (1936) model for the formation of Natural Tunnel.

Tunnel. The original resurgence was a vauculian rising (artesian spring) with a phreatic lift of close to 40m (about 131 ft.) ...and appears to have been some short way downstream of the present cave exit (Waltham, 1988 pp. 13, 14; Parenthesis added).

Regional lowering of the base level eliminated the phreatic loop which left the roof of the cave above water level. The roof of the present tunnel was stable but at the site of the present amphitheater, the roof was unstable and collapsed. As Waltham (1988) noted:

The rock amphitheater at the exit... almost certainly formed by collapse of the cave where it wrapped round an exceedingly sharp left bend... (p. 14).

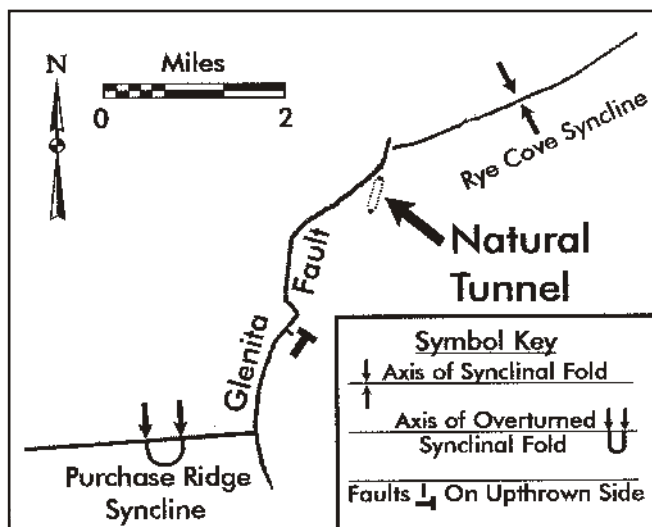


Figure 8. Location of Glenita fault in relation to Natural Tunnel (after Milici, 1990, p. 21).

Waltham surmized that failure of the cave roof occurred “a long time ago” and “Stock Creek has since removed the breakdown...” (p. 14) leaving the steep-walled amphitheater.

Milici (1990) utilized the faulting and folding that occurred in the vicinity of Natural Tunnel to help explain the origin of the feature. Previously, Brent had mentioned that... (1963, p. 1). “...the Rye Cove syncline ...contains many small folds and faults.”

Natural Tunnel ...and the creek that flows through it, Stock Creek, are aligned along a zone of structural weakness that occurs between the gently folded Rye Cove syncline (downfold) on the east and the more tightly folded Purchase Ridge syncline to the southwest (Milici, 1990, pp. 20, 22).

This zone, the Glenita Fault (Figure 8), passes beneath Natural Tunnel. Milici noted that: “Folded and faulted carbonate rock may be seen in both the south and north

portals of the tunnel where the fault passes beneath it" (p. 22) and he stated that the tunnel was formed by the preferential solution of the dolomites and limestones along the fractured fault zone "... during the past million years or more" (p. 20).

Ancestral Stock Creek flowed over the region of Natural Tunnel State Park about 300 ft. above the level of the present creek that passes through the tunnel. A sink developed near which is today the north entrance of the tunnel capturing the water flow which subsequently formed a cavern by dissolution and erosion of the dolomites and limestones in its path. This cavern eventually became Natural Tunnel. The location of the present amphitheater may have been where Stock Creek formerly rose and emerged as a spring above the vicinity of the south portal. With progressive downcutting, Stock Creek incised a steep-sided valley below the tunnel whereas a broader valley developed above the north portal. The erosion process was aided by the presence of abrasive particulate matter in the flowing water. The south portal amphitheater developed as a steep-sided spring.

Why was the roof of the Natural Tunnel preserved during the erosional sequence of events? Milici relates that: "At the tunnel, most of the carbonate strata are subhorizontal or are only gently dipping, a requirement for the construction and maintenance of a large, long-standing arch" (p. 26).

Introductory Young Earth-Flood Model for Tunnel Formation

McQueen (1986) discussed the general development of the Southern Appalachians from a young-earth perspective. Chaffin (1990) examined the faulting in the Southwest Virginia region employing a catastrophic Flood viewpoint. Later Williams et al. (1994) presented a creationist model for the development of a canyon on the Appalachian Plateau. I will use the same approach in this study.

It is assumed that the regional limestones and dolomites were deposited during the Flood. It is assumed also that these calcium-containing sedimentary strata would have set initially similar to the setting of portland cement (Williams and Herdtklotz, 1977, pp. 197–198). Since the newly-deposited sediments would be water-laden, they would be semirigid. These strata would need time under subaerial conditions to dewater which would cause them to further harden.

As Floodwater began to retreat from the region, dissolution and erosion of the newly-deposited carbonates could have developed a sink particularly along a fault zone. As water entered the sink, it eventually formed a phreatic tube (Williams and Herdtklotz, 1977, pp. 193, 197–198; 1978,

p. 88). As more water entered the sink it would enlarge the opening and the underground route over time forming a cavern from which Natural Tunnel would develop. The downcutting by the water containing abrasive particulate matter would have produced an underground cavity beyond the present length of Natural Tunnel. During the same time period, the retreating water above the phreatic tube would dissolve and erode the roof of the cavern reducing its thickness such that the roof would collapse aiding in the formation of a gorge south of the present tunnel. As retreating Floodwater continued to pour through the developing tunnel, it could have exited the underground passage exerting considerable force on the strata at the south portal. With water being directed against the wall at the south portal and exerting pressure overhead from the water above ground level, the amphitheater likely would have formed by cliff sapping (Austin, 1994; Froede, 1996).

As the base level dropped, the carbonate sediments would dewater and harden with time stabilizing the tunnel and the gorge below leaving hardened strata on the steep-sided amphitheater. The area north of the tunnel would have suffered erosion in a more generalized manner being subjected to channelized flowing water in the narrow valley of the present Stock Creek between emerging ridges (cf., Oard, 2001) as the base level continued to decrease. This flow resulted in a somewhat broader valley north of Natural Tunnel.

Appendix: Geomorphic Models

The suggested model for tunnel, amphitheater and lower gorge development is one of many possibilities that could be presented. This model appeals to the karst features and local structural geology of the region. See Williams (2002) for a discussion of the formation of a natural bridge as well as references to the development of canyons in karst landscapes.

Acknowledgments

I thank the many donors to the Creation Research Society Research Fund, interest from which financed a portion of these studies. I am grateful to Carl R. Froede, Jr. for his help and interest in this and the Natural Bridge project and for doing the graphics for the figures. I appreciate the help of Jerry Akridge and Gene Chaffin in supplying some material for the literature review.

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Book Review

Excelsior: Memoir of a Forester by Laurence C. Walker

College of Forestry, Stephen F. Austin State University, USA. 1995, 490 pages, \$20

Books on history and biography should be read in much greater quantities than works of fiction, just as, according to current dietary science, fruits, vegetables, and carbohydrates should be consumed in much greater quantities than meat, fatty foods, and sweets. A Christian should know and practice “You are what you eat” and “You are what you read.” The memoir of Dr. Laurence C. Walker is both history and biography that challenges Christians to honor the Lord Jesus Christ as vocational mentors while actively engaged in the advance of the kingdom of God through Church participation.

Walker was Boy Scout and scoutmaster, forester and educator, soldier and civilian, and lay minister and ordained Presbyterian pastor during the last three quarters of the 20th century. Although his extensive travels all over the world were mainly related to his profession as a forester, he had an eye toward planting seeds of the gospel of Jesus Christ. For example, he carried copies of the Bible into China and gave his personal copy of C.S. Lewis’ *Miracles* to a Chinese man.

In the preface of his memoir, Walker makes his motive clear, “Who...would have the audacity to write about oneself? I write... because... my friends asked me to. They’d heard the tales over coffee conversations through the years.” Early in the book Walker writes, “I trust, dear reader, that you’ve noted that this chapter, like others, is really about mentors.” One such mentor for Walker, when he was a young boy growing up in Washington D.C. in an unchurched family noticeably devoid of a paternal influence, was his scoutmaster, a USDA botanist, who inspired his charges to “do our best to do our duty to God and country.” It was through Walker’s involvement in the boy scouts, which met in a Presbyterian church building, that he became acquainted with the pastor and subsequently responded to invitations to attend services and Bible study.

The context of the book is the career of a forester, without heavy technical jargon associated with the profession, yet the title reveals the foundation upon which Walker built his career, “Excelsior: the higher good.” Walker

waits until the last chapter to explain the reason he selected the title, giving a detailed history of the phrase in relation to the growth of the forestry profession. He ends the chapter with verse he penned for some of his first college students at Stephen F. Austin State University in the pineywoods of East Texas around the Christmas season. It is entitled "A Psalm of the Forester" and it begins, "The feed crib was of rough hewn wood. So was the cross! We commemorate the birth with the living evergreen of the forest. But the Place of the Skull was void of any living tree!" and then ends with, "The Light of the World appeared. And the Shadows of the World could not dim it!" Walker then concludes the book with the statement, "Thus the inspiration for *Excelsior*."

The narrative is peppered with Christian influence and references to Bible passages applied to life experiences and his profession, a delightful blend of Americana, rags to professional success, and "gratitude to The Faithful Friend who guided me all along The Way...", as Walker states on the dedicatory page. An entire chapter is devoted to the numerous organizations in which he participated. If quantity of text is any indication of influence and enthusiasm for involvement, then his brief two paragraphs on The American Scientific Affiliation (ASA), and other brief comments elsewhere in the book, hint of a less than satisfactory experience with that organization. Although no mention is made, positively or negatively, of any creationist organizations (though Walker was surely aware of their existence) one cannot help but wonder if, given the right creationist mentor, Walker would not have responded more enthusiastically to a professional scientific Christian organization such as the Creation Research Society (CRS). In reflecting on the absence of any mention of creationist themes or organizations in Walker's memoir,

I cannot help but be more determined to heed his charge to be a mentor in the natural sciences, yet with the added higher good of magnifying Christ as Creator!

The theme of environmental stewardship and environmental ethics recurs throughout the book, especially in the latter half. At several professional meetings, such as the national ASA meeting and Au Sable Institute, and in many periodicals and journals, such as *Journal of Forestry*, *Presbyterian Journal*, *Texas Parks and Wildlife*, and *Farmer-Stockman*, Walker addressed these issues that sometimes challenged the thinking of fellow Christians. One such example details how Walker (1982) received criticism for an essay submitted for publication which appraised Henry David Thoreau as a selfish person, not worthy as a mentor for Christian environmental stewardship; this sort of critique of Thoreau's view of nature is still necessary among some Christian stewardship organizations which seek to promote wise use of God's creation.

Although *Excelsior* does not explicitly address creationist topics, Walker conveys much encouragement to Christian professionals and educators of the natural sciences to be men and women of faith in the Lord Jesus Christ and seek to mentor others for "the higher good!"

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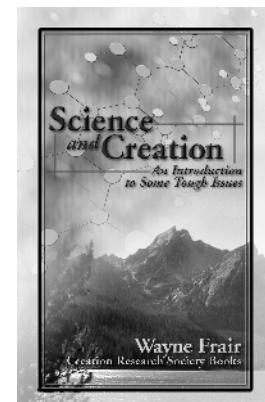
Science and Creation

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- Why should all these subjects be important to me?

Author Wayne Frair earned undergraduate science degrees from Houghton and Wheaton Colleges. His MA. is in embryology from the University of Massachusetts, and his Ph.D. in biochemical taxonomy is from Rutgers University. He is a fellow of the American Association for the Advancement of Science and a past president of the Creation Research Society. Having spent more than forty years in research and teaching, his current status is Professor Emeritus of Biology at The King's College in New York City.

Available for \$6 from Creation Research Society Books. See the inside back cover of this issue for details.



The Galileo Myth and the Facts of History

Jerry Bergman*

Abstract

A review of Galileo and the heliocentric theory controversy reveals that a major reason for his difficulties was opposition from scientific colleagues. The church became involved primarily as a result of pressure from the academic community. This paper also concludes that the claim that scientists

are more receptive to empirical evidence and research than people of faith is questionable. Reactions of today's scientists to innovative ideas and unorthodox views in the area of origins indicate that not much has changed in this area in the past three centuries.

Introduction

In discussions of origins and Christianity in general, the Roman Catholic Church's historical opposition to the heliocentric solar system (i.e., the belief that the Earth and planets revolve around the Sun) is often used to prove the harmful influence of religion on scientific progress. Typical is an editorial in *Omni* that claimed

once a religion becomes politically powerful, it suppresses all "heretical" teachings. Galileo was silenced by the Roman Catholic Church. ... Robert A. Heinlein predicted three decades ago that the United States would be ruled by a religious dictatorship in the twenty-first century (Bova, 1981, p. 6).

A more recent example was an editorial that claimed "Western civilization has progressed since Galileo was branded a heretic for observing that the sun has spots and for daring to adopt a radical new theory that Earth is not at the center of the universe." (Marrison, 2002, p. 10). The Galileo affair may be not only the most quoted example of "persecution" of science by religion, but one of the most misunderstood events in history. An example is the claim by Charles Darwin's great great grandson Matthew Chapman in his book about the Scopes trial:

For supporting Copernican theory in the mid-1600s, Galileo was tried by the Roman Catholic church and put under house arrest for the last eight years of his life. He was not 'pardoned' until 1988 when Pope John Paul II finally conceded that the church had made a 'mistake'. 1988! Over three centuries to concede a scientific point that every man of reason had accepted two hundred years before (2000, pp. 136–137).

Chapman added that Galileo "had been prosecuted by theologians" and then quotes a trial attorney stating "Haven't we learned anything?... Are we to have our children know nothing about science except what the church says they shall know?" (2000, pp. 194–195). The common myths repeated by Marrison and Chapman are in major areas contrary to the historical record. For example, University of New Mexico History of Science professor Timothy Moy concluded that

Unfortunately, Galileo's trouble with the Church later became a popular archetype for the historical relationship between science and religion. Nothing could be further from the truth. For most of the medieval and Renaissance periods, and even stretching into the eighteenth century Enlightenment, the primary supporter of research and teaching in the sciences was the Roman Catholic Church. In fact, one historian of science, John Helbron, has recently published a book entitled *The Sun in the Church* that documents how the Church, in the aftermath of the Galileo affair, continued to promote research into evidence for heliocentrism, even to the point of turning entire cathedrals into giant pin-hole cameras to measure the apparent diameter of the solar disk at various times of the year (2001, p. 45).

The Galileo affair has continued to be a subject of much public interest (Sobel, 1999). Another example is that in 1992 Pope John Paul II officially declared that Galileo was "wronged" by the church and the Inquisition. A review of the historical record shows that Galileo's trial "was not the simple conflict between science and religion so commonly pictured" (Hummel, 1986, p. 116) and that the popular conception of the situation is a myth (Lessl, 1999).

It is widely believed that the eventual acceptance of the heliocentric position was one of the many triumphs of sci-

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Received 9 September 2001; Revised 23 July 2002

ence over religion. This view, immortalized by Andrew White (1955), has been naively repeated ever since (Harris, 1973). White's warfare thesis and work has been thoroughly refuted by many researchers (Brooke, 1991). It is more historically accurate to conclude that, although many Jesuits and other clerics opposed Galileo, the main opponents of the new Copernican position were academicians teaching science in the universities, and that much, if not most, of Galileo's support came from church officials. The distinction between the scientific/academic community and the church was far less pronounced in Galileo's time than it is today. In Galileo's day most European educational institutions were associated with a monastery or other church institution, and professors in Catholic schools often were required to follow the rules set for priests, even having to take vows of celibacy. Nonetheless, academic and clerical roles were often clearly distinguishable, although not totally separate as they usually are today (Livingstone, 1987; Moore, 1981).

From our twenty-first century secular scientific and materialistic perspective, and in view of the atheism generally intertwined with science today, it is easy to dismiss the seventeenth-century controversy as a primary proof of the Catholic Church's antipathy to the results of scientific research that conflicted with religious dogma. Seeger concludes that the Galileo conflict is usually cited as an example of the "supposed warfare between science and theology." In fact, he concludes it is "merely an instance of the perpetual clash between an individual's freedom of thought and society's establishment of authority. ...Conflicts between the individual and society are always taking place" (1981, p. 168).

A Short History of the Heliocentric Revolution

The reactions of seventeenth-century Europeans to the heliocentric theory can be understood only by evaluating the entire situation in its historical context. Throughout history, most civilizations understood the Earth to be a world that existed primarily for their benefit and was the physical center of the Universe. The stars guided them at night and revealed information about their lives, the Sun warmed them and lighted their way, and the rain clouds were created to water their crops.

Until the sixteenth century most of humanity accepted the geocentric worldview, viz. that the Sun, planets, and stars all circled the Earth. The common people took it for granted for generations because it fit a simplistic, straightforward view of the Earth-Sun relationship. Geocentrism was both part of their total worldview and intertwined with their religious beliefs. Few scientists since Aristotle chal-

lenged it, and since Augustine few churchmen had questioned the theory until Copernicus.

It seemed obvious to anyone who had the blessing of vision that the Sun rises and sets, and that the Earth is stationary (Bentley, 1966). Seventeenth-century scientists and non-scientists alike argued that if the Earth moved around the Sun, wind would blow constantly at a uniform speed and intensity (Draper, 1957). If it moves, why do we not feel its movement as we do when we ride a horse? They were not aware that the Earth is blanketed by an atmosphere that moves with the Earth, but compared their experience with traveling on horses to the Earth traveling in space. Also, if the Earth were traveling around the Sun, what prevented everything from flying off, and what prevented the Earth itself from falling into the Sun? Since they had no understanding of centrifugal force or gravity, the new idea was to them blatantly foolish (Walsh, 1911).

Since it was axiomatic that the Sun moves around the Earth, they argued that anyone who denied this obvious fact was wrong. Even today we say "the Sun rises in the East and sets in the West." The Earth's place in the center of the physical and psychological Universe was a belief taken for granted for centuries (Gingerich, 1993). Scientists saw no significant reason to view the Universe in any other way until Copernicus published his *On the Revolution of the Celestial Spheres* in 1530. For years, new astronomical discoveries were altered or interpreted to fit into the established system by elaborate intellectual schemes (Leith, 1973). It was for this reason that it took several generations after Galileo to prove the heliocentric position true (Wallace, 1986).

Although an early sixteenth-century physician probably originated the modern heliocentrism theory, the one first credited with its scientific development was Nicholas Copernicus (Leith, 1973). Copernicus (1473–1543) was a priest, a student of canon law, and, later, a professor of astronomy. His research on the Sun, Moon, and planets eventually culminated in his 1530 work noted above (Nash, 1929). Importantly Copernicus received much support from the church and its popes, especially Clement VII (Hagen, 1908). Cardinal Schonberg and a protestant clergyman, Andreas Osiander, both helped Copernicus to publish his great work (Koestler, 1959). They even arranged for its printing, and the work was dedicated with permission to Pope Paul III (Hoyle, 1973).

At this early date, the opposition was mostly from the academic community. Gingerich (1981) notes Copernicus' book was highly regarded in Lutheran circles and extensively studied throughout their university system. Fear of exposing himself to the ridicule of common people was a major reason why Copernicus' work was not published until shortly before he died. A major reason they opposed the theory was because it proposed a radically new view of the

universe that contradicted the common view of most people.

The Campaign Against Galileo

When Galileo began his crusade for the Copernican position, to his surprise it provoked the ire of many establishment professors. Galileo no doubt reasoned that Copernicus was a respected orthodox scientist who published his work without major problems from the Church (Hoyle, 1973; Kesten, 1945). The problem developed when Galileo's ideas were looked upon favorably by certain influential churchmen and scientists, causing jealousy in many of his rival scientists (Drake, 1957). A major reason for the academic opposition to Galileo was all the various "natural" philosophies, including physics and chemistry, were firmly based on Aristotelianism (Drake, 1980). Many scholars of the time did not value observation, experimentation, or research, a major means of support for Galileo's conclusions (Wallace, 1977; Ronan, 1974). For centuries, many scholars concluded that the basic truths of nature were to be found in Aristotle's writings and those of his learned commentators (Wallace, 1981). Scientific arguments were settled by quoting Aristotle, a geocentrist whose theories of both the universe and philosophy stemmed from geocentricity (Ludwig, 1978). Logical arguments and reason, they believed, were often more to be trusted than were the evidence of one's senses (Santillana, 1955).

The real threat of Galileo to his contemporary scientists was less his position on heliocentricity than his insistence on observation, research, and experimentation to determine reality (Bergman, 1981). It was for this reason that G. A. Magnini, an eminent astronomy professor at Bologna, openly declared that Galileo's observations, which indicated that Jupiter had satellites, must be incorrect (Ronan, 1974). Although the scientific revolution emerged gradually, and many of Galileo's ideas can be traced to before the thirteenth century, Galileo openly challenged the *whole system of determining truth* that existed then, and therein lay most of his problems (Wallace, 1981; Burnam, 1975).

The famous church-Galileo conflict began around 1611, or about 68 years after Copernicus' book was published. The opposition was generated primarily by "... a body of dissident professors at Pisa who ... had allied themselves with a set of courtiers at Florence" (Ronan, 1974, pp. 131–132). Most of the early organized opposition came from the academicians: they were qualified to argue against it, whereas the common people, few of whom were literate, usually could not articulate valid reasons for their opposition (Barbour, 1971). Conversely, Galileo had many powerful supporters both in and outside the church,

a fact that openly infuriated his opponents. Moy notes that Galileo by 1616 had the "support of some powerful liberal theologians, particularly Cardinals Roberto Bellarmine and Maffeo Barberini"—later Pope Urban VIII (2001, p. 44). Some clergy also were very opposed to heliocentrism, and often because of the arguments of the astronomers—and they occasionally tried to use their positions to influence others. Likewise, today many clergy oppose creationism, and their opposition is often based primarily on the authority and power of Darwinists.

To ensure success, Galileo's opposition worked hard to build their case. Although it eventually became apparent that the scientific community's arguments against Galileo's position were not as convincing as they first assumed, Galileo's writings themselves were far less than convincing. Moy concludes that Galileo's 1632 book, which he believed finally proved his case for heliocentrism, did not, but rather:

Galileo's new proof made no sense; it was a cockamamie argument about how the motion of the tides proves that Earth orbits the Sun, and it just doesn't work. When push came to shove (and it did), Galileo simply did not know how to prove that Earth truly moved. Galileo had therefore crossed the line set out sixteen years earlier—he had promoted an idea contrary to Scripture without providing convincing proof of its truthfulness (2001, p. 45).

It is no wonder many of Galileo's critics remained unconvinced. On the other hand, many in the church were anxious for new ideas, and the honors it bestowed upon Galileo made his enemies furious:

They were all jealous of the special treatment Galileo was given [by the church and] of his large salary and of the continual favours bestowed upon him personally by the Grand Duke. In addition, the academics were furious that this braggart of an anti-Aristotelian should be in a position to promote his iconoclastic views (Ronan, 1974, pp. 131–132).

Santillana concluded that during the first half of the seventeenth century

a major part of the Church's intellectuals were on the side of Galileo, while the clearest opposition to him came from secular ideas. It can be proved further ... that the tragedy was the result of a plot of which the hierarchies themselves turned out to be the victims no less than Galileo—an intrigue engineered by a group of obscure and disparate characters in a strange collusion who planted false documents in the file, who later misinformed the Pope, and then presented to him a misleading account of the trial for decision (1955, pp. xii–xiii).

Frustrated at trying to stop Galileo with scientific arguments, his detractors decided that it was much easier to quiet him on grounds of heresy. The church was used by

the academic community to squelch what some academicians felt was a threat to both their method of knowing and their authority. Ronan notes that Ludovico delle Colombe's anti-Galileo faction were

disappointed with the way the argument on floating bodies had gone, [and] decided that it was time to carry the attack on Galileo into court circles, and to shift the emphasis from problems in physics to the far more dangerous ground of religious fidelity. Formal court banquets provided suitable occasions, and one day, when Galileo was not present, the opening salvo was fired by the pious Dowager Grand Duchess Christina who raised the question of the religious orthodoxy of the Copernican view. Unwittingly primed by Boscaglia, the university's strongly pro-Aristotelian professor of philosophy, the Grand Duchess questioned the Benedictine monk, Benedetto Castelli, who was a well-known pupil of Galileo's, asking him whether a moving Earth was not contrary to the Scriptures (1974, pp. 144-145).

In this case the science professors and establishment scholars actually were greater enemies of science than religion. Certain secular astronomers even refused to look through Galileo's telescope to verify his observations, whereas the Jesuit astronomers in contrast were willing to look through his telescope and "saw the phenomena for themselves, were convinced, and turned to honouring and feasting Galileo: after all, was he not Jesuit trained, a true son of the Church, whose fame brought distinction to the Order?" (Ronan, 1974, p. 127). Not only were these Jesuits delighted with Galileo, but also during a visit to Rome he had an audience with Pope Paul III that evidently made such a favorable impression on the Pope that

afterwards church dignitaries vied with one another to do him honour. In brief, the trip was an unqualified success, a triumph for Galileo and his telescope. ... As far as Galileo was concerned, he was overjoyed with the reception he had received; his telescopic observations had been confirmed by the highest astronomical authority in the land; he had the support and friendship of Prince Cesi and, it seemed, the sympathy ... [of] Cardinal Barberini. Church and society were on his side; what more could he ask? (Ronan, 1974, p. 131)

Galileo's main problem, what Santilana called his "fatal mistake," was his

rash indiscretion, his insistence on throwing open to the common people, by writing in the vernacular, a question which was far from being settled ... the proper approach would have been to write elaborate tomes in Latin and then patiently wait for the appraisal of the scholars ... (Santilana, 1955, p. 18).

When Galileo was brought to trial the second time, he was a man of nearly 70, in poor health, and, partly for this

reason, the churches' interference in his life work was actually minor. He had many research interests, most of which he could pursue without problems, and the trial only forced him to regard any findings that directly supported the Copernican system as theory and not fact (Brodrick, 1964; Drake, 1957; 1967; 1974; 1981; 1983). It is also commonly claimed that Galileo was tried and found guilty of heresy. In fact, "Galileo was never charged with nor tried for heresy, as is commonly believed. Heresy was a far more serious offense and carried a much stiffer penalty" (Moy, 2001, p. 45). Galileo was in fact tried and found guilty only of not keeping the agreement he made in 1616 to discuss heliocentrism as hypothetical only until definitive proof was forthcoming. In Galileo's day "no one had yet come up with a convincing proof that Earth really flew around the Sun at great speed, as Copernicus's proposal required" (Moy, 2001, p. 44).

Although the outcome of the second trial hindered him from directly researching heliocentrism, Galileo nevertheless continued to make major discoveries in his many other areas of interest. His last major astronomical discovery made in 1637 proved that the Moon swayed or vibrated as it circled around the Earth. Galileo's defeat was primarily psychological, although it is true that some branches of the Catholic Church later attempted to suppress his heliocentricity work. And, as is quite clear from the literature, the reasons for suppression included the opposition of major portions of academia against Galileo and his ideas.

Ironically, the Catholic Church's response probably encouraged many people who otherwise would not examine the heliocentric view, and as a result many eventually accepted it. Although the heliocentric revolution had begun with Copernicus, most universities still taught geocentricity years after Galileo died (Spielberg and Anderson, 1987). When Harvard was founded in 1636, the faculty remained "firmly committed to the Ptolemaic theory." The facts reviewed here are widely known among science historians. An article published in a journal that is openly hostile to the religious worldview concluded that:

While scholars have (naturally) been unable to come to a consensus on why Galileo was tried by the Inquisition, almost all historians agree that it was *not* primarily because Galileo believed in the Copernican heliocentrism (Moy, 2001, p. 43 emphasis in original)

The Major Sin of the Catholic Church

The Catholic Church's major sin was probably capitulating to the pressure from the scientific community, certain Jesuits and other enemies of Galileo. Only as a result of pressure from the secular establishment and the Aristotelian

philosophers did the Catholic Church firmly side against Galileo (Himmel, 1986). An important factor in the controversy over heliocentrism was the matter of how to interpret the Scripture's descriptions of nature in harmony with the authority of factual observations about nature. The struggle was "a complex power struggle of personal and professional pride, envy and ambition, affected by pressures of bureaucratic politics" (Himmel, 1986, p. 116).¹ Galileo rightly understood that natural theology and divine revelation could not be in conflict. He reasoned that God could not say one thing in His Word and something else in "His natural revelation," the natural world. If there is a discrepancy, it must lie with our understanding or interpretation of either the natural world or God's revelation, and this means more research, study, understanding, and patience (McMullin, 1988). It also means we should not reject scripture for human interpretations of our currently limited scientific data. Science books that are only a few years old are commonly found to be wrong or misleading in the light of new research.

The Catholic Church was by no means innocent, but in fact was guilty of much repression and persecution of dissidents, including various Protestants, Jews, and others who dared to disagree with it. The scientific community, though, also has been historically guilty of much persecution of its dissidents, heretics, and even its most promising sons (Brewster, 1841; Nash, 1929). And science may be even more guilty than some religionists (Walsh, 1911).

Examples of the Same Problem Today

The same problem still exists today, and many mainline Church leaders are again making the same mistake that they made in Galileo's time by siding with the secular establishment and supporting evolutionary naturalism (Johnson, 1995; Moore, 1979). They have again rejected Galileo's "Book of Nature" concept and elevated nature not only to a god status, but to the creator as well.

The orthodox science position is that the creation created itself and that natural law only is responsible for, and can fully explain, the existence of everything in the Universe. Many prominent opponents of creationism and even intelligent design today are theologians (Numbers, 1992). Editorials such as in the secular humanist magazine, *The Free Inquirer*, commonly claim that the evolutionists' strongest allies are the clergy. Many modern denominations may again be proved wrong for defending a belief system that is both without empirical foundation and intellectually bankrupt. History may also again condemn religion for once more siding with the scientists:

Today many churches and theologians have great respect for natural scientific conclusions. Sometimes they suppress ideas they would espouse in the ab-

sence of those conclusions.... But holding unwarranted respect for all things scientific is dangerous. It was ever so: when Greek science became widely available in the West in the thirteenth century, it eventually helped to provide theologically dogmatic answers to the great cosmological questions. Will modern theologians and churches adopt uncritically modern natural scientific ideas concerning origins and order and convert those ideas to theological dogma today? (Maatman, 1994, p. 181).

The history of the university reveals that the academic community not uncommonly has been, and still is, intolerant of dissonant views (Bergman, 1993). Once convinced of the righteousness of a cause, educated persons sometimes are more vehement in suppressing opposition than their less-educated brethren. It is no accident that Hitler arose, and the Holocaust occurred, in a country that had a higher educational level and a greater percentage of Ph.D.'s than any other nation in the world. With very few exceptions, academia supported Hitler's tyranny and policies (Morse, 1968).

Kindness, compassion, and love for one's fellow humans are not a prerequisite to earn a Ph.D., and the highly intelligent often are stereotyped as sadly lacking in these qualities. Few universities encourage the development of these traits, and many probably suppress them. Higher education often exposes one to other cultures and peoples, and may increase tolerance in these areas, but it does not always increase tolerance for a diversity of ideas. All too often education indoctrinates those in its care in a certain worldview, and for this reason college graduates have re-

¹One reviewer of this paper stressed that I should add that Galileo tried to defend heliocentrism to Catholic theologians by arguing that Biblical scholars should take into consideration well-established facts about the world from science as they interpret Scripture: "The Catholic Church at the time did not generally appreciate the now well-understood concept of phenomenological language in Scripture. Scripture describes events as they appear to an observer on Earth. To take scripture to be a literal precise description of the actual processes involved (like scientific theories) fails to interpret Scripture as it would have been understood by the original readers. In general, this was not appreciated in Galileo's day by the church, and is still a concept rejected even today by today's geocentrists. The Catholic Church's sins included they gave too much credence and authority to Aristotelian philosophy and did not have an adequate approach for interpreting Scripture. This made them unable to accept important new discoveries. Although they also capitulated to pressure from the scientific community, I would view that as more of a symptom of the problem and not the root problem."

markably similar views on a wide variety of social questions, from abortion to zoophilia, from gun control to religion (Robertson, 1981). In our age of almost worship of the science enterprise, it is quite possible that a more accurate view of reality will be dismissed simply because it does not conform to some body of scientific opinion. And the view often most at issue is religion:

In research universities, "the religious people keep their mouths shut ... And the irreligious people discriminate. There's a reward system to being irreligious in the upper echelons." Stark suggest that perhaps more NAS members are religious than think it politic to admit (Larson and Witham, 1999, p. 91).

Censorship of professors and ideas has been with us for a long time, and is still very much with us today. Gruber's extensive study concludes that the problem of suppressing minority views in science—or those that were considered threatening to the existing social order—was historically common in

virtually every branch of knowledge, repressive methods were used: lectures were proscribed, publication was hampered, professorships were denied, fierce invective and ridicule appeared in the press. Scholars and scientists learned the lesson and responded to the pressures on them. The ones with unpopular ideas sometimes recanted, published anonymously, presented their ideas in weakened forms, or delayed publication for many years (1981, pp. 203).

These practices are still true today. Max Planck, after discussing his revolutionary work that concluded energy, like matter, exists in units or quanta, stressed: "It isn't a matter of the strength of the arguments. It's a matter of the old scientists dying off" (quoted in Durden-Smith, 1981, p. 91). Before an article is published in a scientific journal, it must be approved by a board of reviewers or *referees*. The valid requirement to select work of high quality not uncommonly results in excluding unorthodox or new theories, blurring the distinction between refereeing and censoring. Rejection of a scientific paper because it disagrees with one's personal opinions is common, and sometimes a new journal is founded because of such incidents. Professor Bateson, when serving as a referee, once rejected a paper submitted by Karl Pearson and his colleagues who responded by founding a new journal called *Biometria* as an outlet for their articles.

Unfortunately, many ideas in science are at first seen as "fringe" or pseudo-science. One very efficient strategy for insuring that certain ideas are not seriously discussed in scientific circles (much less gain acceptance) is for critics to label them "pseudo-science" before they are examined carefully. This often insures that they will not get a fair hearing. Pomeranz found that acupuncture, administered by his co-worker to anesthetized animals, caused neuron

cells to no longer fire for about twenty minutes. Pomeranz became extremely interested in acupuncture and pain. Unfortunately, though, Pomeranz found it was difficult to interest others in his research to the extent that he

has had grant applications turned down for work on "acupuncture," only to have them accepted the following year for "peripheral electrical stimulation"—in effect, the same thing, as almost all acupuncture involves the use of electrical charges. He has had to combat the skepticism of his peers by using 10 control groups in an experiment where one would be more usual. Though his more conventional work has appeared in *Science*, the most prestigious of the American scientific journals, he has yet to publish a single paper there on acupuncture and its effects. "In fact, they've never taken one paper, however highly reviewed," he says, "that didn't knock acupuncture." (Durden-Smith, 1981, p. 91).

Even highly qualified scientists have difficulty publishing if their ideas are too controversial. One of the most eminent modern astronomers, the late Fred Hoyle, lived for many years "almost in exile from the scientific world community" (Overbye, 1981, p. 69). A founder of a major research institute at Cambridge University in 1967, he was widely considered one of this century's most creative, published (and controversial) astronomers.

After study and pondering the origin of life problem for some time, Hoyle concluded that conditions on Earth were never such that life could have originated naturally here. His problems stemmed not so much from his new theories, which he admitted had problems, but from questioning some of the older scientific theories that have become sacred such as the spontaneous generation of the first form of life. Hoyle concluded that "Heavy government funding of science is the mainspring of a degeneration of science into conformity. The system has a natural evolution towards killing minds" (quoted in Overbye, 1981, p. 72).

His research led him to postulate that if life arose naturally, it must have "originated in space and migrated to Earth aboard comets" or similar means (Overbye, p. 69). Hoyle also got into trouble for questioning the Big Bang hypothesis, the theory that matter, energy, space, time, and the laws of physics flung themselves into being "like a party girl popping out of a cake." Hoyle concluded: "It seemed absurd to have all the matter created as if by magic" (Overbye, p. 70).

Although he was recognized as a highly influential thinker in astronomy and was knighted by Britain's Queen Elizabeth II in 1972 for his contributions, conflicts with colleagues over his conclusions became so great that he was forced to leave Cambridge in 1971 (Maddox, 2001, p.270). Yet, one well-known astronomer admitted he did not believe "there have ever been any victories against

Hoyle" (Overbye, 1981 p. 72). The long term editor of *Nature* John Maddox stated that

only last year came the book *A Different Approach to Cosmology*, by Hoyle, Geoffrey Burbidge and Narlikar, published by Cambridge University Press. This is a scholarly rather than a polemical work, in that it is a well-documented guide to extragalactic evidence against the Big Bang (a term, incidentally, intended to be derisive, that was coined by Hoyle himself in a broadcast lecture of 1952). My own conviction is that Hoyle's scepticism was well-founded. But it is too soon to tell how the Big Bang will be replaced by some other cosmology. That is heterodoxy. Soon after *A Different Approach to Cosmology* appeared, I asked one of Hoyle's former colleagues if he'd read it. "Wouldn't waste the time," was the reply. The hope must be that civility will break out among Hoyle's enemies now that he is dead (2001, p. 270).

Maddox adds that Hoyle and three colleagues published in 1957 in *Reviews of Modern Physics* a "classic paper now known affectionately as B²FH. Fowler won a Nobel prize for his work. Hoyle, shamefully, did not" (2001, p. 270).

Francis Crick, likewise a Nobel Prize winner and one of the most eminent living scientists, also has voiced heresy. Like Hoyle, Crick feels that the conditions never were appropriate on the Earth for the self-formation of life, and thus also has hypothesized a panspermia theory (Crick, 1981). Niles Eldredge, who himself has been under fire because he has questioned the slow, gradual Darwinian evolution and advocates in its place a form of the punctuated equilibrium theory, stated that

Crick's book strikes me nothing short of a disaster. To be sure, poorly written books by eminent scientists abound, and ... Crick has every right to hold—and publish—any idea he wants, however odd it may seem. But in science, ideas for which there are few ways to test, for which there is virtually no accumulated corroboration, and which address phenomena for which there are simpler hypothesis, usually do not command book-length treatment (1981, p. 94).

Did Crick also encounter difficulties in obtaining grant money and publishing his views as a result of this book? Some people feel this book, at the least, tarnished his reputation. One may experience difficulties publishing in a refereed journal, but sometimes can publish in the open market, although even best-selling authors such as Velikovsky have experienced problems (Bloch, 1975). Velikovsky's main thesis is the major events in the history of Earth and other planets have been dominated by catastrophism rather than uniformitarianism (Goldsmith, 1997). He correlated these proposed catastrophes with world events, including those mentioned in the Bible. Gardner notes that the first response of many scientists to

Velikovsky's work, led by Harlow Shapley of Harvard University, "was one of rage," and a

flood of indignant letters to the publisher from scientists who threatened to boycott the firm's textbooks, led to the dismissal of the associate editor who brought the manuscript to the company's attention. Publication rights were turned over to Doubleday. ...which has no textbook department ... (Gardner, 1957, pp. 28–29).

Block noted after *Worlds in Collision* was published in 1950, "a modern classic case of academic demagoguery" followed:

Scientists and scholars who supported Velikovsky's thesis—and even those who simply defended his right to be heard—were shouted down. Some, like astronomer Gordon Atwater and Macmillan editor James Putnam, were summarily dismissed from their positions. Favorable reviews of the book were killed before their publication, to be replaced by fervent attacks on 'irresponsibility' in the publishing industry. All too frequently, these attacks were written by scientists who admitted that they had not read *Worlds in Collision*, while those who had read the book grossly misrepresented the author's position and ignored or distorted his evidence. The book's publisher, Macmillan, came under such pressure in the academic community that it was forced to transfer the publication rights to Doubleday, even though at that time the book had been 20 weeks on *The New York Times* best seller list (1982, p. 929).

The 1950 meeting of the American Association for the Advancement of Science set up a "theory-censoring board" to prevent publication of what in their judgment was "the wrong kinds of science books" such as those that openly support creationism or Biblical ideology. One difference is that Galileo has largely been vindicated by science, while the jury is still out on many of Velikovsky's ideas. This is precisely the point: it is easy to condemn or censor ideas that seem wrong, but few condemn those whose ideas seem correct. Therefore, those whose ideas seem wrong are the scholars in need of protection.

Although Velikovsky's work is still very controversial, some claim that certain of his predictions have proved correct, and his ideas are no less fantastic than some of those proposed today by other, more mainline catastrophists such as the theory of dinosaur extinction proposed by Luis and Walter Alvarez (see Alvarez, 1997). Velikovsky engaged in a written debate with Albert Einstein right up to the latter's death in 1955, and although Einstein "accepted Velikovsky's evidence of recent catastrophes," he was adamant that certain other of his ideas were wrong until

just a few days before he died, Einstein learned that radio noises had been detected from Jupiter, he offered to use his influence to arrange other experi-

ments on Velikovsky's behalf. Albert Einstein died with *Worlds in Collision* open on his desk (Bloch, 1982, p. 931).

The major reason for university terminations today is not incompetence, but rather conflicts between the fired professor and his or her colleagues based on differing beliefs and opinions about academic or political/cultural matters (Bergman 1980; 1993).

Hoyle is not the only modern eminent astronomer who has suffered a fate that in many ways is worse than that of Galileo. Linus Pauling, who has the rare distinction of earning two Nobel Prizes, likewise dared to oppose the scientific community. Finding it difficult to obtain grant money for his research, he was forced to set up his own foundation so he could support his research from public contributions (Gardner, 1991). Horgan concluded that "science today is locked into paradigms. . . and if you try to get anything published by a journal today" that contradicts the orthodox paradigm chances are "the editors will turn it down" (1995, p. 47).

Significance of the Galileo Case for Science

Religion has no monopoly on intolerance. Intolerance is a characteristic of imperfect humans and a trait that all of us must work assiduously to overcome. Testifying today against Darwinism can result in death threats, as has happened to Fred Hoyle's colleague, Chandra Wickramasinghe (threats that, according to the March 1982 issue of *Discover* magazine, the police took "very seriously.") Isaac Asimov concluded that if a

heretic is himself a scientist and depends on some organized scientific pursuit for his living or for his renown, things can be made hard for him. He can be deprived of government grants, of prestige-filled appointments, [and] of access to the learned journals (Asimov, 1977, p. 7).

Today, more than ever before, we must realize that in experimental science ideas should be silenced *only* by empirical evidence that comes from experimentation and replication (Redondi, 1987; Langford, 1965). Since origins science is at its core, history, and not directly based on empirical, laboratory science, much speculation is involved. It is unfortunate for science that there is not more tolerance in this area in the twenty-first century.

Reports of terminations and other problems in academia based on religious beliefs now abound in the literature, forcing one to ask, "Have things changed much since Galileo?" The answer is, probably not very much. Harvard's Owen Gingerich concluded that "...scientific censorship, remains in our world today, and it may well be far more effective and insidious than in the seventeenth cen-

tury" during the time of Galileo (1981, p. 60). Sir Fred Hoyle in an introduction to one of his books concluded:

The popular belief is that the Copernican Revolution and the inquisition of Galileo are things of the past. Human societies, it is claimed, have progressed beyond the stage when such outrages could happen again. In this book we show that the Copernican Revolution is far from over, and that society has not improved since the sixteenth century in any important respect. If anything the situation may have got worse, with the successes of the Industrial Revolution conferring upon human beings a degree of arrogance not seen before (1993, p. 1).

The fact that many science heretics are proved wrong and fade into oblivion does not justify the persecution often meted out to science innovators. Asimov warned that in science the insiders or professionally trained scientists, what he calls endoheretics, are "sometimes right, and since startling scientific advances usually begin as heresies, some of the greatest names in science have been endoheretics" (Asimov, 1977, p. 12). This is proving true, even today. And as is true in the current creation-evolution controversy, Darwinists have worked hard to gain support from both the clergy and the common people. Although many clerics also opposed Galileo's position, they were critical of him and his work for reasons having nothing to do with religion (Schirmacher, 2000; Gerard, 1908). They, too, were part of the zeitgeist of the time, and as is also true today in the Darwinism controversy, many clerics went along with the conclusions of the academic establishment.

Acknowledgments

I want to thank Bert Thompson, Ph.D.; Clifford Lillo, M.A.; Ernie Johansson, Ph.D., and John Woodmorappe, M.A and two anonymous reviewers for their comments on an earlier draft of this article. The conclusions in this article are the author's alone and the reviewers do not necessarily share them.

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Book Reviews

Boltzmann's Atom by David Lindley The Free Press, New York. 2001, 260 pages, \$24

Just a century ago, many scientists rejected the concept of atoms. Ernst Mach (1838-1916), for example, rejected atoms because they could not be directly seen. Ludwig Boltzmann (1844-1906), in contrast, promoted atomic theory since atoms nicely fit his theoretical research on gases. Still today there is ongoing, good natured tension between experimental and theoretical physics, although the existence of atoms is now clear.

Boltzmann is of interest to creationists since he pioneered the understanding of the Second Law of Thermodynamics. His classic paper in 1877 gave the statistical definition of entropy, the universal tendency in nature toward disorder. Neither author Lindley nor Boltzmann apparently understood the conflict between the Second Law and evolutionary progress. In fact Boltzmann became a promoter of the new ideas of Darwin. Boltzmann's words: "The overall struggle for existence of living beings is...a struggle for [order], which becomes available in the flow of energy from the hot sun to the cold earth" (p. 225). As we know today, raw energy without intricate processing brings only further disorder, not order. Boltzmann was on good terms with the outstanding theoretician and creationist

James Clerk Maxwell (1831-1879). The book gives intriguing details about several personalities. For example, Maxwell wrote poetry, often used humor, and he spoke with a strong Scot accent. Boltzmann was a pianist, father of five, and was a poor lecturer. Maxwell was a theist but Boltzmann apparently was not.

Boltzmann did not have a happy life. He was afflicted by *neurasthenia*, a term of his day for depression and anxiety. He finally took his own life by hanging. This sad practice of suicide was popular in Vienna around 1900. The author makes an important general statement concerning faith: "There comes a time when circumstances are so hard that muddling through doesn't work any more. Then one has to fall back on reserves of inner strength, on principles or beliefs. And if there are no such principles or beliefs, perhaps death begins to seem the only option" (p. 223). A eulogy for Boltzmann by Ernst Mach took another direction. Mach concluded that, in view of the intense rivalry over ideas between scientists, "the surprising thing was perhaps that cases such as the unfortunate death of Boltzmann did not occur more often" p. 218). In other words, he was surprised more scientists didn't kill themselves!

There is one additional view of Boltzmann's life and death. I believe he understood deeply the meaning of the Second Law, and lacking an understanding of its theological connection with the Curse, depression and futility naturally followed. Written on Boltzmann's tombstone in

Vienna is his classic statistical expression for entropy or disorder, $S = k \log W$. Boltzmann's death itself was an ultimate expression of this law.

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***Creation, the Flood and Historical Dating* by John G. Read
Apocalypse Press, <http://apocalypsepress.com>. 2002, 206 pages, \$13**

Author Read, not to be confused with geologist John K. Reed, is a retired aerospace scientist/engineer. He is to be commended for sharing his thoughts on creationist geology and astronomy. Ten pages and photos describe wrong-order rock strata. These include the Keystone and Lewis Overthrusts. Twice as many pages critique radioisotope dating, mainly the problem of discordant results. Fully half the book discusses the chronologies of Egypt, Judean kings, and the life of Christ. Unfortunately, the astronomy discussion is weak. Read believes the universe may be

much smaller than we assume (p. 77). He also prefers the geocentric view of an unmoving earth (p. 84). Read suggests that there was an original tenth planet, the special domain of Lucifer (p. 127). This planet was later destroyed to produce the asteroid belt, craters throughout the solar system, and intense radiation that helped preserve fossils during the Flood. A future edition of this book would be improved by including an index.

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***Resurrecting Genesis* by John R. Hadd
Dorrance Publishing Co., Inc., Pittsburgh, PA. 2002, 240 pages, \$24**

Author Hadd completed a career of Federal government policy service. He has studied the creation-evolution debate for over three decades. This book is well written and attempts to "challenge ... orthodox Darwinism without surrendering to fundamentalist creationism" (cover).

Four distinct approaches to origins and history are defined: materialistic evolution, theistic evolution, progressive creation, and young-earth creation (p. 103). Hadd lists three "problems" with the young-earth view as favored by the CRS (p. 103). First is the literal interpretation of Genesis 1. Second is the young age view itself, thousands of years instead of billions. Third is reliance on the Genesis Flood for reshaping the entire earth's surface. The book is somewhat confusing since Hadd thoroughly and correctly debunks radioisotope dating, a mainstay of old-earth thinking. He also describes in detail the tremendous tectonics which accompanied the Flood. An ark made of reeds is promoted as described by David Fasold (p. 79). It is unclear whether Hadd prefers a local or global Flood.

The author holds to the progressive creation view. He believes that God orchestrated many animal/plant creations and extinctions over eons of time before mankind's appearance. The reason, Hadd says, was to provide man-

kind with object lessons (fossils) on the stewardship of life on earth (p. 66). This view is rather strange, that animal extinctions somehow teach the importance of life. In response, Hadd writes "No human being...has any place attempting to dictate strategy to the Creator" (p. 98). Hadd has simply been forced into this position of multiple animal extinctions by the progressive creation stance.

Much detail is given to cataclysmic events in earth history. These include interactions with other planets and the theories of catastrophists Isaac Vail, Immanuel Velikovsky, and Donald Patten.

Several valuable appendices are provided. Ten pages are given to the Williamsburg Charter, a 1998 document which promotes religious liberty. Fifty pages are given to *Commentary* reprints of David Berlinski articles which challenge evolution and the big bang. Also included are 32 follow-up letters which appeared in *Commentary*, both for and against Berlinski.

The reader may not agree with author Hadd's viewpoints but the information is nicely laid out and is challenging.

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Dust Storms From the Sub-Saharan African Continent: Implications For Plant and Insect Dispersion in The Post-Flood World

Carl R. Froede Jr.*

Abstract

Modern large-scale dust storm events provide an excellent analogy for understanding the global dispersion and repopulation of floras and insects in a post-Flood world. Through recent studies of dust storm outbreaks in western China and the sub-Saharan African continent, scientists have discovered that considerable amounts of soil and organic materials can be transported across vast regions in short periods of time. Some of the latest studies addressing massive dust storm events and their impact on the Western Hemisphere have come from the African continent.

Many dust storms today originate from the sub-Saharan African continent. The magnitude of these events is dependent upon several factors, including; storm intensity, prevailing wind patterns, and the size of the desert across which the winds blow. Tremendous volumes of dust and organic materials can be incorporated into individual dust storm events. This material can be transported across the Atlantic Ocean in a matter of days. To-

day, there is ongoing research into the effects that African dust storms have on the Western Hemisphere.

The Bible speaks of wind as a transport for insects and animals (accomplishing the will of God) in the books of Exodus and Numbers, so the idea of windborne transport of plants and animals should not seem foreign to the Jew or Christian. Large-scale dust storms can help the young-Earth creationist understand how the planet could be rapidly transformed from a relatively barren place to one covered by vegetation and insects. In order to do this there must be fertilized seed, a means of transport, and insects to work the new plants. All three of these factors can be supplied by a single large-scale dust storm. Modern African dust storm events provide possible insight into how the post-Flood world could have been rapidly vegetated in a manner that does not require the transportation of seed-bearing plants *only* via post-Flood ice age land bridges or water transport.

Introduction

Dust has probably existed since the creation of the heavens and the Earth. We read in Genesis Chapter 2 that "God formed man of the dust of the ground." The topic of dust has gained recent popularity with the release of an interesting book on the subject by Hannah Holmes (2001). The world's vast desert environments have been studied to better understand the interrelationship of wind, sand, and dust (Breed and Reheis, 1999; Brookfield and Ahlbrandt, 1983; Greeley and Iversen, 1985; Péwé, 1981; Pye, 1987, 1993). Dust storm events linked specifically to the African continent have also been studied and reported (Morales, 1979).

Large-scale dust storms have only recently been investigated scientifically although knowledge of these events

spans thousands of years. Uniformitarian scientists believe that historically, dust storms on the African continent were more prevalent during glacial periods when the climate was more arid, rather than wet interglacial periods (Bowles, 1975; Parmenter and Folger, 1974; Pokras and Mix, 1985). Significant accumulations of quartz (derived from the African continent) in offshore sediments has lead to the conclusion that trade winds were at higher intensities during the Pleistocene (Kolla, Biscaye, and Hanley, 1979). Today's dust storm outbreaks are related to Sahelian droughts (Prospero and Nees, 1977). Soil/dust source areas can be traced to areas where deserts are expanding and strong storm fronts stir the upper ground surface that incorporates the dust within it. As these storms grow in size and strength, they increase their carrying capacity. Many of these storms have sufficient intensity to carry their loads across large bodies of water (i.e., Atlantic and Pacific Oceans) and drop their sediment and organic loads on continents in other hemi-

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Received 10 December 2002; Revised 10 January 2003

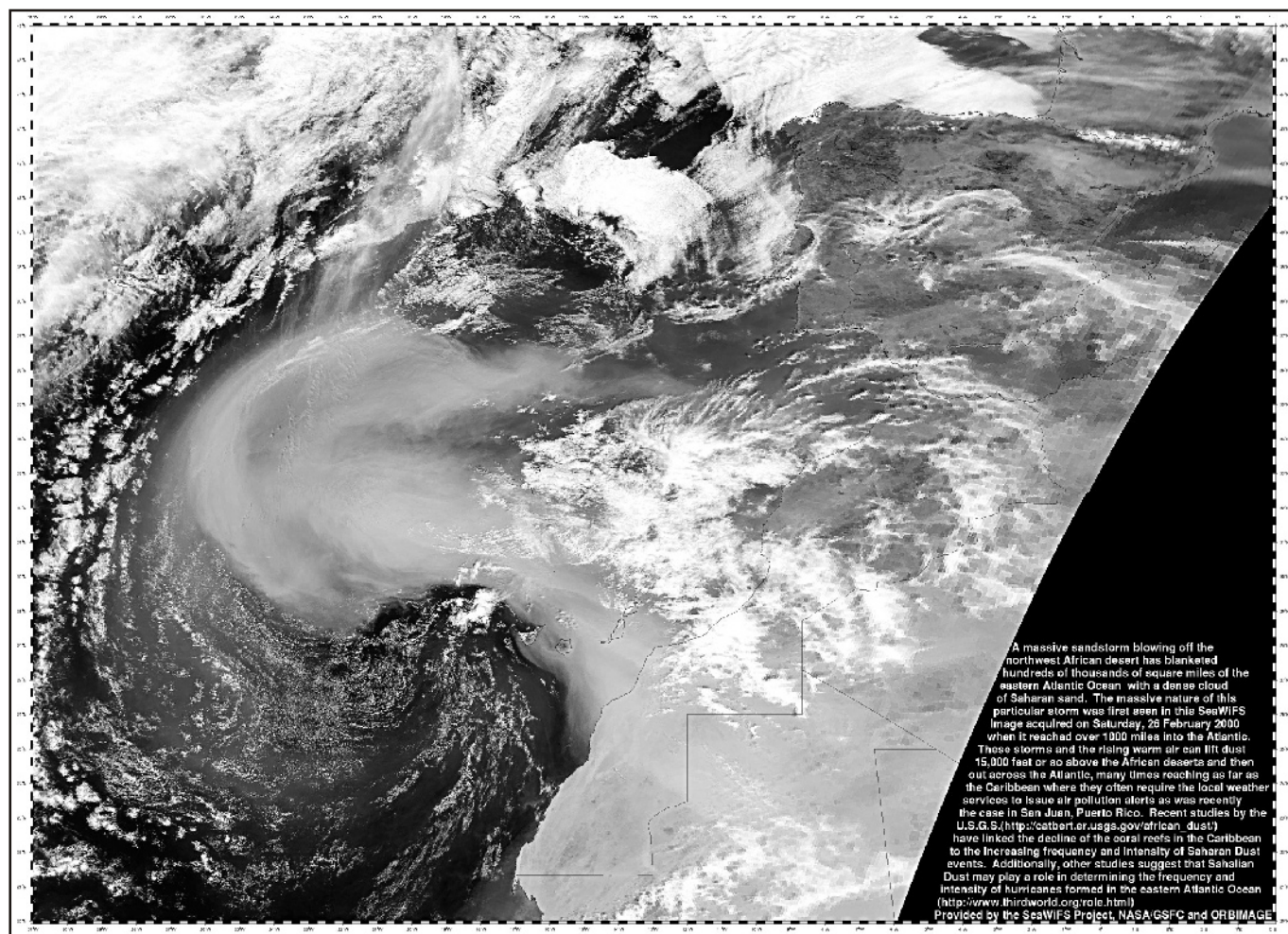


Figure 1. A massive sandstorm blowing off the northwestern African desert has blanketed hundreds of thousands of square miles of the eastern Atlantic Ocean with a dense cloud of Saharan sand. The massive nature of this particular storm was first seen in this SeaWiFS image acquired on Saturday, 26 February 2000, when it reached over 1000 miles into the Atlantic. These storms and the rising warm air can lift dust 15,000 feet or so above the African deserts and then out across the Atlantic, many times reaching as far as the Caribbean. Provided by the SeaWiFS Project, NASA/GSFC and ORBIMAGE. (Text modified from NOAA image).

spheres. Plant seeds along with potentially corresponding insect communities can appear overnight from a storm event thousands of miles away.

African dust storm events have recently become the focus of several investigations in an effort to determine their impact on the Western Hemisphere (Griffin, Kellogg, Garrison, and Shinn, 2002; Prospero, 2001; Swap, Ulan-ski, Cobbett, and Garstang, 1996). Unmanned satellite imagery (Chiapello, Prospero, Herman, and Hsu, 1999) as well as images obtained from the orbiting space shuttle (Apt, Helfert, and Wilkinson, 1996) reveals the tremendous volumes of sediment being transported across the Atlantic Ocean. This influx of dust across the Atlantic impacts both people and the environment, and it likely has done so since sometime following the Flood. This process yields interesting possibilities in understanding the spread of plants and insects in a post-Flood world.

African Dust Storms

African dust storms have likely occurred at two separate periods in Biblical history. The first was following the Flood, before the landmasses were covered in vegetation, and the second was in our Present-Age Timeframe (Froede, 1995; 1998) when the Saharan desert formed of sufficient size to yield considerable dust for separate storm events. However, only recently have scientists discovered the timing of these events, the soil/dust transport process, and its effect on our society in the Western Hemisphere.

Dust storms occur when strong fronts sweep across the region of sub-Saharan Africa lifting dust derived from top-soil along with other available organic matter. The magnitude of these events is dependent upon several factors, including; storm intensity, prevailing wind patterns, and the size of the desert across which the winds blow (Figures

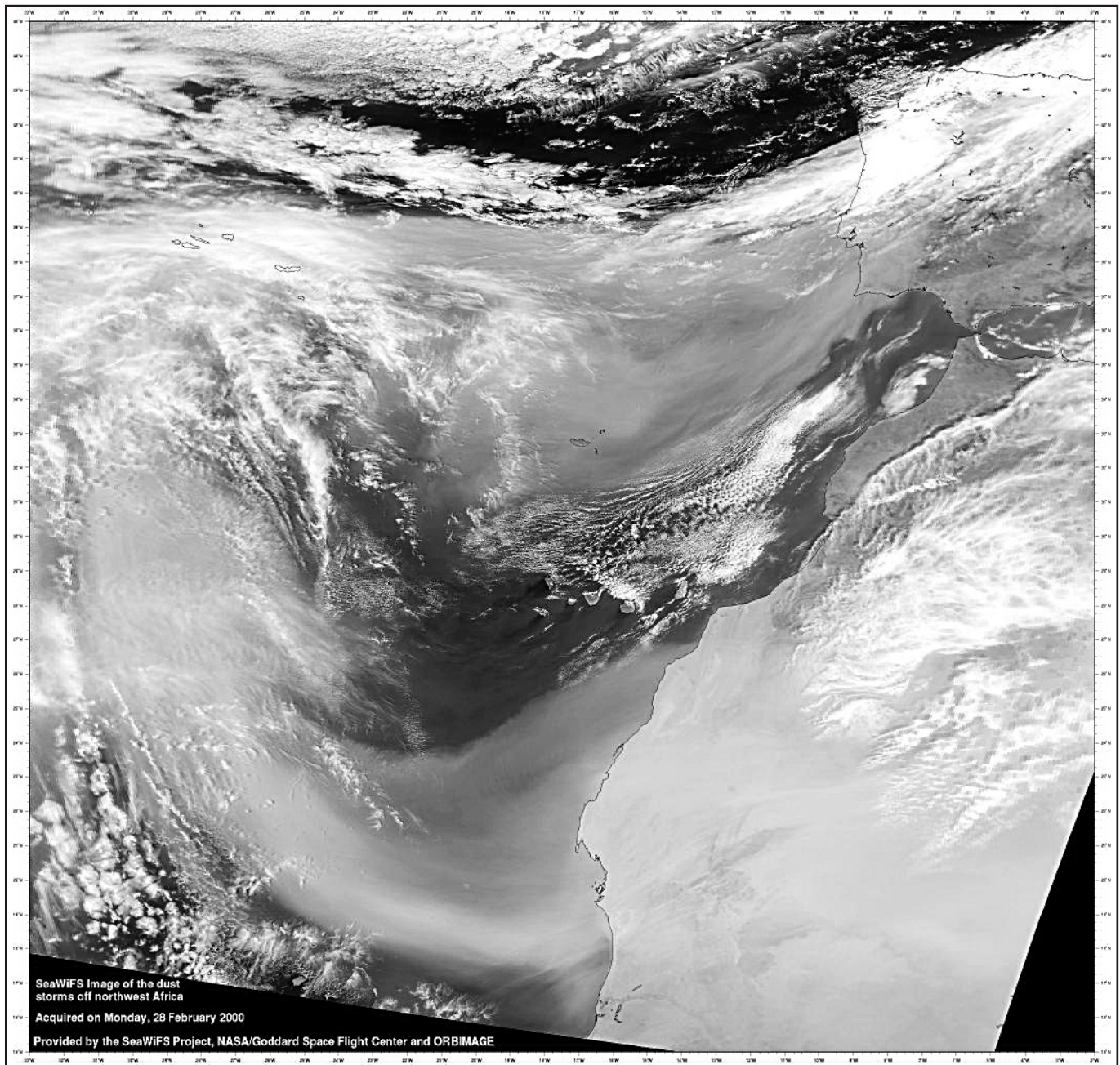


Figure 2. SeaWiFS Image of the dust storms off northwestern Africa. Acquired on Monday, 28 February 2000. Provided by the SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE. (Text from NOAA image).

1, 2, and 3). With a large storm, both dust (Glaccum and Prospero, 1980; Perry, Cahill, Eldred, Dutcher, and Gill, 1997; Prospero, Bonatti, Schubert, and Carlson, 1979; Prospero and Nees, 1986; Rognon, Coudé-Gaussen, Revel, Grousset, and Pedemay, 1996) and insects (Ritchie and Pedgley, 1989; Rosenberg and Burt, 1999) can be lifted to great heights (up to 15,000 feet) and transported great distances.

Airborne dust studies on Barbados since 1965 have identified the African continent as a significant source of dust (Delany, Delany, Parkin, Griffin, Goldberg, Rei-

mann, 1967; Prospero, 1968). Studies indicate that 25 to 37 million tons of dust are transported through the longitude of Barbados each year—a volume sufficient to maintain the present rate of pelagic sedimentation across the entire equatorial North Atlantic (Prospero and Carlson, 1972). Saharan dust is known to be deposited across portions of South America (Prospero, Glaccum, and Nees, 1981), and has been identified as an important soil component in the Amazon Basin (Swap, Garstang, Greco, Talbot, and KDillberg, 1992). Saharan dust has also been identified as the parent material for soils developed in the

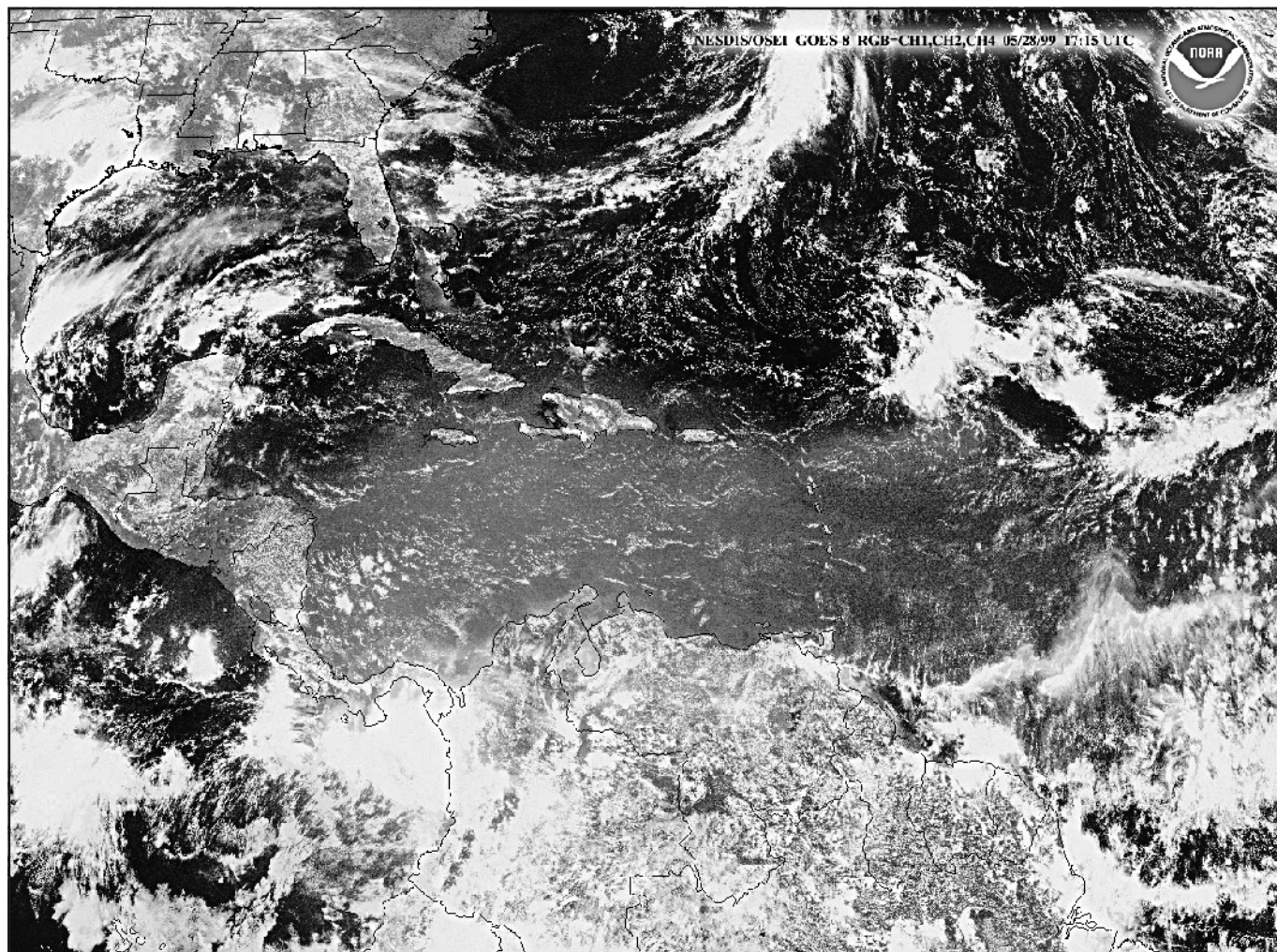


Figure 3. Airborne dust over the Caribbean Sea. This dust originated in the Sahara Desert of western Africa where it was lifted and carried off the coast by strong winds. (Text modified from NOAA image). NOAA GOES 8 satellite image dated May 28, 1999.

islands of the Caribbean and western Atlantic (Foos, 1991; Muhs, Crittenden, Rosholt, Bush, and Stewart, 1987; Muhs, Bush, Stewart, Rowland, and Crittenden, 1990).

Recent studies indicate that contaminants entrained within the African dust storms have caused coral reef die-off in the Caribbean Sea (Shinn, Smith, Prospero, Betzer, Hayes, Garrison, and Barber, 2000; Smith, Ives, Nagelkerken, Ritchie, 1996). The fungus *Aspergillus sydowii* derived from African dust is killing the coral reefs in both the Caribbean and the Florida Keys (Holmes, 2001) [Figure 4]. Pollution has also been identified in rather high concentrations within dust storms, but the pollutant levels are tied to the sources of the dust, so that the contamination levels vary for each dust storm (Griffin, Garrison, Herman, and Shinn, 2001; Griffin, Kellogg, and Shinn, 2001; Prospero, 1999).

The iron found within dust has been documented to stimulate diatom/plankton production where it falls on the open ocean (Duce and Tindale, 1991; Jickells, 1999). Other minerals in dust also appear to enhance the growth

of microscopic marine life. Recent documentation has revealed a direct link between African dust storms and the outbreak of red tides (Appendix).

Clearly, tremendous energy is involved in lifting and transporting all of this material across the Atlantic Ocean during storm events. Presently, large dust outbreaks continue to come from the sub-Saharan desert on a seasonal basis.

Wind Transport in the Bible

The Bible (all scriptural references from Morris, 1995) is not mute when it comes to the issue of windborne transport of insects and other animals. The first reference of wind as an agent of animal displacement comes from Exodus, chapter 10:

v. 13 And Moses stretched forth his rod over the land of Egypt, and the Lord brought an east wind upon

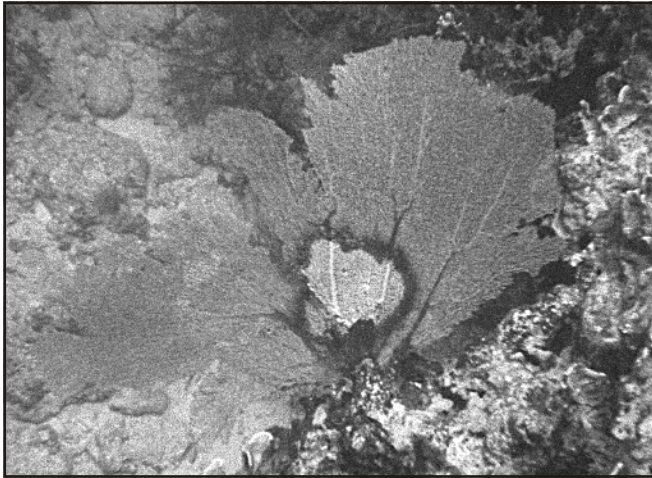


Figure 4. A sea fan dying from the fungus *Aspergillus sydowii* in the Florida Keys.

the land all that day, and all that night; and when it was morning, the east wind brought the locusts.

v. 19 And the Lord turned a mighty strong west wind, which took away the locusts, and cast them into the Red sea; there remained not one locust in all the coasts of Egypt.

Later, when the Jews were wandering in the wilderness, we read from the book of Numbers, chapter 11:

v. 31 And there went forth a wind from the Lord, and brought quails from the sea, and let them fall by the camp...

Reference to windblown dust comes from Psalm 18:42:

Then did I beat them small as the dust before the wind...

Possible Implications to the Post-Flood World

The post-Flood world must have been a barren place until plant life began to cover the ground surface. The spread of seed-bearing plants was likely rapid and not dependent on human migration. Today's African dust outbreaks provide us with a means of understanding how plants and insects could be spread around the world in a rapid manner. The physical translocation of other small creatures (e.g., birds) is also possible as a result of this type of storm event.

The islands of the Bahamas are many hundreds of miles from any continent. They are of rather recent origin, but contain an abundance of plant and insect communities. Even during the Ice Age, the islands were sufficiently isolated by deep water to prevent the formation of land bridges connecting them to continents. Obviously, the plants and animals are not native to the islands, rather transplants from other locations. Insect nest traces (Figure 5) are all that remain of what are thought to be digger wasps that inhabited the islands in a former time (Curran

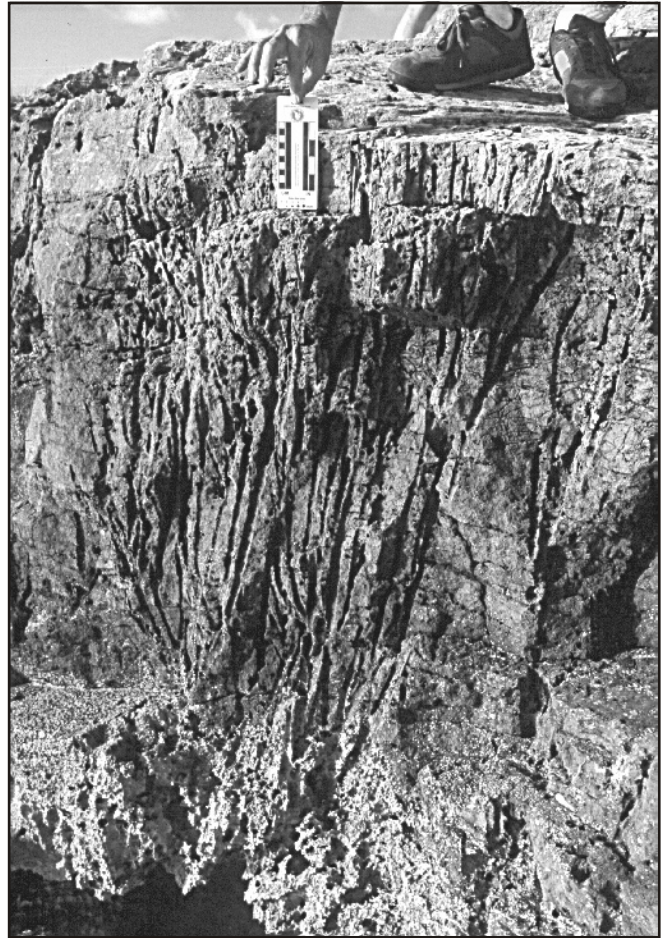


Figure 5. Digger wasp insect traces exposed on the shoreface of an Holocene eolianite on San Salvador Island, Bahamas. The outcrop faces the Atlantic Ocean. Scale in inches and centimeters.

and White, 1987; Curran, 1997). Their origin is likely from the African continent, transported to San Salvador Island, Bahamas thousands of years ago. Plants indigenous to the African continent also occur on the island, but it is unclear how many can be attributed to man or trade winds.

The author has observed terra rossa soils ranging in composition from pink tinted carbonates to red clays (Figure 6), from San Salvador Island, Bahamas to the northern Florida Keys. While some scientists have speculated that the iron is derived from the weathering of the limestone (Isphording, Bundy, George, and Jackson, 1995), there remains little doubt that the majority of terra rossa soils identified in the Caribbean are derived from African dust.

Conclusion

Large-scale African dust storms provide the energy necessary to transport dust and organic materials for vast distances—even across the Atlantic Ocean. The Caribbean

islands have likely long been impacted by African dust storms. As a result, some of the plants and animals thought indigenous to the islands actually have ancestors on the African continent.

These massive African dust storms provide an excellent analogy to likely events in the Ice Age and lower Present Age Timeframes (Froede, 1995; 1998). Plants and animals would have been exposed to large-scale storms during this period of Earth history as climate changed following the Flood (Oard, 1990). Insects and seeds would have been scattered globally by winds. The end result would be a planet rapidly populated by plants and insects.

Appendix

Dr. E. A. Shinn has an excellent website that reviews the damage that African dust is having on the coral reefs in the Caribbean. I recommend that the interested reader review the information provided at: http://coastal.er.usgs.gov/african_dust/satellite.html. Information regarding microbial contamination associated with African dust can be found at the following NASA websites: http://science.nasa.gov/headlines/y2001/ast18jun_1.htm and <http://www.gsfc.nasa.gov/gsfc/earth/toms/microbes.htm>. African dust has recently been linked to red tide events in the Gulf of Mexico, for more information visit the following website: <http://www.gsfc.nasa.gov/topstory/20010824redtides.html>.

Acknowledgments

I thank the many donors to the Creation Research Society Research Fund, interest from which financed a portion of this study. I thank my wife Susan for allowing me the time and opportunity to research and write this article. I also thank Dr. Emmett Williams and Mr. Jerry Akridge for their helpful comments. Any mistakes are my own. Glory to God in the highest! (Prov. 3:5–6).

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Figure 6. A paleosol layer attributed to African dust on Providence Island, Bahamas. The dust accumulated and was buried under migrating (now lithified) oolitic sands. The scale (in inches and centimeters) is at the paleosol level. Paleosol layers like this one have been found throughout the Bahamas and in some of the northern Florida Keys.

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Book Review

Tracks in the Sea by Chester G. Hearn
McGraw-Hill, New York. 2002, 278 pages, \$25.

This is the story of Matthew Fontaine Maury who first mapped the world's ocean currents. Maury (1806-1873) was raised in Virginia and joined the U.S. Navy in 1825. For fifteen years he sailed the seas and reached lieutenant rank. On October 17, 1839, however, Mary's life changed suddenly. His femur was shattered in a stagecoach accident near Somerset, Ohio. The injury eventually healed but Maury's seafaring days were over. A godly man, Mary prayed "for the understanding and the grace to accept his fate" (p. 81).

The accident began a new career direction for Maury which eventually saved countless thousands of lives. He was troubled by news of ships which became lost, suffered long delays because of contrary winds and currents, and which collided with rocks, reefs, or other craft. Maury suspected that there were predictable ocean currents which could provide maps and safe travel lanes. In the first oceanography textbook ever written, *Physical Geography of the Sea* (1855), author Maury attributed his insights to Psalm 8:6-8, "Thou madest him to have dominion over the works of thy hands... and whatsoever passes through the paths of the seas." Chester Hearn, author of the book under review, apparently does not grasp the Christian worldview of Maury. Maury's childhood is described as an endless and dreary routine of Bible memorization (p. 27). For a more positive, excellent overview of Maury's spiritual life, see Meyer (1982).

Maury gathered worldwide ocean current data by analyzing over one million readings (p. 194). He then drew detailed maps which were of immediate use to sailors. Several of the maps are included in this book, and the maps are still widely used today. Maury soon became a leading

national figure. In 1840 he first suggested startup of the U.S. Naval academy in Annapolis, Maryland. Maury declined nomination for Secretary of the Navy, and instead he became the first Superintendent of the Naval Observatory in 1844. His research work expanded to include charts for weather, islands, shoals, the Gulf Stream (p. 104), and observations of sea creatures.

Maury's sea charts gave the fastest course to follow for each month of the year for various destinations. For example, Maury's suggested ocean route from Boston to Rio Janeiro reduced travel time by half, from 72 days to 35 days. Next Maury charted the Atlantic Ocean depths to aid in the laying of communication cables between the U.S. and Europe. As the U.S. Civil War approached, Maury sided with the confederates. He resigned from the Naval Observatory and helped the South develop several warships. After the war Maury fled the country for a time with a price on his head, becoming a citizen of Mexico. Eventually Maury was welcomed back to the U.S. where he helped begin the National Weather Service (p. 242). His final years were spent at the Virginia Military Institute. Mary's life was highly productive and carried a Christian testimony from start to finish. He is an outstanding example of a Christian creationist scientist.

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Photo Essay

Lichens: A Study in Color

(A VanAndel Creation Research Center Report)

George F. Howe and Mark H. Armitage*

Lichens and Aesthetics

The beauty and appeal of lichen colors to humans is not merely incidental or accidental in the nature of things. The late Walter Lammerts, world-renown rose breeder, saw the Creator as a God of love Who provided the various plants and animals not only for man's physical well-being but for his emotional and aesthetic enjoyment. Mute testimony favoring this is the pleasure experienced when viewing a rock that is decked with variously colored lichens (Figures 9 and 10). Poets frequently refer to the beauty and charm observed in the living world. Nina L. Marshall confirmed the aesthetic quality of lichens by quoting the following poem without noting its author, who may have been Marshall herself:

Upon this herbless rock a small gray lichen
Did fix her home. She came with meek intent,
To bless her stern and sterile place of rest;
And presently her gentle sisters followed,
Some vestal white, and some in robes of brown,
And some in yellow vestures, labouring all
At the same work, with tiny cups held out
To catch the raindrops, and with mattocks small
To pierce the rock. And well did they effect
Their destined purpose. (Marshall, 1910, p.12)

Different lichens growing on rocks at the VanAndel Creation Research Center (VACRC), Chino Valley, AZ., have been examined and photographed. At the rear or eastern edge of the VACRC property and on an east-west ridge along its north side, are some rather large areas of hardened lava boulders called Hickey Basalt which are covered by a patchwork of many species of lichens and one moss. The colors of four of these lichens will be discussed and illustrated here. For background information concerning lichens in general consult Howe and Armitage (2002).

VACRC Lichens and Their Colors

Xanthoparmelia is a gray-green foliose lichen with large thallus lobes that can be easily removed from a rock with a knife (Hale, 1979, pp. 39-40; States, 1990, pp. 213-214). These lichens can be seen best in Figures 1, 2, 3, and 4 but

are also visible in several other photographs. The greenish-gray color of this and many other lichen species is a result of:

the fact that a bright green plant [the alga] is covered by a translucent white plant [the fungus]...A magnified portion of a dissected lichen very much resembles a tangle of fine white threads in which are scattered bits of green. (Marshall, 1910, p.23)

But gray-green is not the only color of lichens at VACRC or elsewhere:

Lichens can be white, black, or various shades of red, orange, yellow or green...

Colors are due to the accumulation in the thallus of various pigments, often different lichenic acids. (Doyle, 1965, p.29)

Xanthoparmelia lichens we have studied are seen together in Figures 1, 2, and 10 where their colors can be contrasted. The lemon yellow-colored crustose lichens seen in Figures 1, 2, 5 and 6 are *Acarospora* sp. and Hale described it as:

...one of the most conspicuous crustose lichens, giving a yellow hue to the whole mountainsides. (Hale, 1979, p.32)

Concerning *Acarospora*, States noted that:

Few lichens form such widespread colonies on rock surfaces... whole hillsides and cliff faces in the hot southwestern desert are "painted" with this showy lichen..." (States, 1990, p. 208)

One lemon-yellow to orange-yellow substance present in the lichen genus *Acarospora* is a tetronic acid derivative called rhizocarpic acid, which is a methyl ester of the amino acid L-phenylalanine (Hale 1961, p. 56; Hale 1967, p. 107).

Candelariella is a dull orange-colored lichen (Figures 1, 2, 9, and 10) that in shape and crustose form superficially resembles the lemon-yellow *Acarospora*. Its orange hue results from a polyphoric acid derivative called calycin (Hale, 1961, p. 56; Hale, 1967, pp. 106, 107). Perhaps the widespread growth of this lichen or of other orange-colored lichen species is what inspired the great essayist John Ruskin to write:

Far above among the mountains the silver lichen spots rest, starlike, on the stone; and the gathering orange stain upon the edge of yonder western peak reflects the sunsets of a thousand years. (Marshall, 1910, p. 3)

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The most striking color among the lichens at VACRC is the bright red-orange of *Caloplaca*. It is seen on Figures 1, 2, 9, and 10. *Caloplaca* is a crustose lichen and it owes its bright red hue to anthroquinone molecules produced by the lichen (Hale 1967, p. 130).

Growing in cracks and more shaded areas with the lichens is a hardy moss *Grimmia* (Figures 7 and 8). Recently a thorough review of mosses in light of the creation view was published in CRSQ (Bergman, 1998).

Shielding by Lichen Acids and Pigments

Lichens contain lichen acids and other lichen substances, which have been put to many human uses. Much has been written about possible roles these variously colored lichen substances may play in the life of lichens themselves. They are known to increase the opacity of the upper portion of the thallus (cortex) where they are usually deposited, and this may provide a measure of shielding from the sunlight for the lichen algae. *Trebouxia*, the alga most commonly present in various lichens, has been shown to photosynthesize best at light intensities far below those of full sunlight and hence:

Trebouxia would have a better chance of survival in a highly isolated xeric habitat if protected by opaque hyphae. (Hale, 1967, p. 119)

Auxiliary Photosynthetic Pigments?

Antranorin is one of the lichen colored substances, and researchers found that it:

...acts as a fluorophor emitting fluorescence at a peak of 425 mμ, coinciding with the absorption spectrum of chlorophyll. (Hale, 1967, p.119. 425 mμ = 425 nm)

Hale further suggests that atranorin and other colored lichen substances may reradiate light in very useful wavelengths to nearby algae in the lichen, thus enhancing their photosynthetic efficiency (Amadjian, 1967, p.114).

Protection? Allelopathy?

Workers have speculated that perhaps the pigments and other lichen substances serve to protect the lichen from being overrun by invading bacteria and fungi (Hale, 1967, pp. 17-21). Supporting this view is the knowledge that many lichens contain compounds, which produce an antibiotic effect on microbes: "More than half of the lichens investigated have antibiotic properties" (Stern, 1997, p. 340). As Amadjian (1967, p. 114) pointed out, however, the role of lichen substances keeping down the growth of microbes inside lichens seems exaggerated because there are "...luxuriant populations of microorganisms and insects which inhabit thalli.."

Perhaps these lichen compounds play a part in preventing lichen colonies from being overrun by mosses and other plants, a subject called allelopathy which we have reviewed in an earlier paper (Howe and Armitage, 2002).

Bad Taste

Certainly the lichen pigments are among the compounds that make lichens distasteful to humans such that "...The bitter substances within many thalli, although nonpoisonous, irritate and inflame the digestive tract of humans" (Amadjian, 1967, p. 118). Thus, people use lichens as a food only during times of starvation. Even so, lichen compounds do not prevent all predation on them because the Caribou, for example, consume the *Cladonia* lichen of the tundra as a major food source.

Many lichen substances are deposited either in the cortex (upper portion) or in the medulla (lower section) of a lichen with a high degree of consistency (Hale, 1967, p. 118). Examples of substances routinely deposited only in the cortex, where the algae are present, include pigments such as anthroquinones, tetronic acid derivatives, and usnic acid. Most substances called depsides and depsones, however, are secreted only into the medulla. "Pigments usually occur only in the upper cortex, rarely in the medulla. Most of the colorless compounds are deposited in the medulla" (Hale, 1961, p. 54).

The possible benefit of such a segregated secretion pattern (colored pigments in the cortex, colorless lichen substances in the medulla) can be seen in lowering the light intensities for the algae in the cortex. It is not difficult to enlist this selective distribution as strong evidence supporting design.

Which Partner Determines Production of Lichen Substances?

There is a distinct problem in ascertaining which partner (the fungus or the alga) is responsible for making the lichen substances. Lichen fungi, cultured apart from their algae, cannot produce the diphenyl substances such as the depsides and depsidones;

...most lichen fungi do not produce in culture the same compounds that they do in the lichenized state (Amadjian, 1967, pp. 44-45)

But lichen fungi can produce the monocyclic precursors such as orsellic acid. When cells of the alga *Trebouxia* are grown in culture by themselves, they also are unable to produce the diphenyl compounds. Because the isolated lichen fungi cannot yield the diphenyl molecules, this suggests that the algae are perhaps involved in the coupling of the monophenyl substances into diphenyl molecules. Therefore, the solution of the problem seems to be that lichen acid production results from the mutual physiologi-

cal interaction of the alga and fungus because neither one of them can form the acids independently when cultured alone (Bessey, 1971, p. 219). The combined roles of fungus and alga in this task fits squarely with the belief that lichens are created life forms which have a fungus that was "preadapted" for life with its given algal partner. In an evolutionary scenario, coordinated interactions like these are glibly ascribed to the usual inadequate mechanism: the slow working of natural selection on mutant genes. In either origins scenario, scientific problems remain:

One major unsolved problem in lichenology is the failure of isolated mycobionts to produce in culture the same chemical compounds they produce in lichen associations, (Amadjan, 1967, p. 54).

Possible Future Research

Possible projects for workers to pursue on lichens at VACRC or elsewhere would concern how the lichen actually produces soil: chemically, physically or a little bit of both? What role do the hair-like rhizines play in soil formation? What features of the Hickey Basalt rock make it a choice habitat these four lichens and many others?

Lichens and Spontaneous Generation

In years gone by, life was believed to have arisen rapidly from non-living substances by "spontaneous generation". Marshall found an earlier reference to this ancient belief as it was applied to lichens:

The belief was general that they [lichens] were spontaneously generated. In them the philosopher found the origin of plant life. "Spontaneously, inorganic stone became living plant!" Dr. Hornschuh wrote in 1819, "algae, lichens, and mosses may develop without seed from decomposing water. The decomposition of water induced by warmth and sunlight gives rise to the common ancestral type of algae, lichens, and mosses. The ancestral type is a vegetable infusorium known as monas lens which, when acted upon by light and air, undergoes an evolutionary transformation into algae, lichens, and moss." (Marshall, 1910, p. 22)

Lichens and The Fossil Record

This early form of spontaneous generation was soundly refuted by the experiments of Louis Pasteur. But the same mechanism, supposedly operating at a slower rate, has been propounded by top level biologists for over 50 years to account for the origin of the first living cells. Recently Bergman showed that these evolutionary efforts to give scientific support for the origin of life by chance billions of

years ago have been spectacularly unsuccessful (Bergman, 2000).

One lichen worker speculated that the present day lichen-rock interface is comparable to the proto-soils that developed on the earth's surface "before the emergence of vascular land plants about 420 million years ago" (Lee, 1999, p. 19). Thus Lee believed that lichens originated well before 420 million years ago and that early lichens may have produced the first soils that then prepared the way for land plant evolution.

Some years ago filamentous microfossils that were assigned an evolutionary age of 2 billion years were "...considered to be early lichens but nowadays this appears unlikely" (Purvis, 2000, p. 46). Purvis further noted that the "oldest" undisputed lichen fossil, known as *Winfrenatia reticulata*, is believed to be only 400 million years old, being found in the Rhynie chert, to which evolutionists have arbitrarily assigned this date. Granting all these speculative dates for the purpose of discussion, a serious problem for evolution still remains. Lichens would have made their first appearance in the fossil record 20 million years after the early land plants for which they are assumed to have produced the essential ancient soils!

Fossils are themselves of little help in tracing the steps of the supposed evolution of lichens as Purvis noted:

Normally, fossils tell us about the early history of a group, but neither lichenized nor non-lichenized fungi are well preserved in the fossil record, so we know little about the earliest lichens (Purvis, 2000, p.46).

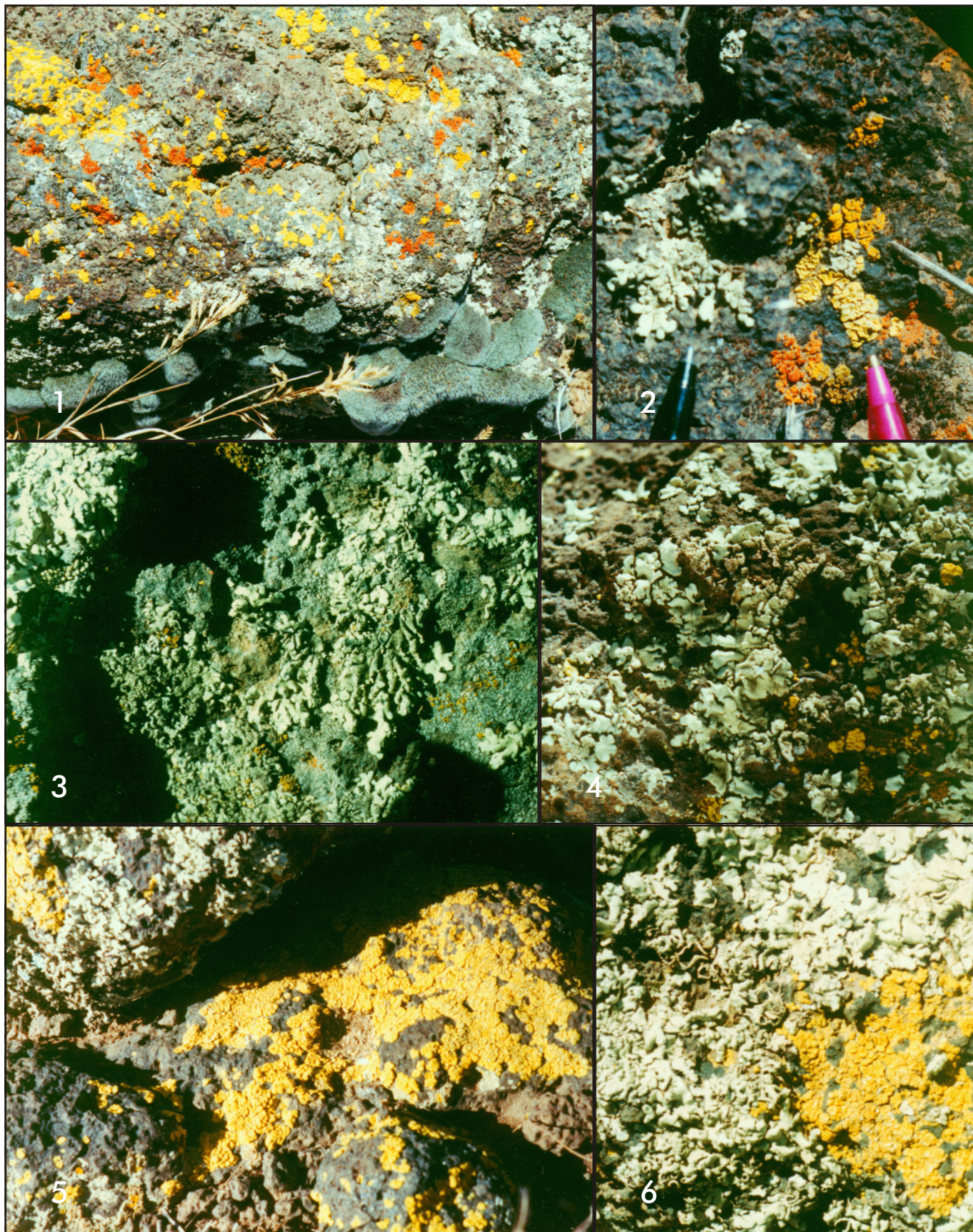
Although Assumed to Be Ancient, Lichens Possess "Advanced" Fungi

Another problem facing an evolutionary account of lichen origins is that while they are generally assumed to have arisen very "early", preparing the way for land plants, their fungi, of the Ascomycota division are highly "advanced" or complex:

... recent molecular studies provide no support for the idea that lichens living today are "ancient" compared with other fungi. In fact, Lecanorales, the order to which lichens belong, is likely to be a relatively advanced group of ascomycetes. (Purvis, 2000, p. 47)

One might assume that negative evidence such as the above would cause evolutionists to search for alternatives or at least to admit that their theory is itself problematic. Such is not usually the case; one worker has in fact rationalized the conundrum as follows:

Of course, this evidence does not mean that lichen-like associations were not among the first to conquer land, but if they were, present day lichens





are not likely to be their descendants (Purvis, 2000, p.47).

Considering the problem of the origin of life itself, the puzzling lichen fossil record, the evidence for intelligent design in lichen pigments, and the probability that lichens are polyphyletic (Howe and Armitage, 2002), it looks like there is a “biotic message” (see ReMine, 1993) telling us clearly that a very intelligent Creator produced many separate kinds of lichens without recourse to macroevolution. Biologists would all do well to heed this message before more valuable time and resources are wasted in attempting to bolster the deficient evolutionary “mechanisms.”

Acknowledgments

We express thanks to the One who produced the fascinating little plants we call lichens and made them in such a way, that by simply studying them, we can draw closer to Him! The authors alone are responsible for the contents of this photographic essay, but we gratefully acknowledge the help of the following people in various phases of manuscript preparation: Emmett Williams, John Meyer, Eugene Chaffin, Stephen B. Austin, and Bobbi Blade. We also express thanks to those who have contributed to the CRS Research Fund and to the VanAndel Creation Research Center Fund, interest from which has helped support various phases of this study. We gratefully acknowledge the skillful help of an anonymous lichenologist who identified these four lichens for us to genus level from our photographs.

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Figure Captions

Figure 1. All lichens and mosses covered in this report are visible in this photograph. The colors are gray-green (*Xanthoparmelia* and others), lemon-yellow (*Acarospora*), orange-yellow (*Candelariella*), bright orange-red (*Caloplaca*). The moss below is *Grimmea*.

Figure 2. The four VACRC lichens—a closer look. From left to right, the black pen points to *Xanthoparmelia*. Above the stick is *Caloplaca*. Above the red pen is *Acarospora* and the stick at the right points to what is most likely *Candelariella*.

Figure 3 This photograph shows *Xanthoparmelia* (the gray-green foliose lichen) at the left and all over the rock at right center.

Figure 4. The foliose nature of *Xanthoparmelia* is visible here on the thalli, which cover the Hickey Basalt rock.

Figure 5. In the center is a large colony of the lemon-yellow *Acarospora* while the upper left gray-green is *Xanthoparmelia*.

Figure 6. A closer view of the lichen *Acarospora* at right (center) shows how its crustose thallus is subdivided into many sections. *Xanthoparmelia* thalli at the left manifest the cup-like ascocarp bodies (dark centers with gray-green borders).

Figure 7. A mound of the moss *Grimmea* is seen here together with a dime for perspective. The moss “cushion” is composed of miniature gamete-producing plants (“gametophytes”) each of which is a stalk with tiny leaf-like phyllodes attached. The orange-brown objects barely visible below the dime are spore-producing organs called sporangia (see caption of Figure 8.) Unlike lichens, mosses produce embryo plants and are not a symbiotic union of algae and fungi.

Figure 8. A close-up view of the same moss *Grimmea* shows the many green gametophyte plants that make up the moss cushion. About 30 of the tiny spore cases (“sporangia”) of the moss plant are visible randomly, and the hole at the top of each sporangium is visible. It is through each of these openings that moss spores are

released. Spores then can grow to produce new gametophytes.

Figure 9. This piece of basalt is plastered with the four lichens being studied along with others too. The red orange band from left to right across the center is *Caloplaca* and above it is a crest-shaped colony of the orange-yellow *Candelariella*. The light yellow *Acarospora* and the gray-green *Xanthoparmelias* can be seen at the far right.

Figure 10. A close up view of the upper right region of the same rock seen in Figure 9 shows the color difference between two lichens, which superficially resemble each other. The yellow-orange crest at left-center is *Candelariella* as contrasted with the lemon-yellow *Acarospora* visible as three or four small thalli at the upper right, surrounding a colony of the gray-green *Xanthoparmelia*.

Book Review*

The Battle for the Beginning By John MacArthur

W Publishing Group, a Division of Thomas Nelson, Nashville, TN. 237 pages, \$22

The Battle for the Beginning, touches on issues, which can be summed up by John MacArthur's observation: "Naturalism has now replaced Christianity as the main religion of the Western World. And evolution has become its principle dogma." (p.11) He supports this observation in his first endnote (p.223) where he documents the fact that Michael Ruse, an evolutionist who claimed that creationism is a religion while Darwinism is science in his testimony at the *McLean v. Arkansas* trial, now admits he was wrong, acknowledging that evolution is grounded in unproven beliefs, no more scientific than the beliefs on which creationism is based. (See Tom Woodward, "Ruse Gives Away the Store: Admits Evolution is a Philosophy." For those with Internet access, log onto <http://www.origins.org/real/ri9404/ruse.html>.)

Based on exegetical sermons he has preached after much study on this subject, MacArthur states: "Therefore my approach in this book will be simply to examine what the biblical text teaches about creation [...] I don't intend to get into in-depth scientific arguments related to the origin of the universe. Where scientific fact intersects with the biblical record, I will highlight that. But my chief aim is to examine what the Bible teaches about the origin of the universe and then to look at the moral, spiritual, and eternal ramifications of biblical creationism to see how it relates to people in today's world." (p.29) "To put it simply," he writes, "evolution was invented in order to eliminate the God of Genesis and thereby to oust the Lawgiver and obliterate the inviolability of His law." (p.25)

With incisive clarity Dr. MacArthur exposes the fallacies not only of evolution and the worldview it promotes, but also of the various attempts by even thinking Christians to reinterpret Scripture to accommodate the old-earth thinking of the Naturalist. He demonstrates the faulty hermeneutic of the framework hypothesis which he exposes as a "view [...] set forth by liberal theologians of the nineteenth century [...] adopted and propagated by some leading evangelicals, most notably Dr. Meredith G. Kline of Westminster Theological Seminary." Describing its destructive method of interpretation, he observes, "The framework hypothesis is the direct result of making modern scientific theory a hermeneutic guideline by which to interpret Scripture." (pp.20-21) He also exposes in detail the fallacies of the old-universe, progressive-creationist teachings of the astrophysicist, Dr. Hugh Ross. (pp.57-65) Dr. Ross, who is considered by many to be evangelical, is founder and director of his ministry, "Reasons to Believe," which actively deceives by mixing a leaven of false doctrine with the truth.

The Battle for the Beginning exemplifies proper biblical hermeneutics, letting Scripture interpret Scripture, as Dr. MacArthur presents a day-by-day analysis of Genesis 1:1-2:3. He then analyzes Genesis 3:1-24, describing the event and consequences of the Fall, "Paradise Lost," and the assured, guaranteed, and promised blessings from the curse to all who truly accept the redeeming grace of Christ's righteousness. Easy to read, properly documented, and well indexed, this book should be read and circulated widely and kept for reference in every library.

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*This review is published by the permission of the Creation Study Group, P.O. Box 1674, Greenville, SC. 29602. It appeared in their newsletter, Number 54, June 2002.

Postdiluvial Soil Formation and the Question of Time Part I—Pedogenesis

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Abstract

Many believe that most soils require great periods of time to form. This argument has been used in an attempt to refute the Bible's claims for a global flood only a few thousand years ago. In addition to arguments based on formation of extant soils, many geologists or paleopedologists see evidence of multiple fossil soil horizons or paleosols in the geologic record. Few, if any, of these researchers have examined carefully the assumptions behind their arguments. In this paper, we define soil, examine the

commonly recognized soil-forming factors, analyze the limitations of the soil-forming factor approach, and describe the complex interactions of environmental factors and soil-forming mechanisms. Arguments for the necessity of great spans of time for pedogenesis are summarized, along with their underlying assumptions. The results indicate that data from soil science are compatible with a diluvial view of earth history.

Soil Defined

Isn't soil just dirt? Although most people have noticed differences of color, texture, and horizon formation in soils, many have never thought about just what a soil is. One of us, a geologist and engineer, has repeatedly raised the ire of his coauthor by referring to soil as "overburden." (He, in spite, refers to bedrock as "underburden.") *Soil* is defined very differently by agriculturalists, engineers and geologists (Hunt, 1972, pp. 152,153). To define *soil* seems very simple until one delves into the subject. Like other fields of study, the seeming simple soon becomes intricate, a reflection of the complexity of the cosmos and the infinitude of its Creator. This complexity often necessitates succinct, technical terms. We have employed only such terms as we consider necessary for accuracy and completeness and have included a glossary at the end of this paper for those readers not familiar with some of these terms.

Soil scientists generally define soil edaphologically, i.e. soil is the natural rooting medium of plants (Brady, 1974, p. 1). This is understandable, since soil fertility is vital to agriculture upon which all of us depend. Typically this means that *soil* extends to a depth of less than two meters from the surface, even though the sedimen-

tary deposit may extend much deeper. "Pedology [the study of soils] considers the soil as a natural body and places minor emphasis on its immediate practical utilization" (Brady, 1974, p. 6). To geologists and engineers, soil is any surficial, unconsolidated sediment or collection of mineral grains and other solid particles (McCarthy, 1988, p.1). Thus, from a geologic perspective, *soil* may extend to depths of tens or even hundreds of meters. The geologic/engineering definition treats soil as a category of sedimentary deposit or a result of *in situ* weathering. It does not necessarily recognize development of features distinctive to *soil forming processes* which affect the suitability of the material as a rooting medium. Tarbuck and Lutgens (1984, p. 125) define soil as "...a combination of mineral and organic matter, water, and air." Blatt, Middleton, and Murray (1972, p. 254) define soil somewhat ambiguously as unconsolidated earth material marked by the presence of soil horizons and the direct influence of organic matter. According to Selley (1976, p. 54), it is "...that part of the weathering profile which is the domain of biological processes. Soil consists of rock debris and humus" Characteristic layering distinguishes "soil" from underlying regolith: an organic rich and biochemically weathered upper layer, abundance of organisms, more intense weathering, and characteristic horizontal layering (Brady, 1974, p. 8). Olson (1981, p. 1) defines soils as "...discrete bodies produced by interactions of climate, vegetation, and surficial geologic materials" Some of these definitions exclude

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Received 10 October 2002; Revised 19 November 2002

unconsolidated, surficial earth materials where biologic processes are minimal (e.g. Antarctica).

Soils definitions and soil taxonomy have been and continue to be areas of debate. Early definitions were largely genetic, "...whereas in 1938 the emphasis was explicitly on zonal pedogenesis, with classification being derived from it, by 1975 the emphasis was almost entirely classificatory, with zonal pedogenesis being implicit at best" (Paton, Humphreys, and Mitchell, 1995, p. 9). Lavkulich (1969, p. 26), in a rather ponderous but comprehensive definition, includes the requirement that soil forming factors have acted over time to differentiate the soil from the parent material, a definition which places pedology in the domain of history rather than science. What Paton, Humphreys and Mitchell refer to is the shift toward scientific (i.e. objective, descriptive) soil classification criteria and away from an unscientific (i.e. subjective, genetic) approach to soil science. There are good reasons for this (Retallack, 1993, p. 1635), but Paton, Humphreys, and Mitchell (1995, p. 9) decry it:

The continuing belief by a considerable number of pedologists that, by using this approach of more precise definition in soil classification, a better pedogenic model would eventually emerge reflects a belief in induction. This means that objective and unbiased conclusions can only be reached by measuring and describing what is encountered without having any prior hypotheses, or preconceived expectations. This viewpoint had been decisively repudiated as long ago as the middle of the nineteenth century, when it was shown to lead to an intellectual impasse and one moreover that no scientist had followed.

They are right insofar as rationalism or positivism is implied. They are wrong insofar as they address induction as an *element* in the scientific method, Popper and others notwithstanding (Klevberg, 1999; Malcolm, 1997; Reed, 1998; 2000a). Zonal pedogenesis, with its emphasis on degree of maturity, was inherently unscientific. Changes in

Generalized Soil Profile		
O _i		Horizon of undecomposed organic matter.
O _e		Organic horizon of partially decomposed organic matter (O _i and O _e usually absent on prairie soils.)
A _p	A	Surface mineral horizon which has an accumulation of well decomposed organic matter which coats the mineral particles and darkens the soil. A _p is used when surface layer is plowed. Granular structure common.
	E	Subsurface horizon which has lost organic matter, clay, iron, or aluminum through eluviation (or other processes) with concentration of resistant sand and silt-sized particles. Platy structure common. Not common in prairie soils. More often found in forested soils.
		B _w — Nontransitional mineral horizon characterized by:
		1. Development of color contrast, blocky or prismatic structure, or both.
		2. No apparent illuviation.
B _w	B _t	B _t — Mineral horizon characterized by:
		3. Relatively greater concentration of silicate clay; may be entirely illuvial or partly epimorphic
		4. Clay films, lamellae, bridges or other evidence of illuviation.
		B _w and B _t horizons are mutually exclusive.
	B _k	Mineral horizon characterized by accumulations of calcium carbonate (CaCO ₃). Not always present in soil profile.
	B _g	Mineral horizon characterized by accumulations of gypsum (CaSO ₄). Not always present in soil profile.
	B _s	Mineral horizon characterized by accumulations of soluble salts. Not always present in soil profile.
	C	Mineral horizon that has been little affected by soil forming processes but may be otherwise weathered.
	C _r	Weakly consolidated bedrock or saprolite. It can be dug through with some difficulty. Roots do not penetrate except along fracture planes.
	R	Relatively unweathered bedrock. Generally penetrable only by drilling or specialized equipment.

Note: Other horizons are possible; this figure is only a *generalized* profile.

Figure 1. Generalized Soil Profile.

soil taxonomy that have occurred during the past century show that soil science, quite in contrast to most disciplines, has moved toward a more scientific and less subjective mode of study. We heartily approve.

For purposes of this paper, we define soil in a modified edaphological, nongenetic way: an unconsolidated mixture of natural materials which serves or may serve as a rooting medium. A generalized soil profile is illustrated in Figure 1.

Soil Formation as an Argument for Long Ages

It is the formation of these distinctive features—horizons contrasting in texture, fabric, mineralogy, color, and organic content—that has been used as an argument that soil genesis requires long periods of time, time far in excess of what the Bible appears to allow (Birkeland, 1974; 1984; Chadwick *et al.*, 1994; Harding, 2001; Natural Resources Conservation Service, 1997; Weaver, 1989). Although the plausibility of seed survival through the global Flood of Genesis has been convincingly presented (Howe, 1971), some have argued that soil conditions at the end of the Deluge would have been inimical to plant life (Harding, 2001, p.8; Yake, 1995, p. 12). The initial salt content of parent materials at the end of the Deluge is not known; however, NaCl is relatively mobile, and the general topic of leaching will be developed in Part II of this paper. Although uniformitarian soil scientists acknowledge that some soils can form relatively quickly (Birkeland, 1984, p. 224; Bown and Kraus, 1981, p. 23) several soil types are widely believed to require long periods of time for their formation. Many of these arguments appear plausible, and we formerly found some of them quite persuasive. Descriptions of several soil orders and some of the arguments used for long ages of soil formation are provided below. Parts of the world where the soil orders considered in this

paper are dominant are shown on Figure 2 (simplified from U.S. Department of Agriculture sources; Brady, 1974, pp. 304, 305).

Oxisols

Oxisols include soils formerly known as *laterites* (1938 classification) and are the most highly weathered soils in the soil classification system (Figure 3). They are typical of hot climates with nearly year-round moist conditions. Oxisols occupy land surfaces considered “geologically old” and occur mostly in the tropical and subtropical regions. Some oxisols¹ are found in areas which are today much drier than was apparently the case when the soils were forming based on their oxic characteristics. The oxic subsurface horizon is generally very high in low-activity clay-size particles dominated by hydrous oxides of iron and aluminum. The depth of weathering in oxisols is typically much greater than for the other soil orders. Weathering and intense leaching remove a large part of the silica from the silicate materials in this horizon (Brady and Weil, 1999, p. 107). Usually the boundaries between subsurface

¹Most soil scientists capitalize names of soil orders like proper nouns in the way that geologists capitalize formal stratigraphic names; however, since these are not formal names, we choose to use lower case.

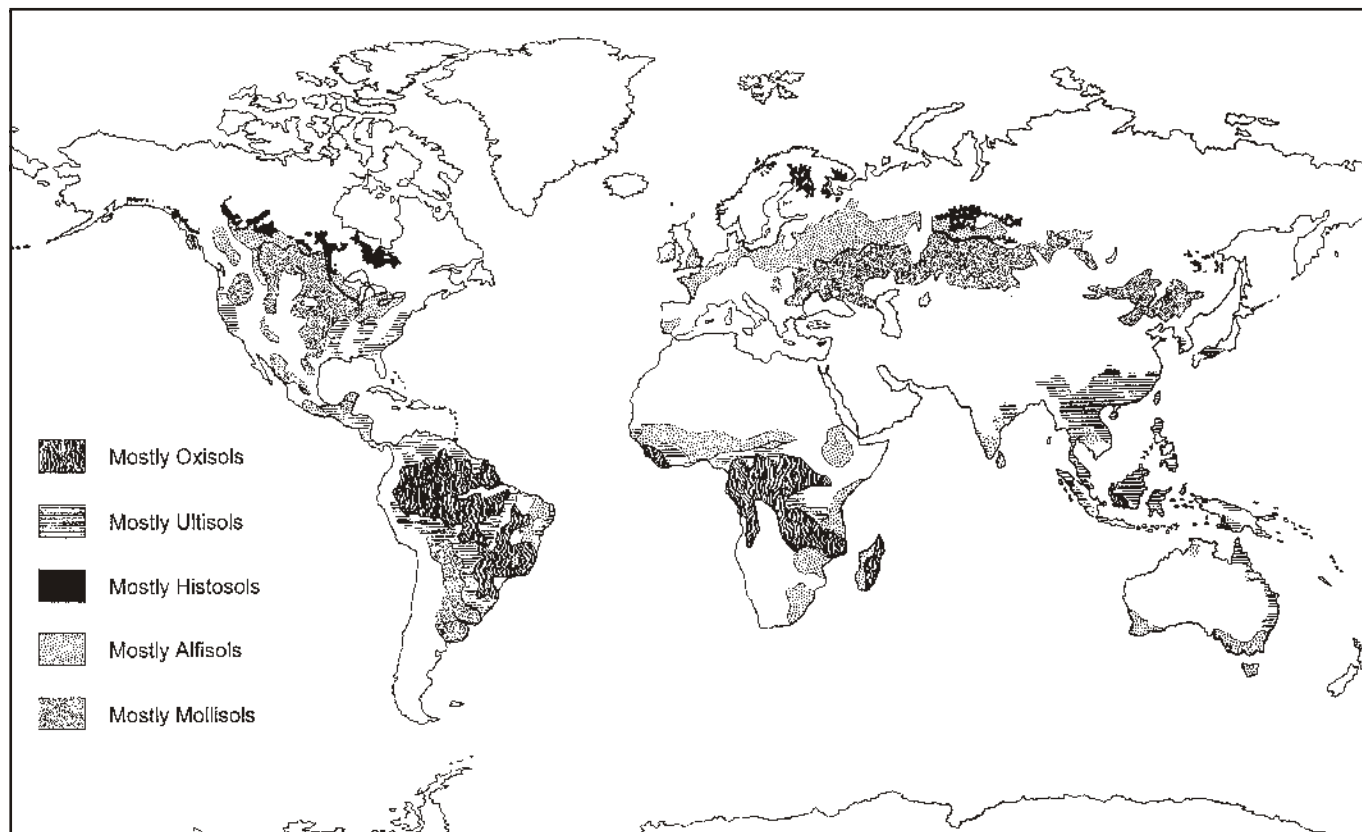


Figure 2. Dominant Soil Orders of the World (data from Brady, 1974, and U.S.D.A. files).

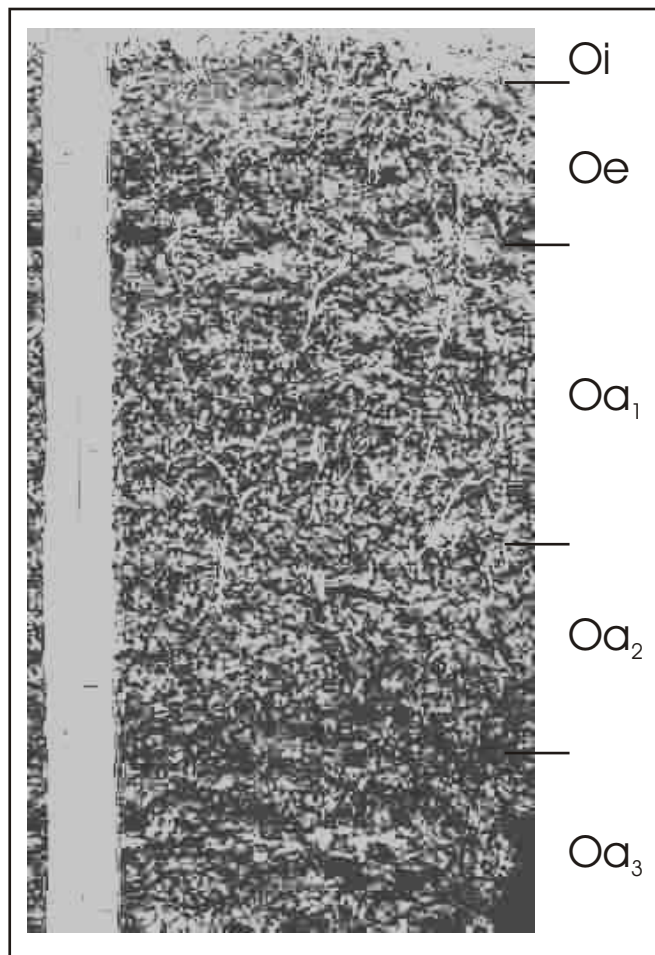


Figure 5. Typical Histosol (U.S.D.A. photograph base).

primary minerals that contain bases with the exception of some micas. Most ultisols appear to have developed under moist conditions in warm to tropical climates (Brady and Weil, 1999, p. 104). Ultisols are usually formed under forest vegetation. Ultisols commonly have both an epipedon and a subsoil that are quite acidic and low in plant nutrients. Ultisols are more highly weathered and acidic than alfisols, but less acidic than oxisols (Brady and Weil, 1999, p. 104). There is more precipitation than evapotranspiration at some season, and some water moves through the soils and into a moist or wet substratum. The release of bases by weathering usually is equal to or less than the removal by leaching, and most of the bases commonly are held in the vegetation and the upper few centimeters of the soils (U.S. Department of Agriculture, 1999, p. 721). Some researchers believe a million years or more have been required to form some of the ultisols in the United States (Birkeland, 1984, p. 223).

Histosols

Histosols are soils that have undergone little profile development because of the anaerobic environment in which

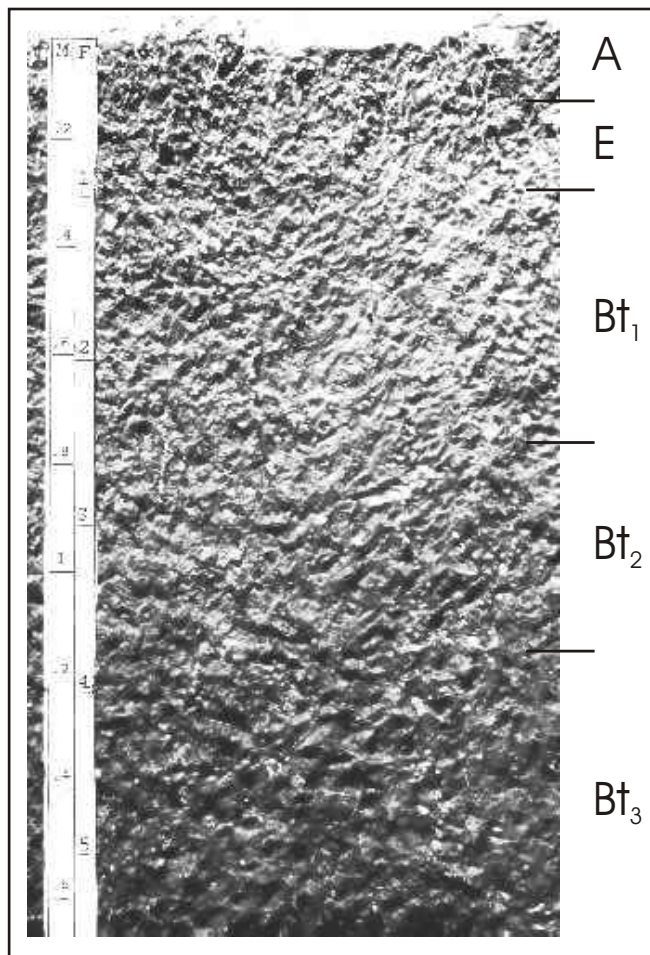


Figure 6. Typical Alfisol (U.S.D.A. photograph base).

they form (Figure 5). Histosols consist of one or more thick layers of organic soil material. Generally, histosols have organic soil materials in more than half of the upper 80 cm of soil, or in two-thirds of the soil overlying shallow rock. Organic deposits accumulate in marshes, bogs, and swamps, which are habitats for water loving plants such as pond-weeds, cattails, sedges, reeds, mosses, shrubs, and even some trees. The residues of these plants sink into the water, which inhibits their oxidation by reducing oxygen availability and, consequently, acts as a partial preservative (Brady and Weil, 1999, pp. 92–93).

Histosols are commonly believed to form gradually as generation after generation of bog plants contribute their remains to the aqueous, anaerobic environment. Retallack (1990, p. 271) states that 20 cm/year of peat accretion is a “maximum conceivable rate,” while rates of less than 1 mm/year are typical (p. 272). On this basis, very strongly developed histosols in Finland, Siberia, North America, and elsewhere, sometimes several meters thick, could require several thousand years to form. For example, at 0.5 mm/year, the Leteensuo Peat Bog in Finland, approximately 10 m thick (Forsman, Slunga, and Lahtinen, 1998, p. 773), would be approximately 20,000 years old.

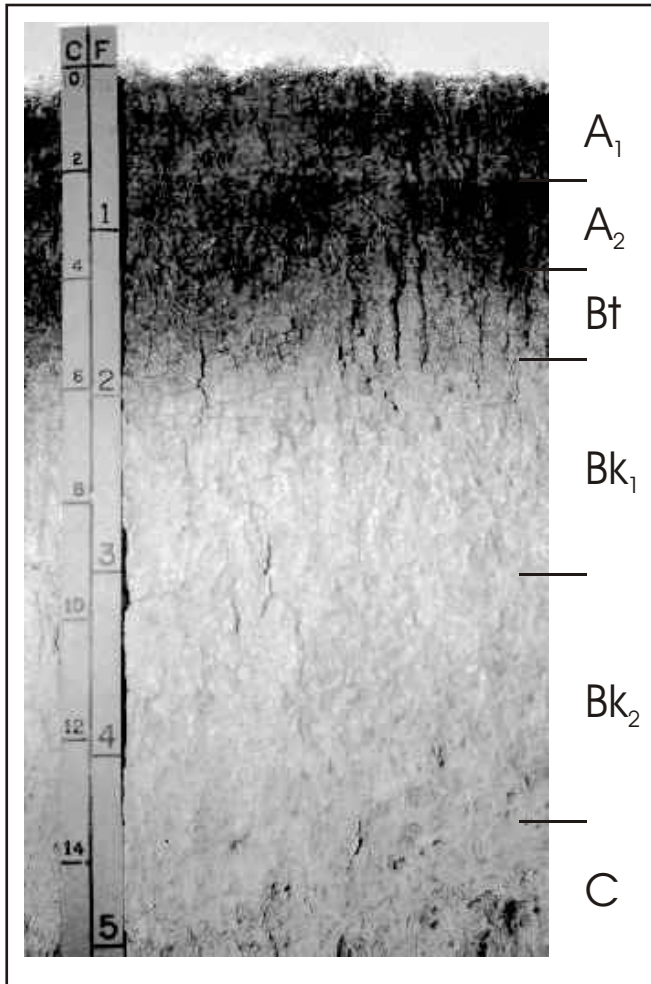


Figure 7. Typical Mollisol (U.S.D.A. photograph base).

Alfisols

Alfisols are understood to form in humid climates, from cool to hot, but they are also found in semiarid tropics and Mediterranean climates (Figure 6). Alfisols are characterized by a subsurface diagnostic horizon in which silicate clay has accumulated by illuviation (Brady and Weil, 1999, p. 102). This clay-rich horizon is only moderately leached, and its cation exchange capacity is more than 35% saturated with base-forming cations (Brady and Weil, 1999, p. 103). Alfisols formed under a forest canopy typically have a leached, light-colored E horizon subjacent to the A horizon. In regions of mesic and frigid soil temperature regimes, alfisols are mostly found on deposits or surfaces classified "late Pleistocene" in the EGP. In warmer regions, they may also be found on "late Pleistocene" or older surfaces if there are only infrequent years when the soils lose bases by leaching or if there is an external source of bases, such as a calcareous dust from a desert (U.S. Department of Agriculture, 1999, p. 163). Alfisols are thought to require at least 10,000 years to form (Birkeland, 1984, p. 224).

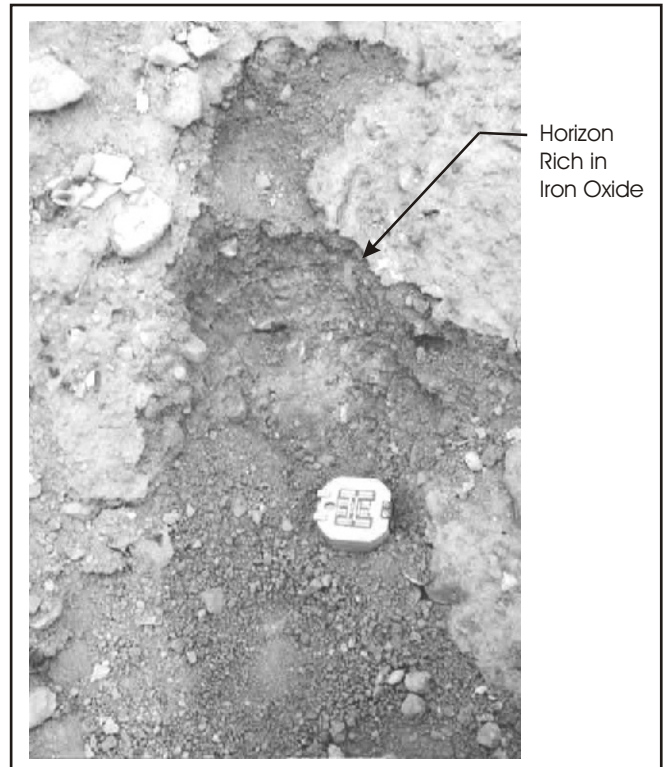


Figure 8. Alleged Paleosol, Cloudy Ridge, Alberta, Canada. The darker soil horizon contains more iron, and the profile is interpreted by some (Karlstrom, 1988) as a paleosol. Brunton compass provides scale.

Mollisols

Mollisols exhibit strong surface horizon development (Figure 7). The principal process in the formation of mollisols is the accumulation of calcium-rich organic matter, largely from the dense root systems of prairie grasses, to form the thick, soft mollic epipedon that characterizes soils in this order (Brady and Weil, 1999, p. 99). Mollisols may have an argillic, albic, or cambic subsurface horizon. Most mollisols are found under grassland vegetation. The high native fertility of mollisols makes them among the world's most productive soils. Beyond the limits of glaciation, mollisols may be in areas of older deposits or on older surfaces dating back perhaps to the "mid Pleistocene" or earlier in the natural history scenario of the EGP (U.S. Department of Agriculture, 1999, p. 555). Mollisols are thought to require approximately 10,000 years to form when an argillic horizon is present, less when a cambic horizon is present (Birkeland, 1984, p. 224).

Other Soil Orders

Andisols, aridisols, gelisols, entisols, inceptisols, spodosols, and vertisols are among other soil orders. In some cases, pedologists with either an EGP or DGP bias can agree that

these soils can form within time periods of several centuries or even less (Birkeland, 1984, p. 224; Fisher, 1983; Hunt, 1972; Jenny, 1941; Lowe, 1986).

Paleosols

Paleosols, which are usually inferred buried soil horizons, pose an even greater challenge for those who believe the earth is relatively young (Figure 8). A paleosol must develop normally as a soil, then be buried (sometimes being subjected to diagenesis), often to be covered by another soil which in turn becomes a paleosol. Multiple paleosols are often claimed by mainstream scientists (Retallack, 1990; Selley, 1976, p. 56). Weaver (1989, p. 107) asserts, "...superimposed soil profiles are the rule rather than the exception." Paleosols are used as an argument against the Bible (Harding, 2001, p.7), and even some creationists see them as strong evidence for long periods of time (Robinson, 1996, p.55).

Soil-Forming Processes

To understand the amount of time required to form a soil, one must understand the major processes involved in pedogenesis. These processes may be thought of as influenced by the environment in which the soil forms and as mechanisms acting within the soil to alter the parent material into the soil we recognize today. Traditionally, pedogenesis has been thought of in terms of *soil forming factors*.

The Five Soil-Forming Factors

Soil formation is a complex process influenced by a host of variables (Brady, 1974). By this point in this paper, those readers with chemistry backgrounds will already be thinking in terms of equations of state. However, isolation of independent variables is very difficult if not impossible. There is no comprehensive equation of state for soil known, e.g. $S = f(T, w, t, \dots)$. As a result, soil formation is generally envisioned as the result of *soil forming factors*, which are complex variables representing independent, dependent or interdependent variables affecting soil formation (*complex* is used here in the common, nonmathematical sense of the word). These five soil forming factors are: climate, parent material, topography (or geography), biology and time. On this basis, the traditional equation of state for soil can be written as $S = f(C, M, G, B, t)$.

Functional analysis of soils is not based on physical, chemical, or biological theories. The entire analysis involves but one hypothesis, namely, the assumption that the variables climate, organisms, topography, parent material, and time, plus some ac-

cessory factors such as seasonal variations of climate and ground-water table, suffice to define any soil. The functions themselves are purely observational, and their validity depends solely on the skill and experience of the investigators in selecting suitable areas for study. This represents a distinct advantage over other systems of soil descriptions that rely on speculative mechanisms of soil-forming processes (Jenny, 1941, p. 262).

One of us, with a strong background in chemistry, symbolized these factors mathematically as partial derivatives before encountering Jenny's notation of half a century ago; the more modern notation is used here and summarized below.

Ideally, the ability to measure each of the factors would provide all the information needed to define a given soil and its origin. In reality, soil systems are too complex and present knowledge too limited.

The factors theoretically are independent variables, in that field sites can be found in which the factors vary independently of each other. Although the factors can be dependent variables in some field sites, their only real value in a rigorous quantitative factorial treatment is as independent variables (Birkeland, 1974, p. 125).

Climate (C) is perhaps the most important of the five soil forming factors (Brady, 1974, p. 303). Although this assertion has been the basis of much debate (Paton, Humphreys and Mitchell, 1995, pp. 26–28;), a large number of soil scientists consider the climatic factor paramount in soil formation. Weaver (1989, p. 106) states, "The rate of chemical weathering and soil formation is largely controlled by climate." Because the climatic factor includes both temperature and moisture variables, not only does it determine the rate of soil formation, but also many of the secondary minerals that result from epigenesis in the soil environment. Because of the assumption that soil formation has occurred during great spans of time, some assert that the climatic factor dominates the other factors, including the type of parent material, in determining soil characteristics (Brady, 1974, p.303; Selley, 1976, p. 55).

Parent material (M) is an obvious factor affecting the formation of soil. The effect of parent material is illustrated by the development of distinct soil series under similar conditions of climate, topography, and vegetation (Figure 9). The fact that topography and vegetation are influenced by parent material will be further developed later in this paper. Contrary to its apparent simplicity, the definition of parent material is a matter of debate. By *parent material*, some mean the unweathered bedrock from which the soil is assumed to form (Paton, Humphreys, and Mitchell, 1995, p. 95; Tarbuck and Lutgens, 1984, p. 125), some view it as the soil state at a somewhat arbitrarily selected initial time (Jenny, 1941, pp. 45, 52, 53), and some include all regolith below recognizable soil horizons

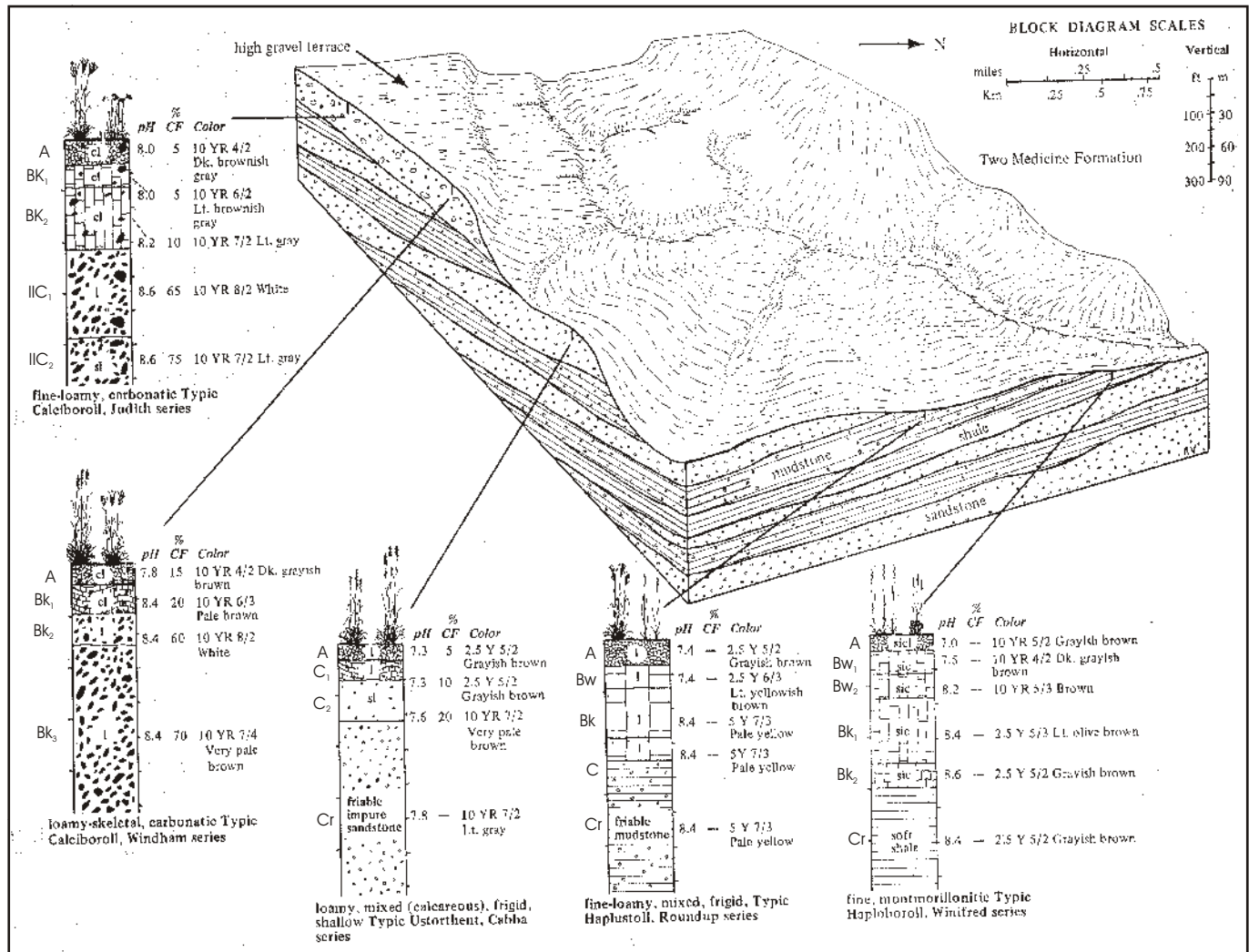


Figure 9. Role of M illustrated by soil development on Two Medicine Formation (Based on Veseth and Montagne, 1980).

(Brady, 1974, pp. 7,8). "In view of these logical and practical difficulties, we prefer to define parent material as *the initial state of the soil system* and thus avoid special reference to the strata below the soil, which may or may not be parent material" (Jenny, 1941, pp. 52,53; emphasis his). "Mathematically speaking, we should say that parent material becomes soil after an infinitely small time interval dt " (Jenny, 1941, p. 45). It is generally believed that M is most important at first, C becoming dominant later (Weaver, 1989, p. 106). Thus, with time, the disparate soil types illustrated in Figure 9 should become increasingly similar.

The importance of the *topographic* factor (G) is illustrated by Figure 10. Topographic position influences the microclimate, altering the temperature regime by slope position and the soil moisture regime by slope angle. It therefore modifies C, probably its most important effect (Brady, 1974, p. 309). Geomorphologists emphasize the larger scale, including not only modifications to the clima-

tic effects but also inferred differences in M and supposed geologic history. Geomorphology and hydrogeology can be very important to soil studies (Daniels, Gamble, and Cady, 1971, pp. 51-88).

The *biotic/biologic* soil forming factor (B) is important to epigenesis, leaching, and fertility. According to some (Paton, Humphreys, and Mitchell, 1995, pp. 33-86), B is responsible to a significant degree for the development of texture contrast soil horizons. Microbes, vegetation, and animals all influence soil formation. Biologic activity appears to be very important for epigenetic changes (Birkeland, 1984, pp. 74, 75). Lichens can produce a measurable weathering effect on exposed rock surfaces (Birkeland, 1984, pp. 75, 76; Chadwick *et al.*, 1994). "As soon as plants gain a foothold in a weathering rock or in recently deposited soil material, the development of a soil profile has begun" (Brady, 1974, p. 310). Decaying vegetation produces greatly elevated levels of carbonic acid, produces organic sesquioxide complexes, and binds, mixes, and moves soil

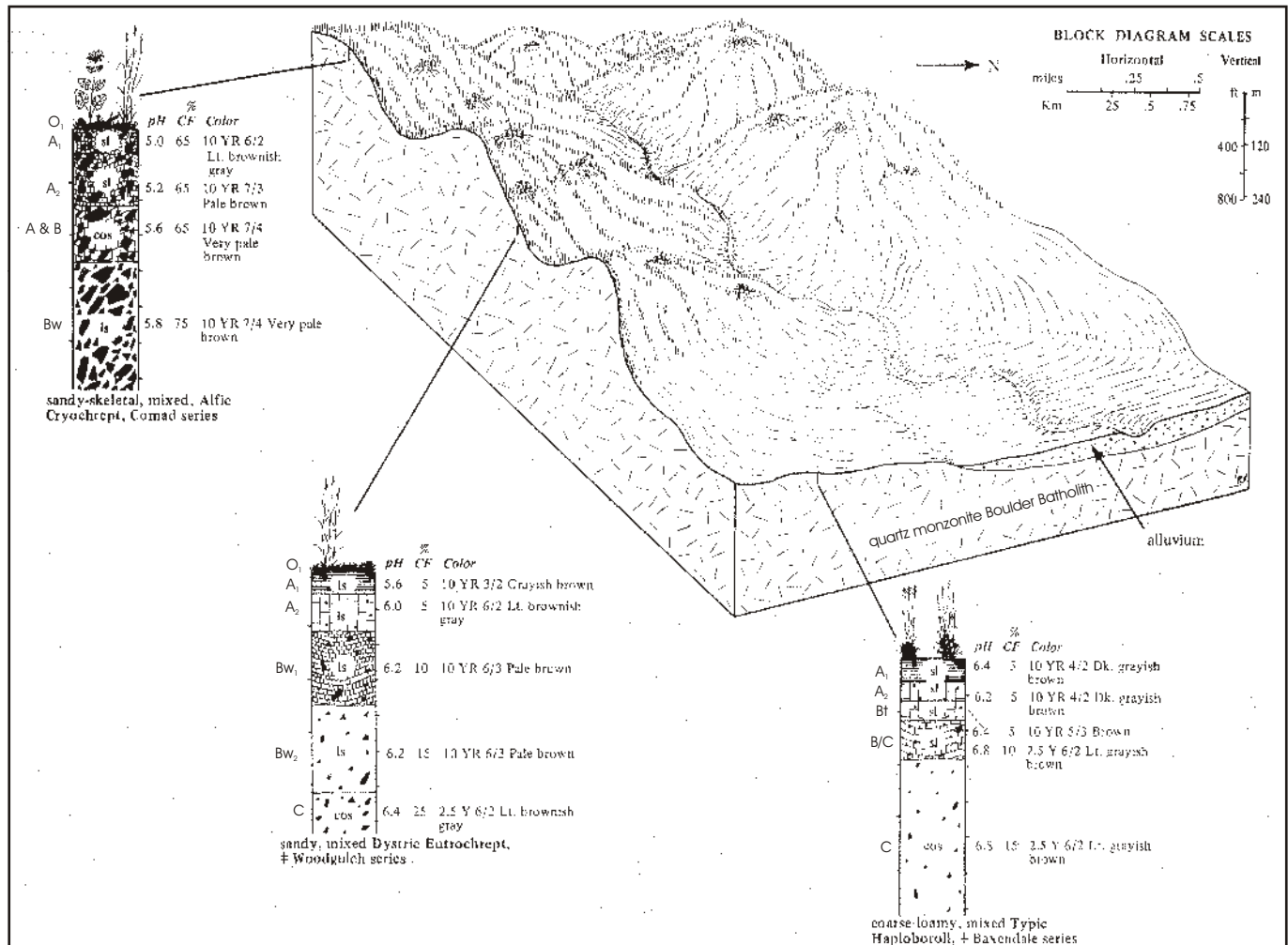


Figure 10. Role of G illustrated by soil development on Boulder Batholith (Based on Veseth and Montagne, 1980).

particles (Paton, Humphreys and Mitchell, 1995, pp. 17 ff.; Brady, 1974, p. 310). The development of "laterites" (acrorthox) is inferred to depend on vegetation based on near absence "prior to the Devonian" (Blatt, Middleton, and Murray, 1972, p. 257). Both plants and animals are responsible for bioturbation, creatures as diminutive as ants and earthworms being capable of considerable soil mixing (Paton, Humphreys, and Mitchell, p. 65).

The final soil forming factor is *time* (t). For conflicting geologic paradigms, this is the most contentious of the five "soil forming factors." Weaver (1989, p. 106) states, "The rate of chemical weathering and soil formation is largely controlled by climate. Regardless of the climate, the rate is relatively slow." Long periods of time are generally assumed, sometimes being inferred from differences in soils in areas of apparent glaciation versus nonglaciated areas (Brady, 1974, p. 309), by argillic horizons or horizons of carbonate accumulation (Gile and Grossman, 1968, p. 15), or rates of leaching or epigenesis (Chadwick *et al.*, 1994, p. 102). "We see from this brief review of soils that long periods of time are required for physils to form in

soils; superimposed soil profiles are common and may represent as much as 100 m.y. [million years] of weathering" (Weaver, 1989, p. 107). "Most systems of soil classification contain, in some form or another, the idea of soil-forming factors. Among these, the factor time or degree of maturity occupies the most prominent role" (Jenny, 1941, p. 48). In general, uniformitarian thinking has produced a biased view of time as both primary in importance to soil formation and vast in supply. Largely ignored have been the sage observations of Jenny (1941, p. 31):

The estimation of relative age or degree of maturity of soils is universally based on horizon differentiation. In practice, it is generally maintained that the larger the number of horizons and the greater their thickness and intensity the more mature is the soil. However, it should be kept in mind that no one has ever witnessed the formation of a mature soil. In other words, our ideas about soil genesis as revealed by profile criteria are inferences. They are theories, not facts. This accounts for the great diversity of opinion as to the degree of maturity of specific soil profiles.

Table I. Comparison of Parameters—Soil Forming Factors.

Factor	Description	Notation	Description
C	Climatic soil-forming factor	$\partial S/\partial C$	Change in soil state as a result of climatic influences
M	Parent material soil-forming factor	$\partial S/\partial M$	Change in soil state as a result of mineralogical influences
G	Geomorphic (topographic) soil-forming factor	$\partial S/\partial G$	Change in soil state as a result of influences of topography or geomorphology
B	Biotic soil-forming factor	$\partial S/\partial B$	Change in soil state as a result of influences of vegetation, animals, and microbes
t	Time soil-forming factor	$\partial S/\partial t$	Change in soil state due to time

The list of controversial soil types is quite long. Whatever the correct interpretation may be, it is evident that the issues center around the factor time in soil formation.

A slightly more mathematically oriented perspective might have spared some of this controversy. Examine the expressions in Table I. If the climatic factor, $\partial S/\partial C$, is a function of time, how can it be considered a soil forming factor distinct from time? How can time, t , be considered a soil forming factor distinct from climate? How can t be considered a soil forming factor distinct from $\partial S/\partial M$, $\partial S/\partial G$, and $\partial S/\partial B$, all of which are functions of time? This is similar to defining *white* as “the color white”—one cannot use a term to define itself. It is widely recognized that these soil forming factors are interdependent. As Jenny observed (1941, p. 267), “It is improbable that a function between two s properties that possesses general validity will ever be found.” But what often seems to escape notice is this: *time itself is not a soil forming factor*. Time is implicit in the other four factors, a crucial point that some have recognized (Birkeland, 1974, p. 128; Jenny, 1941; Lavkulich, 1969, p. 34). If one could hold C , M , G , and B constant while varying only t , *soil formation would not occur*, not in a billion years, for it is the cumulative effect of these other *time-dependent* processes that produces soil. For this reason we assert, *time itself is not a soil forming factor*.

Time is Implicit in Soil Formation

Some, although recognizing the definitional problem of time as a soil forming factor, have rejected it as an important distinction in studies of pedogenesis. “Some workers have criticized Jenny for including time as one of the factors, because by itself time does nothing to a soil. Its importance, however, lies in the fact that most soil-forming processes are so slow that their effect on soil is markedly time-dependent” (Birkeland, 1974, p. 128). Not only does this assertion fail to recognize the mathematical confusion introduced by simultaneously including time as a factor and an independent variable within the other factors, but the uniformitarian assumption of rate is philosophically untenable (Reed, 1998; 2000a; 2001). It also renders im-

possible a natural history analysis of the kind attempted in this paper because gradualism is assumed *a priori*.

While time alone cannot be considered a soil forming factor, it is implicit in all of the processes that do contribute to soil formation (An exception could be made for parent material, depending on how it is defined. Our definition of M does include time dependency.). One cannot consider the effect of C without t , for C is a function of the global heat balance, circulation, moisture, and other variables, *all of which act in space-time*. Similarly, G and B (and M as we define it) are functions of t . Thus, though it is not possible to hold time constant or another variable which is itself a function of time, it is possible to express variations in the soil state as if the other time-dependent factors were held constant. In practice, the only potentially effective approach is an attempt to examine soils in similar and proximate locations where significant variation can be expected to be limited to only one factor (Birkeland, 1974, pp. 128, 129; Jenny, 1941, p. 262; Figures 8 and 9). While evaluating the relative importance and qualitative changes in the soil state resulting from various factors, one must always be conscious that time is implicit.

Ambiguity in the Boundary Conditions of Soils

Another cause of confusion and often error is ambiguity in the boundary conditions of a given soil. It should be obvious that determination of the initial conditions of most soils is beyond the reach of science (Adler, 1967; Hunt, 1972; Jenny, 1941, p. 31; Klevberg, 1999; Reed, 1998; 2000a; 2000b; 2001). This may be alleviated in pedologic studies by concentrating on observed changes in the soil state or simply assigning an arbitrary initial state (e.g. the state of the soil at the time observation begins). Even neglecting natural history implications (Reed, 2000a; 2000b; 2001), ambiguity exists in how the soil forming processes are defined (Birkeland, 1974, p. 126). A useful approach to this problem is that taken in physics and engineering: the use of a control volume. For purposes of this paper, we define the control volume as the space occupied by a specific soil, bounded vertically by the soil-atmosphere interface and arbitrarily assigned maximum rooting depth, and hori-

zonally by the common pedological demarcations between soils of a series. Use of this control volume concept enables us to distinguish between *environmental factors*, which principally influence soil formation from outside the control volume, and *soil-forming mechanisms*, processes operational solely within the control volume. "A clear distinction should be made between factors and processes [soil-forming mechanisms] ...processes form the soil. The factors, in contrast, define the state of the soil system" (Birkeland, 1974, p. 125). Both environmental factors and soil-forming mechanisms are processes occurring within space-time; thus, expressions of changes in the soil state, S , due to one of these processes must acknowledge its occurrence in time. The word "change" implies time.

The Five Environmental Factors

The four commonly recognized "soil forming factors" (time being excepted) generally effect soil formation from outside the control volume.

As used here, $\partial^2 S / \partial C \partial t$ refers to the time derivative of change in soil state due to climate. We recognize that climate may and likely did change considerably during the past. We concur with the majority of pedologists that climate is probably the most important environmental factor in the long run. How long that run was is a question we shall address shortly.

As used here, $\partial^2 S / \partial M \partial t$ refers to the time derivative of change in soil state due to the nature of the parent material. Parent material has a profound effect on the nature of the resulting soil. As an environmental factor, acting from outside the control volume, $\partial^2 S / \partial M \partial t$ includes both positive and negative inputs.² Positive inputs include materials deposited by wind, water, ice, or gravity. Negative inputs include erosion (removal of material from the control volume).

As used here, $\partial^2 S / \partial G \partial t$ refers to the time derivative of change in soil state due to geomorphic factors, including both geomorphology and the site topography. For constantly changing topography, the effects of G on soil formation (i.e. $\partial^2 S / \partial G \partial t$) are clearly nonlinear. The geomorphic environmental factor acts primarily to modify the climatic (C) and parent material (M) factors. Thus, our definition of control volume implies a constantly changing spatial upper boundary determined by $\partial^2 S / \partial G \partial t$.

As used here, $\partial^2 S / \partial B \partial t$ refers to the time derivative of change in soil state due to biologic agents. Although the bi-

otic environmental factor appears to transgress the boundaries of the control volume through soil-dwelling organisms, it can be envisioned as modifying the boundary in a manner similar to G but in a much more complex fashion. It is primarily the physical and chemical effects of these organisms on the mineral matter and deposited organic matter that contribute to soil formation. We therefore treat the effect of biologic agents as an environmental factor.

In addition to the four environmental factors that are commonly recognized as soil-forming factors, we include the effects of ground water. Although ground water may seem of limited importance, the presence or absence of an elevated water table is very important to soil formation. It is not implicit in any of the other environmental factors. Jenny (1941, p. 92) acknowledged that ground water, often included in G (his r or topographic soil forming factor), is often on par with the other soil-forming factors, though it may be neglected when more than ca. 3 m below the ground surface. He also acknowledged the existence of soil forming factors beyond the common five that could be important *locally*, and considered ground water of local importance. We consider the presence or *absence* of ground water to be of greater significance than acknowledged by many establishment pedologists in the past.

As used here, $\partial^2 S / \partial W \partial t$ refers to the time derivative of change in soil state due to ground water effects. We define $\partial^2 S / \partial W \partial t$ as an environmental factor despite its occasional "invasion" of the control volume, since it sometimes is not spatially limited to a given soil but may drastically affect soil-forming mechanisms. Some pedologists have recognized the importance of ground water in soil formation (Birkeland, 1974, p. 148; Daniels, Gamble, and Cady, 1971, p. 55; Hunt, 1972, p. 113; Jenny, 1941, p. 262; Twidale, 1990). Ground water occurrence is certainly affected by topography, but ground water may have a much greater role in geomorphology than previously realized. "Many familiar landforms, major and minor, originate at the weathering front through the interplay of groundwater and bedrock" (Twidale, 1990, p. 36). Proximity of ground water also strongly influences vadose zone moisture through capillarity and vapor phase diffusion. The presence and movement of water in and through the soil is clearly one of the most important variables in the formation of soil from parent material (Brady, 1974; Jenny, 1941; Twidale, 1990, p. 32).

Table II summarizes the five primary environmental factors affecting pedogenesis.

The Four Soil-Forming Mechanisms

Changes that occur within the soil control volume can be thought of as *soil-forming mechanisms*. These are the pro-

²As an *environmental factor*, rather than a soil-forming mechanism, changes in available parent material that may be added to the soil (i.e. control volume) via sediment transport or subjacent regolith may be symbolized by ΔM (removal of material from the control volume via erosion can be represented as $\Delta M < 0$).

Table II. The Five Environmental Factors of Pedogenesis

Factor	Description	Notation	Description
C	Climatic environmental factor	$\partial^2S/\partial C\partial t$	Change in soil state as a result of climatic influences
M	Parent material environmental factor	$\partial^2S/\partial M\partial t$	Change in soil state as a result of mineralogical influences
G	Geomorphic (topographic) environmental factor	$\partial^2S/\partial G\partial t$	Change in soil state as a result of influences of topography or geomorphology
B	Biotic environmental factor	$\partial^2S/\partial B\partial t$	Change in soil state as a result of influences of vegetation, animals, and microbes
W	Ground water environmental factor	$\partial^2S/\partial W\partial t$	Change in soil state as a result of ground water effects

cesses that actually turn the parent material into soil. The rates at which soil-forming mechanisms operate and the pathways they follow are determined by the environmental factors.

As used here, $\partial^2S/\partial E\partial t$ refers to the time derivative of change in soil state due to effects of epigenesis, i.e. mineral transformations due to chemical weathering. This is one of the most important mechanisms in soil development and has received much attention. In general, silicate minerals are transformed into silicate clays (physils) and hydrous aluminum and iron oxides. Carbonate minerals are typically dissolved, leaving a silicate residuum. In general, weathering rates are greatest for minerals at the top of Bowen's Reaction Series³ and least for quartz, on the bottom (Figure 11).

As used here, $\partial^2S/\partial P\partial t$ refers to the time derivative of change in soil state due to effects of physical weathering, including both breakdown of individual rock and mineral grains, and translocation of soil particles (i.e. particle movement within the control volume). Breakdown of rock or

mineral grains produces an increasingly finer grained soil texture. Movement of particles within the subsurface enhances soil development, such as formation of argillic or cambic horizons, color contrasts and stratification. Physical processes, including surface winnowing by wind or water and translocation in the subsurface (eluviation/illuviation), tend to segregate particles by size and may result in a texture-contrast soil with visually identifiable horizons. Bioturbation tends to mix particles of different sizes and blend organic matter, producing a thicker and better developed topsoil.

As used here, $\partial^2S/\partial L\partial t$ refers to the time derivative of change in soil state due to effects of leaching of ions from the solum by meteoric water. Leaching is a function of vadose

³Bowen's Reaction Series is a hierarchy of igneous minerals illustrating an upward-increasing elevation of temperature and pressure for mineral stability, with quartz formed at the lowest temperature and pressure and olivine and anorthite at the highest.

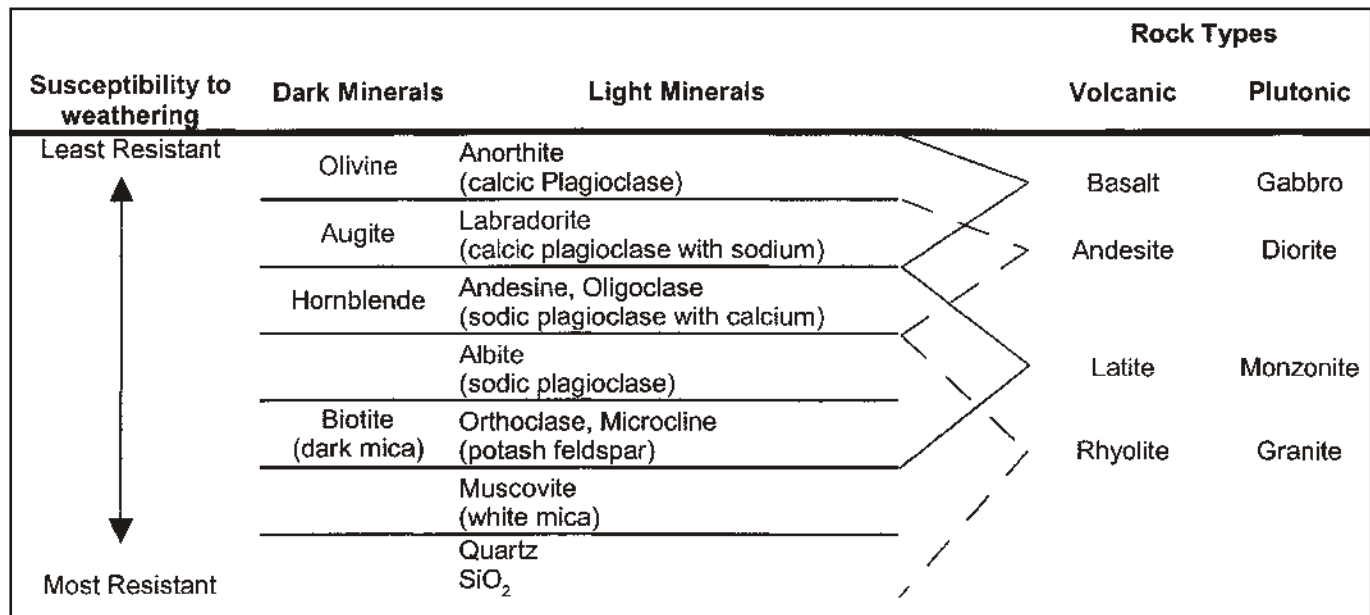


Figure 11. Bowen's Reaction Series. Susceptibility to weathering of various minerals is greatest for those that crystallize first. Not illustrated are the effects of crystal size (larger crystals are more susceptible to weathering) and fractures or defects.

Table III. The Four Soil-Forming Mechanisms.

Factor	Description	Notation	Description
E	Epigenetic soil-forming mechanism	$\partial^2 S / \partial E \partial t$	Change in soil state due to effects of epigenesis
P	Physical weathering soil-forming mechanism	$\partial^2 S / \partial P \partial t$	Change in soil state due to effects of physical weathering
L	Leaching soil-forming mechanism	$\partial^2 S / \partial L \partial t$	Change in soil state due to effects of leaching of ions from the solum
O	Organic matter soil-forming mechanism	$\partial^2 S / \partial O \partial t$	Change in soil state due to effects of organic matter

zone hydrology and geochemistry. Free water must be available as a vehicle for transport of soluble bases and cations from the upper portion of the solum, and it must be in contact with mineral grains or hygroscopic water long enough for the ions to enter solution. Soluble substances in soil organic matter may also be leached, sometimes resulting in complex reactions with minerals and ions released from the minerals. Iron and aluminum oxides are most resistant to leaching and tend to persist in highly leached soils. Ions leached from the upper (A) soil horizon may be redeposited in the subjacent B horizon, often forming a spodic (usually Bs, Bh, or Bhs), gypsic (By), natric (Bn), salic (Bz), or calcic (Bk) horizon.

As used here, $\partial^2 S / \partial O \partial t$ refers to the time derivative of change in soil state due to effects of organic matter present in the soil. The organic matter is contributed by both plants and animals, including microbes. Organic matter is essential to soil productivity and affects the other soil-forming mechanisms. "As a result of the near-surface breakdown of dead organic matter, the carbon dioxide concentration at the biosphere/lithosphere interface can be up to ten times greater than the normal atmospheric level," state Paton, Humphreys, and Mitchell (1995, p.17), "Around living plant roots the hydrogen-ion concentration is even greater." Organic matter may accumulate above mineral matter (an O horizon) or mixed with mineral matter to form topsoil (A horizon).

Table III summarizes the four soil-forming mechanisms.

Complexity of Pedogenesis

The variables governing soil formation are indeed myriad and complex in their interaction, as illustrated in Figure 12. These processes include chemical reactions and physical processes that are governed by thermodynamic rate laws (Lavkulich, 1969). None of these variables—climate, geomorphology and topography, biology, ground water, epigenesis, translocation, leaching, or organic decay—is independent of time. Even parent material is a function of time when mineral transport is acknowledged. Presuppositions about natural history must, therefore, profoundly af-

fect inferences about pedogenesis. The effects of natural history presuppositions on soil formation inferences in the light of pedogenic data will be addressed in Part II of this paper.

Acknowledgments

We appreciate the helpful information and criticisms of this paper we received from Mssrs. Myles Grotho and Michael Oard and the two anonymous reviewers. *Deum laudamus* (Isaiah 55:10,11).

Glossary

- argillic: said of a soil horizon characterized by accumulation of clays through illuviation.
- bioturbation: rearrangement of soil particles within and between horizons as a result of the actions of organisms.
- cambic horizon: said of a mineral soil horizon that has a texture of loamy very fine sand or finer, contains some weatherable minerals, and is characterized by the alteration or removal of mineral material. The cambic horizon lacks cementation or induration and has too few evidences of illuviation to meet the requirements of the argillic or spodic horizon (Brady and Weil, 1999).
- capillarity: the property of soil, a function of pore size, that draws water above the water table and against gravity until equilibrium is reached between the adhesive forces acting on the soil water and the increase in potential energy. Fine-grained soils have greater capillarity than coarse-grained soils.
- Deluge: the unique global Flood cataclysm (*mabbul* in Hebrew) that occurred during Noah's lifetime as described in the Bible.
- DGP: the "diluvial geologic paradigm," a stereotype of the view that earth history has been dominated by catastrophic processes (principally the Deluge), a relatively short history as indicated by the Bible, and creation. Energy is the most important geologic variable.
- diluvial: resulting from or pertaining to the Deluge.

edaphology: the study of the relationships between soils and living things, particularly plants, including human use of land for agriculture.

EGP: the "establishment geologic paradigm," a stereotype of the prevailing view that earth history has been dominated by gradual processes, immense amounts of time, and evolution. Time is the most important geologic variable.

eluviation: removal of particles (particularly clays) from a soil horizon into a lower part of that horizon or into subjacent horizons.

epigenesis: formation of new minerals from previous minerals through surficial processes, typically chemical weathering (e.g. formation of physils from feldspars).

epimorphism: change in the outward form of mineral crystals and aggregates in response to weathering processes.

extant soils: soils existing in the present, i.e. dynamic natural bodies composed of mineral and organic matter which may function as a rooting medium and are subject to currently operating soil forming processes.

geomorphology: study of the shape of the earth's surface, particularly at a regional to global scale; also, a synonym for *topography* but at a larger scale.

illuviation: accumulation of clays in a soil horizon as the result of translocation.

paleopedologist: one who investigates paleosols or inferred fossil soils, viz. buried soils that are no longer affected by soil forming processes.

paleosol: a fossil soil, i.e. a soil that has been preserved in the geologic record or buried deeply enough that it is no longer subject to soil forming processes.

pedogenesis: the formation of a soil from mineral and organic matter.

physil: any of various hydrous, aluminosilicate minerals classified as phyllosilicates and often referred to as "clay minerals." The term "clay" is applied to particles smaller than about 2 microns, while physil particles (clay minerals) may be larger than this and some nonclay mineral particles may be smaller. Most clay particles are physils.

sesquioxide: a highly oxidized molecule consisting of a cationic center (often metallic or organic) surrounded by hydroxyl ligands. Sesquioxides are typical of soil horizons subjected to significant chemical weathering and leaching, often under forest cover.

spodic: said of a soil horizon characterized by accumulation of iron and aluminum sesquioxides, organic complexes and organic matter, and frequently found beneath an E horizon in forested terrain.

vadose zone: the portion of the soil profile that is typically aerated, not saturated by water; it lies above the water table and superjacent to the capillary fringe.

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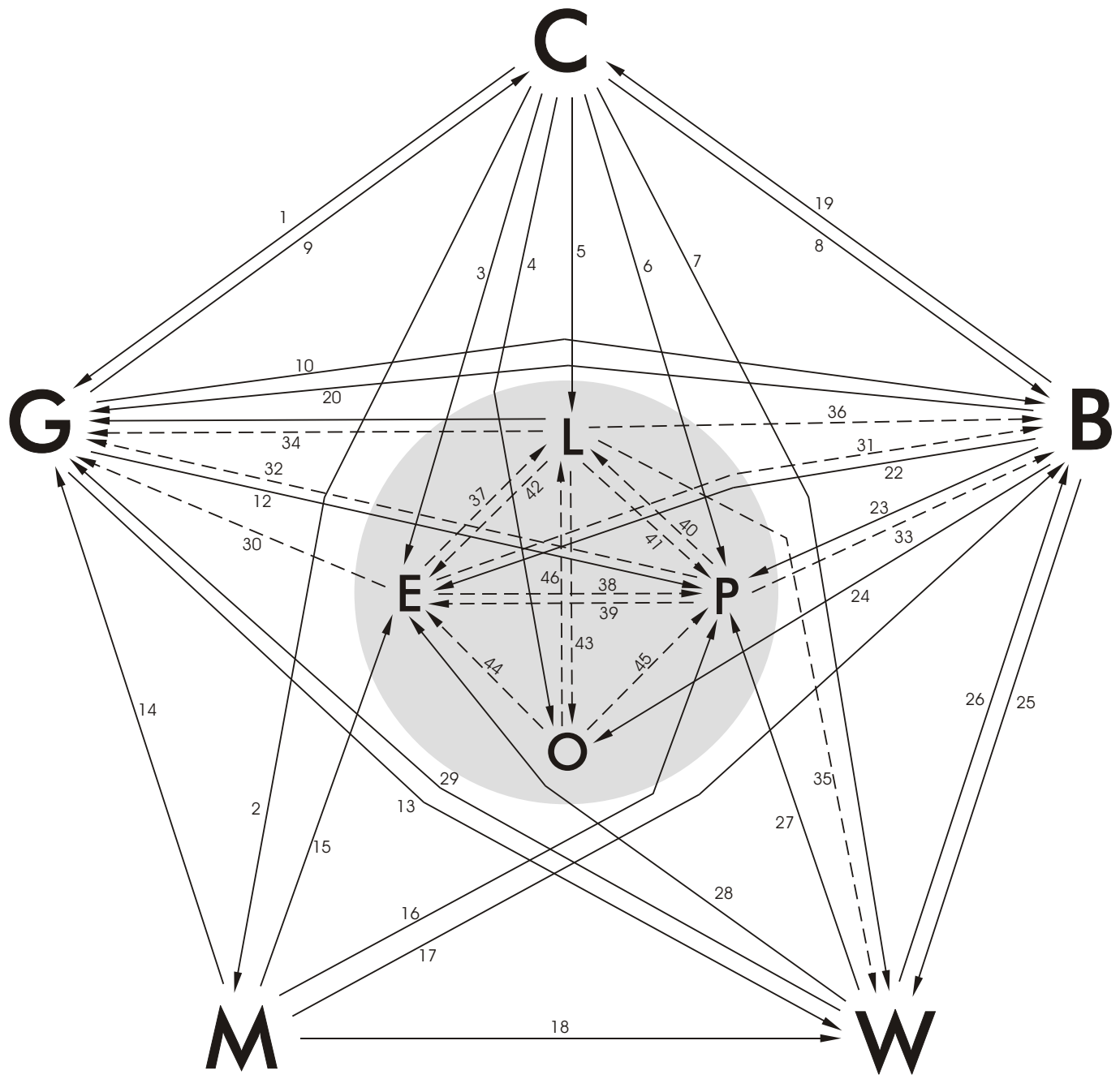


Figure 12. Interrelationships of Environmental Factors and Soil-Forming Mechanisms.

Figure 12. Interrelationships of Environmental Factors and Soil-Forming Mechanisms.**Key to the Numbers**

1. Climate has a profound effect on topography.
2. Climatic factors induce transport of new mineral matter into and out of control volume (i.e. the soil).
3. Climate, particularly moisture and temperature, affect weathering rates of minerals.
4. Climate, particularly moisture and temperature, affect rate of decay of organic matter.
5. Climate determines soil moisture available for leaching.
6. Climatic factors, particularly available moisture and freeze-thaw, induce breakdown of soil particles and movement in the subsurface.
7. Climate is a very important variable in determining ground water occurrence.
8. Climate has a profound effect on plant and animal communities.
9. Geomorphology influences climate.
10. Topography, via microclimatic effects, affects organisms, particularly plants.
11. Topography, via effects on soil moisture, affects the rate of leaching.
12. Topography affects the subsurface movement of soil particles.
13. Topography influences ground water occurrence and movement.
14. Initial geology (parent material) often dominates development of topography.
15. Parent material determines the susceptibility of resultant mineral species to chemical weathering.
16. Parent material determines the susceptibility of resultant mineral species to physical weathering or transport in the subsurface.
17. Parent material has a marked effect on which organisms can survive or thrive.
18. Parent material has a profound influence on ground water occurrence and movement, both macroscopically and microscopically.
19. Vegetation moderates climate.
20. Organisms affect the rate of change of topography (animals accelerate, plants retard).
21. Vegetation intercepts precipitation and reduces amount of water penetrating solum.
22. Plants exude organic acids that accelerate chemical weathering.
23. Bioturbation is ubiquitous and can be extensive.
24. Plants and animals add organic matter to soil.
25. Plants can affect ground water levels through interception of precipitation and transpiration of soil moisture.
26. The proximity of the water table can affect plant and animal communities.
27. The proximity of the water table can affect subsurface movement of soil particles.
28. Ground water can influence moisture levels in the vadose zone and rates of chemical weathering of minerals.
29. Ground water and surface water may interact to affect topography.
30. Mineral transformations can affect topography and rates of erosion.
31. Mineral transformations can affect vegetation, especially through changes in water retention and cation exchange capacity.
32. Physical weathering and segregation of soil particles can affect topography and rates of erosion.
33. Physical weathering and segregation of soil particles can affect plant and animal communities.
34. Leaching can affect topography through alteration of soil and regolith (e.g. erodable saprolite, karst).
35. Soluble bases and cations leached from soil may affect ground water quality.
36. Leaching of ions from soil may affect vegetation, particularly through loss of nutrients.
37. Mineral transformations may affect leachability.
38. Mineral transformations may affect susceptibility to physical weathering and mobility of soil particles in the subsurface.
39. Breakdown of soil particles increases surface area and hence chemical weathering; movement of soil particles in subsurface may shift chemical equilibria (e.g. oxidizing to reducing).
40. Physical weathering and segregation of soil particles may affect the rate of leaching.
41. Leaching may affect susceptibility to physical weathering and may influence soil particle mobility through changes in soil texture.
42. Leaching may shift chemical equilibria and thus chemical weathering rates and processes.
43. Soluble products of organic decay may be leached from the upper soil horizons.
44. Organic decay produces carbonic acid; organic compounds may form chelates.
45. Organic matter may absorb soil moisture and thus reduce downward migration of fine particles; organic matter may reduce soil cohesion.
46. Organic matter may reduce leaching rates through absorption of moisture; products of leaching may change due to ion exchange.

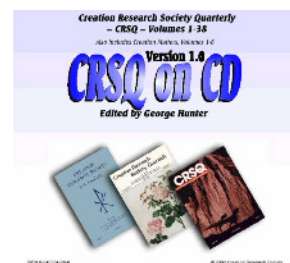
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The Nature of Redshifts and an Argument by Gentry

Andrew S. Repp*

Abstract

Robert Gentry's New Redshift Interpretation (NRI) is one of several proposed creationary cosmologies. In defending the NRI, Gentry claims that the standard interpretation of cosmic redshifts is badly in error. In particular, he argues that

cosmologists' purported "cessation assumption" is falsified by operation of the GPS. This article examines the nature of various types of redshifts in order to evaluate his claim. It concludes that his claim is incorrect.

Introduction

Much of the work to date in scientific creationism has focused on biology and geology, for the simple reason that some of the most direct evolutionary attacks on the biblical record have come from these fields. Creationists have done much less work in astronomy and cosmology, as noted by Faulkner and DeYoung (1991, p. 87). One exception is Robert Gentry, who in 1997 proposed a creationary cosmology which he called the "New Redshift Interpretation" (NRI). The NRI universe is roughly spherically symmetric about the Milky Way galaxy, finite in extent, static in geometry, and surrounded by a shell of hot hydrogen. The model attempts to explain the galactic redshifts and the cosmic microwave background radiation, two facts often cited in support of the evolutionary Big Bang Model (BBM). The NRI interprets the galactic redshifts as the result of both gravitational and kinematic effects rather than as evidence for cosmological expansion.

Gentry later wrote ten articles defending the NRI and attacking the BBM. He originally posted them on the electronic archive maintained by Los Alamos National Laboratories (www.arXiv.org), but they were deleted from the server, presumably due to the articles' creationary content. They are now available on the internet at <http://www.orionfdn.org/PosterSession>.

Gentry is to be commended for attempting to construct a cosmology that integrates scientific observations and revealed truth. Nevertheless, I Thessalonians 5:21 commands us, "Prove all things; hold fast that which is good." Thus, creationary scientists have the responsibility of critiquing this theory both scientifically and biblically. Cooperstock, Faraoni, and Vollick (1998), and Carlip and Scranton (1999), proponents of the BBM, address various

aspects of the NRI; they include specific calculations in support of their arguments. Creationists, with the higher motivation of a biblical mandate, must do the same.

In fulfillment of this mandate, this paper seeks to evaluate the fifth article (Gentry, 2001) in Gentry's poster session series. In his article, Gentry attacks the idea of cosmological expansion, pointing to what he calls "the fatal flaw in the spacetime expansion postulate" (p. 2). His argument is summarized (largely in his own words) as follows:

1. BBM cosmologists believe that the cosmic expansion causes "wavelength expansion while a photon is in-flight, with complete cessation of expansion's effects during the emission and absorption process" (p. 3). Gentry calls this assumption the "cessation assumption" (p. 3) and asserts that "it is absolutely essential that it be invoked" (p. 3) by defenders of the BBM.
2. In contradiction to this "cessation assumption," Einstein's theory "predicts gravity affecting light during emission, *in contrast to causing in-flight wavelength change, as required by the expansion hypothesis*" (p. 4, emphasis in the original).
3. GPS operation shows "unambiguously that gravity operates during photon emission, without producing any in-flight change in λ whatsoever" (p. 5). Gentry specifically denies that photons "exchange energy with the gravitational field when passing through a potential gradient" (p. 5).
4. Therefore, both Einstein's theory and the operation of the GPS falsify the cosmic expansion hypothesis.

Gentry concludes that acceptance of cosmic expansion as evidence for the BBM "ranks as one of the greatest faux pas in the history of science" (p. 7).

This article contends that Gentry is mistaken. In the following sections I argue that, measured from the proper ref-

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Received 31 August 2002; Revised 23 October, 2002

erence, photons *do* lose energy in flight when traveling against a gravitational potential; that BBM theorists make, in fact, no “cessation assumption”; and (most damagingly to his position) that Gentry confuses the operation of gravity (as a mechanism for producing redshifts) with the effects of cosmic expansion. The intent of this article is not to criticize a fellow believer, nor to appear to support the BBM, but to follow the biblical mandate of I Thessalonians 5:21.

Redshifts

In order to support the assertions made above, we examine the nature of various types of redshifts. The term “redshift” refers to a decrease in the frequency of incoming light; that is, light normally emitted at one frequency is received by us at a lower frequency. (The corresponding term “blue-shift” refers to an *increase* in the frequency of incoming light.) It turns out that the light from most galaxies exhibits a redshift roughly proportional to the galaxies’ distance from us. Most cosmologists consider this pattern of redshifts to be evidence of cosmic expansion, a conclusion which Gentry disputes. There are three known causes of redshifts; we examine each in the following sections.

Kinematic Redshift

If an emitter of light (or of any kind of wave) is moving away from the observer, then during the time between the emission of two successive wavecrests, the emitter will increase its distance from the observer. As a result, it will take slightly longer for the second wavecrest to reach the observer than the first, resulting in a decrease in the observed frequency. This effect, commonly called the Doppler Effect (although the name is sometimes used for the other types of redshifts), is easily observable with sound waves emitted by automobiles. It is useful in identifying binary stars by means of the periodically shifting spectral lines (Hänsch, 1991).

We derive the classical kinematic Doppler Effect as follows. Suppose an emitter E is moving radially away from a receiver R with relative velocity v . Then in the time Δt that it takes E to emit successive wavecrests, E has increased its distance from R by $\Delta t \cdot v$, so the that time between the two wavecrests, as measured by R , is $\Delta t + \Delta t \cdot v/c$. Hence, the ratio of the wavelength λ_E measured by E and the wavelength λ_R measured by R is

$$D \frac{\lambda_R}{\lambda_E} = \frac{c + v}{c} = 1 + \frac{v}{c}. \quad (1)$$

With the advent of special relativity, the classical formula required alteration, as follows, to account for the effects of time dilation. Suppose E is moving radially away from R at a

relative speed of v , and suppose E measures the time interval Δt between emission of successive wavecrests. Then R will measure that same interval of time as $\gamma(v)\Delta t$, where $\gamma(v) = 1 - (v^2/c^2)^{-1/2}$ is the “Lorentz factor,” the factor by which relative motion dilates time. (this derivation assumes that the relative motion of E with respect to R is purely radial.) During this time, as measured by R , the distance between E and R increases by $\gamma(v)\Delta t \cdot v$, and hence the wavecrests arrive at R separated by a time interval of $\gamma(v)\Delta t + \gamma(v)\Delta t \cdot v/c$. Thus the ratio of wavelengths becomes

$$D \frac{\lambda_R}{\lambda_E} = \gamma(v) \left(1 + \frac{v}{c} \right), \quad (2)$$

which is simply the classical expression multiplied by the Lorentz factor.

Gravitational Redshift

Einstein’s theory of special relativity did not take gravitational forces into account. He expanded it to include gravity (thereby formulating the theory of general relativity) by assuming the following Equivalence Principle (EP): “all local, freely falling, nonrotating laboratories are fully equivalent for the performance of all physical experiments” (Rindler, 1977, p. 18). In other words, Einstein postulated that one could effectively transform gravity away by considering observers to be in free fall.

The resulting theory of general relativity concludes that light emitted within a gravitational field is redshifted when observed by a receiver outside of the field (or, strictly speaking, at a lesser gravitational potential). The reasoning, qualitatively, is as follows. Suppose you have a laboratory falling freely in a gravitational field. Say an emitter on the floor shines a beam of light toward the ceiling. By the EP, the freely falling lab is (locally) equivalent to a lab with no gravity, so a sensor on the ceiling will see the light with the same frequency at which it was emitted. However, an observer outside the lab will see the emitter traveling away from him. Hence, to the observer, the light will be redshifted, as discussed in the section above.

To quantify the amount of the redshift, let the gravitational field have strength g and let the cabin have length l . The emitter E begins emitting light the instant the cabin is dropped. Let ν_E be the frequency of the light as measured inside the freely falling cabin. Now suppose the outside observer R is positioned so that he is even with the ceiling of the lab just as the first light hits the ceiling. The time taken for the light to traverse the lab is l/c , and hence the lab is now moving at a speed of gl/c . Hence, by Equation 1 (we here ignore special relativistic effects), the ratio of the wavelengths will be

$$D \frac{\lambda_R}{\lambda_E} = 1 + \frac{gl}{c^2}.$$

Rewriting the expression in terms of frequency,

$$\frac{\nu_R}{\nu_E} = \frac{c^2}{c^2 - gl},$$

or,

$$1 - \frac{\nu}{\nu_E} = \frac{\nu_R}{\nu_E} - 1 = \frac{gl}{c^2}. \quad (3)$$

So we see that the gravitational redshift is indeed, as Gentry (2001, p. 6) claims, the result of the fact that “two observers at different potentials are comparing identical photons in reference frames that have intrinsically different physical characteristics. In essence, if you move to a different potential, you establish a different reference frame for energy measurements of photons originating from outside your new frame.” Does this fact imply, then, as Gentry also claims, that it is incorrect to consider a photon to be losing energy as it climbs out of a gravitational potential well? In answer, let us develop a differential version of Equation 3 and perform some integration.

First we replace l with Δr , where r is distance from the center of gravitational attraction. Suppressing the subscript, we have

$$\begin{aligned} \frac{\nu}{\nu} &= \frac{g}{c^2} \frac{r}{r} \\ \frac{\nu}{r} &= \frac{g\nu}{c^2} \frac{1}{r} \\ \frac{d\nu}{dr} &= \frac{g\nu}{c^2}, \end{aligned}$$

letting Δr approach zero, and thus

$$\frac{d\nu}{\nu} = \frac{g dr}{c^2}. \quad (4)$$

Replacing g with GM/r^2 (where G is the gravitational constant and M the mass of the gravitating object) we obtain

$$\frac{d\nu}{\nu} = \frac{GM dr}{c^2 r^2}.$$

Integrating, we obtain

$$\ln \nu = \frac{GM}{rc^2} + C,$$

whence, allowing ν_0 and r_0 to be the initial frequency and distance, respectively, we obtain the following equation for the frequency of the photon as it travels through a gravitational potential gradient:

$$\nu = \nu_0 e^{\frac{GM}{c^2} \left(\frac{1}{r} - \frac{1}{r_0} \right)}. \quad (5)$$

Since ν is a decreasing function of r , one can clearly consider the photon to be losing energy as it climbs out of

the gravitational well. Indeed, it is possible to obtain Equation 4 from Planck's relation $E = h\nu$ if one considers the photon to be losing energy to the field as it travels upward (Rindler, 1977, p. 268). One can even use the classical expression for potential energy, namely, $dU = (GmM/r^2)dr$, to do the same, as long as one remembers that the photon cannot change speed and therefore must change frequency to conserve energy.

These calculations show that Gentry on this point is correct in what he affirms and wrong in what he denies. If one constantly changes freely falling reference frames as the photon moves along, we see that the redshift is the result of the change of reference frames. Or, if you watch a photon climbing out of a gravitational potential well, you see it losing energy to the field. The whole point of the EP is that the two ways of looking at the situation are equivalent.

For this cause it is proper to say that Gentry misunderstands what the operation of the GPS tells us. According to Alley (in Gentry, 2001, p. 5),

If the physical clock adjustments have been made as described above so that all clocks are keeping a common coordinate time, then there is no effect on the frequency of the radiation as measured in that coordinate time. However, the contractor had included in the computer programs to operate the system just such a correction, *effectively correcting twice for the relativistic effects* (emphasis added).

In other words, to correct for frequency change and to correct also for coordinate change is to correct twice for the *same* effects. The operation of the GPS actually reaffirms the EP, which tells us that the two ways of looking at gravitational redshifts are equivalent.

In summary, gravitational redshift is the result of the photon struggling against the gravitational field, losing energy to it. Or, equivalently, it is the result of the effects of gravity on spacetime, causing the need for different reference frames at different potentials.

Expansion Redshift

The third type of redshift is, like the preceding type, a general relativistic effect, but it is completely distinct from both gravitational and kinematic redshifts. It is caused by the expansion of the space through which the wave is traveling, resulting in an “expansion” (redshifting) of the wave itself. The process is analogous to drawing a wave on a sheet of rubber and then stretching the rubber in the direction of the wave's travel. It is the commonly accepted explanation for the redshifts of the distant galaxies (Rindler, 1977, p. 213; Misner, Thorne, and Wheeler, 1973, pp. 776–778; Peebles, 1993, pp. 96–98; Bedran, 2002, p. 406).

The derivation of the formula for the expansion redshift (also called the “cosmological redshift”) is straightforward.

First, we let $R(t)$ be the radius of curvature of the universe at time t . Note that by “radius” we do *not* mean the distance from a central galaxy to an edge galaxy; indeed, the BBM universe is homogeneous (Rindler, 1977, pp. 201–202) and thus has “no edge and no center” (Humphreys, 1994, p. 19). The quantity $R(t)$ refers rather to the amount of curvature of the spacetime continuum of general relativity. (It could in theory be calculated by various geometrical means from observations, but not measured as a physical length in our three-dimensional universe.) As expansion proceeds, $R(t)$ grows; if the universe were to contract, $R(t)$ would shrink.

Now suppose a distant galaxy E emits light of wavelength λ_E at time t_E . Two wavecrests leave E separated in space by a distance of λ_E , and if the path over which they travel does not expand in flight, receiver R will observe them at time t_R with the same separation. However, if their path expands proportionally to $R(t)$ during flight, then the ratio of λ_E and λ_R will be given by

$$D = 1 + z = \frac{R(t_R)}{R(t_E)}, \quad (6)$$

where z is the amount of the redshifting that takes place.

Note that Equation 6 contains no velocity terms; z cannot therefore be measuring any sort of kinematic redshift. The only thing that matters is how much the universe expands between emission and reception of the photon. The expansion could have occupied billions of years or a fraction of a second (or a few days of the creation week), and the amount of redshift would be the same. There might have been no relative motion at all when the photon was emitted, nor when it was received (all the expansion having taken place during the intervening time), and the expansion redshift would be the same. Thus the kinematic and expansion redshifts are qualitatively different. One could think of the kinematic redshift as the result of motions through space, whereas the expansion redshift would be the result of the motion of space itself. Quantitative differences between the two types of redshifts are explored by Bedran (2002).

The expansion redshift differs also from the gravitational redshift. As seen in the development of Equation 3, we did not make any assumptions of cosmic expansion, nor, in the development of Equation 6 did we make any assumptions about gravitation. Indeed, in the BBM, there is no large scale pattern of gravitational attraction, the mass distribution being assumed homogeneous; hence it predicts expansion redshifts but no (large scale) gravitational redshifts. Conversely, a static universe could well exhibit gravitational redshifts but would have no expansion redshifts.

Gentry contends that cosmologists assume the expansion effects cease during emission and reception of the light. To show that cosmologists assume no such thing, I

will rederive Equation 6 by following the method adopted by Misner *et al.* (1973, pp. 776–778), one of the sources referenced by Gentry. Misner *et al.* use the following Robertson-Walker metric for spacetime, which is the standard metric for the BBM:

$$ds^2 = c^2 dt^2 - R(t)^2 \left[\frac{d^2}{1 - k^2} - d^2 \sin^2 d^2 \right], \quad (7)$$

where $R(t)$ is the curvature of space, η is a “comoving” radial coordinate (i.e., a galaxy that starts at a given value of η will remain there as it is carried by the cosmic expansion), k can have the values 1, 0, or -1 (depending on whether the universe is positively curved, flat, or negatively curved, respectively), and θ and ϕ are standard spherical coordinates.

Place the origin at earth (the Robertson-Walker metric allows one to locate the origin at any point) and consider a galaxy at a radial distance of η_E . It emits two successive wavecrests toward the origin (earth) at times t_{E_1} and t_{E_2} . We neglect any proper motion of the earth relative to space; one could in theory take it into account using an additional kinematic Doppler correction, but our focus is on the effects of the expansion. We first consider the emission of the waves. Clearly

$$c t_{E_2} - c t_{E_1} = \lambda_E. \quad (8)$$

Next consider the propagation of the light. Since the ray is traveling radially toward the origin, $d\theta$ and $d\phi$ in Equation 7 are zero. Since light travels along null geodesics, ds^2 is also zero. This fact necessitates that $-R(t)d\eta/(1 - k\eta^2)^{1/2} = c dt$, where the negative sign is due to the fact that the light is traveling towards the origin, causing a decrease in η as t increases. Therefore, integrating along the geodesic, we can write

$$\int_{t_{E_1}}^{t_{E_2}} \frac{d}{1 - k^2}^{1/2} = \frac{c}{R(t)} \int_{t_{E_1}}^{t_{E_2}} dt \quad (9)$$

and

$$\int_{t_{E_2}}^{t_{R_2}} \frac{d}{1 - k^2}^{1/2} = \frac{c}{R(t)} \int_{t_{E_2}}^{t_{R_2}} dt \quad (10)$$

for the two wavecrests. Since the coordinate η is comoving with the expansion, and since the same galaxy emits both wavecrests, we know $\eta_{E_1} = \eta_{E_2}$, so the left hand sides of Equations 9 and 10 are equal. Now subtracting Equation 9 from Equation 10, we obtain

$$\int_{t_{E_1}}^{t_{R_2}} \frac{c dt}{R(t)} = \int_{t_{E_1}}^{t_{R_1}} \frac{c dt}{R(t)} \quad (11)$$

$$\int_{t_{R_1}}^{t_{R_2}} \frac{c dt}{R(t)} = \int_{t_{E_1}}^{t_{E_2}} \frac{c dt}{R(t)} \quad (12)$$

$$\frac{c t_{R_2} - c t_{R_1}}{R(t_R)} = \frac{c t_{E_2} - c t_{E_1}}{R(t_E)}. \quad (13)$$

Finally, consider the reception of the light. Once again, it is clear that

$$R \quad ct_{R_2} \quad ct_{R_1}. \quad (14)$$

Now combine Equation 13 with Equations 8 and 14 to obtain

$$\frac{R}{R t_R} = \frac{E}{R t_E},$$

whence

$$z = \frac{R}{E} \frac{R t_R}{R t_E} = 1,$$

just as in Equation 6. It is clear from the approximation symbol in Equation 13 (which appears in Misner *et al.*) that cosmologists do *not* assume that the expansion effects cease during emission and reception, but only that they assume such effects are negligible.

To see that such an assumption is valid, let us approximate the amount of expansion that takes place during the emission of a photon. Take, for instance, the α line in the hydrogen Balmer series, which has a period of 2.19×10^{-15} seconds. Assign this value to $t_{E_2} - t_{E_1}$, which we shall call Δt . To estimate the current speed of expansion, we consider Hubble's constant, which equals $R'(t)/R(t)$; the estimate given by Lang (1991, p. 519) is $50 \text{ km s}^{-1} \text{ Mpc}^{-1}$. Taylor and Wheeler (1992, p. 297) state that 13.2×10^9 is a value for $R(t)$ that is compatible with observations. Using this value, multiplying, and changing units, we obtain

$$R \Delta t = 2.025 \times 10^{10} \text{ cm/s}. \quad (15)$$

Hence, the amount of expansion during the emission of an α Balmer line wave is

$$R \Delta t = R \Delta t \Delta t = 4.43 \times 10^{-5} \text{ cm}. \quad (16)$$

This number is 33 orders of magnitude smaller than the estimate for R . Therefore, by Equation 6, the effects of expansion during emission (and, similarly, during reception) are utterly negligible when performing redshift calculations. The estimate obtained in Equation 16 is admittedly crude, but it serves to demonstrate that the "cessation approximation" (*not* assumption!) made by cosmologists is eminently reasonable.

Discussion

In summary, there are at least three distinct possible causes of redshifting:

- Proper motion of the emitter with respect to the receiver,
- Differing gravitational potential at the emitter and the receiver, and
- Expansion of spacetime between emission and reception.

In developing the equations for these different types of redshifts, I have also noted the following points:

- One *can* legitimately consider photons to be losing energy in flight as they climb out of a gravitational potential well; alternatively, one can consider the difference in energy to be the result of different coordinate frames;
- Cosmologists do *not* assume that the effects of expansion cease during emission and reception; rather, they assume (correctly) that the effects are small enough to be negligible.

However, we have not yet considered the main problem with Gentry's article, which is that he confuses the gravitational redshift with the expansion redshift. While both are general relativistic effects, we have seen that they are distinct. Gentry seems (correctly) to distinguish them by saying, "Astronomically determined redshifts can be explained by Doppler and gravitational effects, independent of spacetime expansion" (2001, p. 2). Nevertheless, a glance at his argument (summarized at the beginning of this article) shows that it relies on an identification of the two. Even if cosmologists *did* make a "cessation assumption" about the expansion redshift (limiting it to effects on the photon in flight), and even if gravity *did not* (from any point of view) affect the photon in flight, there would be no contradiction, for the gravitational redshift and the expansion redshift are completely distinct. To identify the two is to invalidate any argument that depends on such identification. Hence, while the BBM may yet rank "as one of the greatest faux pas in the history of science," it will not be because of this particular argument by Gentry.

It remains to consider whether there is any evidence for cosmic expansion. Let us first consider biblical evidence. Many passages speak of God "stretching out the heavens," using a variety of words in various contexts to communicate the same idea. Humphreys (1994, p. 66) lists seventeen such verses. While it is perhaps possible that all seventeen references are purely metaphorical (referring to the expansiveness of the sky as seen from the earth), the variety and quantity of the verses lead one to suspect that God literally did "stretch out" the heavens (i.e., space—or spacetime from an Einsteinian viewpoint). Thus a literal reading of Scripture provides evidence for spacetime expansion at some time in the past.

The main scientific evidence for such expansion remains the observed pattern of extragalactic redshifts, wherein the redshift of a galaxy is roughly proportional to its distance from earth. Misner *et al.* state the standard reasoning as follows: "Observed quasar redshifts of $z \sim 1$ to 4 cannot be gravitational in origin; objects with gravitational redshifts larger than $z \approx 0.5$ are unstable against collapse... Nor are the quasar redshifts likely to be Doppler; how could so massive an object be accelerated to $v \approx 1$ without complete disruption? The only remaining possibility is a cosmological redshift" (1973, p. 767). (Note that Misner *et al.* are using units for velocity such that $c = 1$.) This reason-

ing seems cogent, especially considered in light of the biblical statements mentioned above.

Conclusion

Gentry is to be strongly commended for attempting to formulate a creationary alternative to the BBM. Other creationists have proposed cosmologies and/or cosmogonies consistent with the biblical record. David Harris (1978) outlines a scheme in which a wave of light speed decay propagates outward from the earth at the time of the Fall. Russell Humphreys' White Hole Cosmology (1994) has received much attention. Barry Setterfield continues to refine his theory of light-speed decay (originally proposed in Norman and Setterfield, 1987, and most recently in Setterfield, 2002). These theories must all be developed to the point where they can make quantitative predictions that will distinguish them from each other and from the BBM.

"The works of the Lord are great, sought out of all them that have pleasure therein" (Psalm 111:2). All creationists with the necessary qualifications are urged to "seek out" the works of the Lord in creating and sustaining the cosmos, evaluating current theories and proposing new ones as necessary. The motive for doing so is higher than any apologetic value such efforts might provide; we do it to magnify the greatness of our Creator.

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Survey: Views on Human Life Origins

In the United States, people's views of the origins of human life have varied little over a period of 15 years. The following survey was taken by telephone calls to 1003 adults on November 6–9, 1997.

Which of the following statements comes closest to your views on the origin and development of human beings?

1997	1993	1982	
39%	35%	38%	Human beings have developed over millions of years from less advanced forms of life, but God guides this process.
10	11	9	Human beings have developed over millions of years from less advanced forms of life. God has no part in this process.
44	47	44	God created human beings pretty much in their present form at one time within the last 10 000 years or so.
7	7	9	No opinion.

Emerging Trends 21(1) Jan. 1998, Princeton Religion Research Center

Notes from the Panorama of Science

Water Boatman: Rapid Resistance to Metal and Acid?

When the Anaconda Copper Company abandoned its mining complex in Butte, Montana, it shut off power to a million-dollar underground pumping station. Ground water promptly flooded the underground workings and began filling the 425 m deep Berkely Pit. Sulfide ores, including pyrite, chalcopyrite, azurite, bornite, sphalerite, and galena, contributed to a brew so acidic that it was said that virtually nothing could live in it. The water formed a deep green pond in the bottom of the enormous pit. A viewing stand on the south side of the pit made an interesting stop for Butte residents to watch the rise of the water. As the water level rose, it suddenly became blood red, then took on its present dark red color. Meanwhile, the Montana Bureau of Mines and Geology has been researching the pit water and various possible means of treating it before it nears the top of the pit and begins affecting shallow aquifers. Algae were discovered a few years ago in the pit water, and in April of 2001, a Montana Tech graduate student discovered that the poisonous pond is now home to the Water Boatman (Family Corixidae). She and two of her professors collected several specimens which continued to thrive in the water from the "Berkely Pond." One of them

speculated that "the bugs may have developed their metal and acid tolerance over hundreds of years" in the natural and manmade sources of acidic waters in the area. Creationists frequently point out that the potential for tolerance to antibiotics, climate extremes, or other stressors are often latent in a population and that only gene frequency shifts. Was this potential already present in the Water Boatman population? Could they have "adapted" almost immediately when only those individuals with acid and metal tolerance survived in the Berkely Pit? Addressing these questions may shed light on the ability of aquatic and marine organisms to survive the extremes of the global Flood cataclysm.

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Irreducible Complexities and Behaviors in Birds, Hydras, and Whales

In the debate between creationists and macroevolutionists, the creationists have a potent argument in irreducible complexities which stand as concrete walls to both cosmic and biological macroevolutionary progression. The components of an irreducibly complex system cannot work apart from each other and they must come into existence at the same time, something that random, progressive macroevolution cannot accomplish. I submit that irreducible complexities are far more prevalent than one may think.

I think that animal behaviors qualify as irreducible complexities. The dictionary defines a behavior as "an organism's muscular or glandular response or responses to stimulation": hence, at the basis of behaviors is the muscle-nerve pairing. As common as these phenomena are, each is amazingly complicated in its own right. Motor nerves and the muscles they serve allow the organism to respond to its environment. The simple behavior of a single muscle-nerve pair is irreducibly complex.

Consider the hydra, one of the simplest of animals. It is essentially a stomach with tentacles. The hydra's complex behaviors are nevertheless rather detailed. It catches food, ingests it, and somersaults to change its location. It is most

unlikely that the hydra consciously initiates these movements and therefore, both of these behaviors must be innate. The "hardwiring" of its complex behaviors mirrors that of a single muscle and nerve. A creature's toe, for example, should not wriggle when it intends to chew. The morphologies and the innate behaviors of the hydra are encoded in its DNA. Any change in a species' DNA is by mutation and, therefore macroevolutionary. Whatever the hydra species had before, the intricate neural net and musculature it has now, according to macroevolution, was supposedly acquired progressively through trial-and-error. The hydra's complex behaviors of catching and eating food are so necessary that the question is then begged, "How did they survive before they *learned* to survive?"

The behaviors of aquatic mammals are other examples. Whales certainly find their environments incompatible with childbirth. Without the survival instincts that the mother whale needs, their calves would drown. As maintained by macroevolutionists, these instincts for calving must be acquired by the whales through a progressive continuity. But the macroevolution of cetaceans cannot proceed until they consistently give birth in the water. While one may point to seals and other amphibious mammals as

possible transitional forms toward fully aquatic mammals, they all nevertheless birth their young on firm ground. Thus the behavior of water birthing in whales is dependent on a consistent aquatic lifestyle, which is not possible until the instinct for land birthing is lost.

Even the simple behavior of a muscle's response to its nervous stimulus is irreducibly complex. The forms found in an organism, from its cells to its systems, are guided by DNA. Because a muscle transmits a force and a nerve transmits a bioelectrical impulse, the muscle is elongated between its points of attachment. According to the macroevolutionary model, these points of attachment, as well as muscle shapes, are determined by random chance while displaying an upwardly progressive continuity. In order to fill the needs implied by their functions, the muscle-nerve pairs must be at the right place at the right time and yet they must get there gradually. This is asking for the unlikely.

Of special significance are the tiny arrector pili muscles, which move the feathers of birds and the hairs of mammals. Under macroevolution, these integumentary adjuncts are derived from reptile scales. But the origin of these complicated arrector organs poses a problem for macroevolution.

When a bird needs to excrete wastes, it ruffles its feathers. This complex behavior is for sanitation purposes, keeping its feathers clean. Some of the evident benefits are to hold down unwanted odors and to discourage parasites. Before the supposed ancestors of birds could have evolved

feathers, though, both the behavior involved and the arrector muscle-nerve pair would have been unnecessary. There would have been no need for the muscle without the feather. The advantages of the behavior would have been unavailable during the evolution of their feathers. But the needs generated by the evolving proto-feathers would have been unfilled without the arrector muscles. Can the evolution of an organ occur when its functions cannot as yet be fulfilled?

At first glance, the old conundrum, "Which came first, the chicken or the egg?" appears to be an irreducible complexity itself because of the mutual needs of the chicken and egg. Fiat creation of the kinds circumvents the problem of irreducible complexity because each organ's needs were recognized and filled immediately by the Creator. Macroevolution falls prey to the problem of irreducible complexity, however, because it has to operate through probability within the constraints of progressive continuities. Indeed, the only explanation for biological, irreducible complexities under macroevolution would be a fortunate mutation that would bring all the necessary components together at one time: in other words, a "hopeful monster." Among the problems with such hopeful monster scenarios is that no such totally complex and helpful mutations occur in nature.

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The Incredible Stability of *Drosophila*

In a short item in *Nature* (Smith and Eyre-Walker, 2002), an estimate is given of how many positive gene mutations there have been in *Drosophila simulans* and *Drosophila yakuc*. A number of genes were worked on out of the 13,600 genes possessed by *Drosophila*. It is estimated from these figures that about 270,000 positive gene mutations have occurred, or one every 45 years, which equals to one positive mutation every 450 generations. It is postulated from these data that the split between the two species of *Drosophila* took place some six million years ago.

I am not interested in evolutionary dating, but in what the number of mutations may signify. They demonstrate how remarkably stable the form of *Drosophila* is. If 270,000 positive gene mutations have not moved *Drosophila* from its form as a fly, then we can see that no evolution has occurred, or is every likely to occur. This fact is self-evident.

The present developmental stage of any life form is the result of mutational changes in the past, that have taken place after the original kind was created. The principle of symmetric variation is responsible for maintaining life

forms within their respective kinds no matter what mutations may occur. This is done because of the way amino acids are coded. Even if a mutation occurs, usually it will lead to the use of the same amino acid in the resulting polypeptide (Brown 1999 and 2001). More frequently a mutation will eventuate in the replacement of one amino acid by a very similar amino acid in that same group of amino acids. Least frequently of all, a mutation causes the replacement of an amino acid by a different amino acid of an entirely different group. Normally, however, such broader mutations are returned to their original coding by the organism's own repair systems, although a few may remain. This is all part of what I call symmetric variation and it is certainly a major means by which the Creator maintains both stability and flexibility in His created kinds.

To give an example of all this, the amino acid valine will be used. Valine can be coded by four different sets of mRNA codons which are: GUU, GUC, GUA, GUG. If the last base is changed, the same amino acid being produced in the polypeptide as seen when GUU, for example, is changed to GUA.

If any of the initial bases are changed, then variation within the group to which valine belongs is produced. Some examples are, if GUA is changed to AUA, isoleucine, which is in the same amino acid group as valine, is produced. If the same codon is changed from GUA to CUA then we get another member of the valine group, leucine. Finally, if any change in the second base occurs, then an amino acid from outside the group is put into the resulting polypeptide (Brown, 1989).

In a work where ultraviolet radiation was used on an active gene in mice, the life form's repair system restored 85% percent of the changes to their original state within 24 hours (Anon, 1986, p. 33). Mutations do not normally occur on this scale and therefore one would expect the repair systems to do even better over generations. Support for the above can be seen in two cases, both of which show that in related life forms the main mutational changes are those from one amino acid to another within the group to which the first amino acid belongs (Dolittle, 1985, p. 81; Graur, 1985, p. 55).

A final point to make is the enormous amount of genetic potential that life forms have. In some organisms such as man, the genetic potential is greater than the number of atoms in the known universe (Ayala, 1978, p. 55). Even though each life form has great genetic potential, thanks to symmetric variation and the repair mechanisms, life forms remain in their kinds.

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Book Review

In Our Hands By Arnold Arem
 Times Books, New York. 2002, 271 pages, \$24

Anyone interested in anatomical design, carpal tunnel syndrome, touch therapy, or left-handedness would enjoy this book. Author Arnold Arem is a constructive hand surgeon living in Tucson, AZ. He accepts completely the evolutionary origin of mankind, but is overwhelmed by the intricacy of the human hand. The book's first sentence gives honor to anatomist Charles Bell (1774-1842) whose premise was that the very existence of the human hand proved the existence of God (p. 1).

Arem believes that our hands provide our chief distinction from the animal world. In fact 750,000 distinct hand gestures have been estimated, far more than English words (p. 156). I myself recall South Pacific performers who "danced" with their eyes and hands, telling entire stories with intricate hand movements. In considering hand design, many features come to mind including fingerprints, sign language, braille, and our unique opposable thumb.

The current medical status of limb amputation is surveyed (p. 192). Loss of a finger is found to impact distant

parts of the body in many ways. "The body operates a bit like a large organization" (p. 197), and problems with any single part effect the whole. Arem also discusses skin grafts, artificial skin, and current pioneer efforts at limb reattachments and transplants.

Arem explores carpal tunnel syndrome, a hand numbness caused by pinching of the median nerve. A novel, suggested cause of this current epidemic is the elimination of the carriage return motion in typing. Computer keyboards provide no break from repetitive hand movement (p. 207).

The author is amazed by the ability of the human hand to heal, and he tends toward Eastern mysticism. However, some of his patients challenge him with Christian testimonies (p. 151). Arem reverently mentions (p. 172) some of the final words of Christ on the cross, "Into thy *hands* I commit my spirit" (Luke 23:46). The author presents a very strong case for created, designed hands.

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Letters to the Editor

Gray Clouds in the Heavens

"For in six days the Lord made the heavens and the earth"—Exodus 20:11. This one verse of Scripture appears to be quite problematic for the "neo-gap" theory Gorman Gray is trying to promulgate. Not only does his book (Gray, 1997) devote many pages (see the 18 listings of it in his Scripture index) to trying to explain it away, but also he has now added several more pages of defense in a letter to this journal (Gray, 2002).

Exodus 20:11 is a thorn to Gray because he does not want God to have made the whole cosmos within the six days of Creation. Instead he wants to have a gap of billions of years occurring *before* the first day in order to give light from distant galaxies time to get here. One problem for Gray is that Hebrew lexicons, including the one I cited (Brown, Driver, and Briggs, 1979, p. 1030), say that the phrase "the heavens and the earth" means "the universe." If God indeed made the whole universe within six ordinary days, as a straightforward reading of the verse indicates, then Gray's theory goes down the tubes.

In his letter, Gray's first defense is a claim that God's use of the words "the sea" after "the heavens and the earth" invalidates the latter's usual meaning, "the universe." However he cites no Hebrew lexicon or Hebrew scholar to substantiate his pronouncement. He merely uses a few words of jargon, "merism" (*sic*) and "hendiadys," apparently hoping that readers unfamiliar with the terms will assume they refer to some well-known rule of grammar that justifies his claim. Such an assumption would be wrong. The lexicons make no such exception to the meaning of the phrase; they still insist on "the universe."

Gray's second line of defense is several paragraphs of rambling rationalizations trying to show that in this verse, the word "heavens" means only the earth's atmosphere, and nothing above it. But would an ordinary reader of the Bible before the 18th century have understood the word

that way? The answer is "no," because before that time, nobody made the distinction we do today between the atmosphere and space. Instead, the pre-modern reader would understand "the heavens" to be that which contains *everything* he could see above him—birds, clouds, sun, moon, and stars. What the pre-modern believer understood would be what God intended the word to mean to us today also. We deceive ourselves if we limit His word "heavens" to mean only our modern concept of the atmosphere. Scripture has other ways to communicate the latter idea, one of which I pointed out in my book (Humphreys, 1994, pp. 60–61).

Gray's theory seeks to make enough time for starlight to reach the earth. But the growing field of creationist cosmology is in the process of providing us with several reasonable ways (not just my own theory) to get the light here within the six ordinary days to which Genesis 1 and Exodus 20:11 (plus many others) limit theorists. In view of these answers, why does Gray still insist on stretching Scripture to accommodate his long ages?

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The First Russian Creation Scientific Anthology

The creation science movement in Russia is growing. Due to distribution of popular books on creation science, many Russian Christians are getting to know about scientists who confirm the reliability of the Scriptures. This results in an increasing understanding of the necessity for creation science by both Christian layman and scientists who doubt evolution and an old Earth. But for a long time technical results of foreign creation scientific investigations were inaccessible to Russian readers, and Russian creationists did not have a common center for publication.

For the purpose of eliminating these defects the Society for Creation Science (Moscow) and "Palomnik" (Pilgrim) Publishing House have prepared and printed the first issue of a creation scientific anthology SOTVORENIE ("creation" in Russian). It is the first periodical that contains technical creation papers by both Russian and international creationists in various areas of the natural sciences and humanities.

Some of the papers were previously published in *Creation Ex Nihilo Technical Journal*, the *International Con-*

ference on Creationism Proceedings (Pittsburgh, USA), the *Creation Research Society Quarterly*, and other international publications. Articles in the first issue address subjects in the fields of epistemology, mathematics and physics, astronomy, geology, biology, anthropology, chemistry, archaeology, and sociology. This issue also includes a discussion on “evolutionism: a science or ideology?” led by Drs. A. V. Lalomov and A. V. Khomenkov. It will be the first time the articles are published in Russian.

The editorial staff consists of Russian and international creationist experts in various fields of research. The illustration shows the cover of this publication.

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Flood Geology Does Not Explain the Fossil Record

This is in response to Mr. Akridge’s letter “Further Reflections on the CCC Model”, (*CRSQ* 39:65-68), Mr. Akridge posed a number of questions, which I will answer:

1. How can thick deposits (even miles thick) of sedimentary material containing fossilized animals and plants and covering much of the present land surfaces be explained in a pre-Flood context?

That question was answered in my first letter, Lain, E. C. 2001. “Defense of CCC model”, *CRSQ* 38: 165-168. See the remarks by Eusebius and Jasher.

2. How can a “Cretaceous” sedimentary stratum in Alabama be age-correlated with a “Cretaceous” stratum in England without using the principles of evolution-based biostratigraphy?

How do you correlate elephants in Africa with elephants in India?

3. Why do fossils of animals and plants from over the globe demonstrate their having lived in warm to moderate climate conditions?

How did you determine that those organisms lived in those environments without using the principle of evolution-based uniformitarianism and biostratigraphy?

4. How is the Flood boundary both locally and globally differentiated from strata deposited during the events of Creation Week and the curse of mankind?

If we knew the answer to that, there would not be a controversy. The CCC Model is exactly that, a model, a hypothesis, not a dogma. It has not been tested. The way to do that is to lay it alongside Genesis and the geologic record to see if it stands the test.

5. Does the presence of fossils in rock strata deposited during Creation Week conflict with the Scriptural teachings of no death existing before the introduction of sin?

I neither stated nor implied that fossils were deposited during Creation Week. I said that the fossil record (same as geologic record) supported the events of Creation Week. The rest of the question is a theological matter and does not belong in this discussion.

6. What was the mechanism for the origin of continental glaciation in the pre-Flood world?

That question is irrelevant! To my knowledge no one knows what caused the Pleistocene glaciation. There were mountains before the Flood. That implies climatic zones. There was also rain before the Flood. That can be proven. You cannot deny the possibility of glaciers.

7. Why are modern examples of widespread catastrophic activity not observed?

Again the question is irrelevant and is based on an erroneous assumption.

Now I will deal with Mr. Akridge’s effort to prove that the raindrop imprints, mud cracks, ripple marks and footprints were the result of the Flood. He acknowledges “...Rain impacts, mud cracks, footprints, and ripple marks are very fragile and easily modified or destroyed before petrification process can begin...” (*CRSQ* 39:66). I stated essentially the same thing in my letter (*CRSQ*, 38:165-168). Yet we are asked by Mr. Akridge to believe that the dinosaurs were fleeing to higher ground to escape the advancing Floodwaters. There is no evidence whatsoever for that statement. We are asked further to believe that those fragile artifacts of rainprints, etc. survived this horrendous Flood which the author describes as having consist of “...tidal forces, wave action and tsunami events...” (*CRSQ* 39:66) And where is the proof for all of this violence in the basin containing the above mentioned mud-cracks etc.?

It is true mudcracks can form under the ocean at great depths by colloidal action which enables some muds to expel water under water. You get the same results by leaving Jell-O sit in the refrigerator for a few days. The Jell-O will crack and expel water to its surface. However, the presence of raindrop imprints always signifies a continental environment not a marine environment. Except for a small amount of marine deposits, the Triassic beds are all continental. The Newark Formation is a string of rift basins. It is a series of long and narrow highland mountains and low basins. Great quantities of nonmarine sediment were

dumped into the basins from the adjoining highland mountains. The quote from Dunbar and Waage stated in part, "No marine fossils have been found anywhere in the Newark Group. Land plants and fresh water fish are locally abundant..." This is one of three examples that I gave in my first letter of time indicators and could not have been formed by a Flood. Let us assume, for it is an assumption, for the sake of objectivity, that these three indicators of the passage of time were buried by the Flood. They were not the result of the Flood. They were not the result of the flood any more than Pompeii and Herculaneum were the result of the eruption of Mt. Vesuvius, which buried them beneath a thick blanket of volcanic ash. They were there first. I believe that traditional Flood Geology is flawed and does not explain the fossil record at all.

Wind Pollination and Numbers of Insects

I read with interest Colin Brown's "Aerodynamics of Wind Pollination in Living and Fossil Plants," *CRSQ*: 38(4): 212. It reminded me that our evolutionist friends consider wind pollination to be a very primitive system. However, I sense that our Creator God devised this system on purpose. When I think how many pollinating insects would be required to replace wind pollination, I can visualize that

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many of our grasslands and forests would be uninhabitable by humans, due to the immense numbers of such pollinators that would be required.

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Book Review

The Right Questions: Truth, Meaning, and Public Debate by Phillip E. Johnson
 InterVarsity Press, Downers Grove, IL. 2002, 191 pages, \$16

The modern intelligent design (ID) movement began in 1991 with the publication of *Darwin on Trial* by a then-obscure Berkeley law professor, Dr. Phillip Johnson. The ID movement and Dr. Johnson have come a long way since then. The idea that life originated from an intelligent cause has become respectable once again, and Darwinian evolution is receiving strong challenges on many fronts.

Before Johnson started his work, creationists of various persuasions fought with each other over such issues as the age of the earth, Flood geology, and the meaning of the fossil record. While these issues are important, Johnson argued that these are not the key questions with regard to public debate. Johnson launched a new strategy; it might be called "unite and win" (p. 9).

What Johnson did was to ask the right questions: "Is nature all there is? Can natural forces alone explain the universe and everything in it? Did life arise by blind, materialistic Darwinian processes, or does the evidence point to other forces?" (p. 9) Christians may argue about *how* God

created, but they all agree that the universe is the work of a personal, all-powerful God.

The beauty of Phillip Johnson's approach is that it has the ability to unite Christians across a broad spectrum. Indeed, many believe the ID movement has largely achieved this goal, and naturalistic philosophy is feeling intense pressure as a result.

This latest book by Phillip Johnson is considerably different than his earlier works, which in general concentrated on the logic and science associated with the Darwinian evolution vs. intelligent design controversy. *The Right Questions* is an intensely personal account in which Johnson talks more about his personal faith and less about evolution and design.

Johnson spends a fair amount of time discussing how science is defined, a fundamental question in the evolution/design debate. Is science limited to exploring *natural* explanations for natural phenomena, or should *all logical* explanations (naturalistic or not) be considered?

In today's world "a credulous public is taught to accept philosophical naturalism/materialism as inherent in the definition of science" (p. 33). *Naturalism* is the philosophy that nature is all there is. That is, it's the belief that there is no supernatural aspect to existence. Naturalism says that everything can be explained by the laws of chemistry, physics, and random chance.

At the same time, however, modern discoveries in biochemistry and other branches of science are providing new compelling evidence that nature is *not* all there is to reality. The discoveries that DNA has a complex *code* (information), and that many biological systems have the property of "specified complexity" provide strong support for the intelligent design of life.

Nevertheless, the science establishment, due to its naturalistic bias, continues to suppress and dismiss this compelling evidence. Johnson says that most people "instinctively recognize that a supernatural intelligence must be at work in the wonder of biology. It takes years of indoctrination to learn to ignore the evidence of intelligent design that is so apparent before our very eyes" (p. 35).

Interestingly, while the science establishment holds fast to its naturalistic philosophy, most Americans aren't buying it. For example, a *Cleveland Plain Dealer* poll (May 2002) found that only 8 percent of Ohioans accept naturalistic evolution as the best explanation for the origin and de-

velopment of life. Most of the rest believe that an intelligent cause was involved.

The debate between evolution and design/creation usually focuses on the first chapter of Genesis: "In the beginning God created...." Johnson says it is time to focus instead on the first chapter of John: "In the beginning was the Word...." The Word (God) implies *information* and *intelligence*. Johnson argues that "the evidence of science shows that 'in the beginning was the Word' is as true scientifically as it is true theologically, spiritually and in every other way" (p. 141).

In July of 2001 Dr. Johnson suffered a debilitating stroke that hampered him physically, but his mind remained sharp and focused. In the process of his recovery, Johnson's faith in God was strengthened and entered a new dimension. His newly found, deeper trust in God is reflected in *The Right Questions*. Phillip Johnson has been asking (and answering) the right questions for a dozen years now, and in the process he has transformed the evolution/design debate in ways that will have repercussions for years to come.

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Video Review

Unlocking the Mystery of Life A video produced by James Adams

Illustration Media, illustramedia.com. 2002, 65 minutes, \$20.

In 1993, several scientists and other professionals met in California to discuss their mutual dissatisfaction with evolution theory. This group gave birth to the current *intelligent design* movement. Included were Phillip Johnson, Paul Nelson, Dean Kenyon, Michael Beke, Stephen Meyer, and William Dembski. This video describes the meeting and the motivations of the men involved.

About one-half of the video presentation is given to the design of the amazing bacterial flagella. This biological "outboard" motor is amazingly similar to electric motors built by Michael Faraday in the 1820s. The tiny threadlike (one micron) flagellum can rotate at 100,000 revolutions per minute, and can stop completely in one-quarter turn. This is an outstanding example of irreducible complexity. Evolutionists suggest the flagellum evolved from "co-op-

tion" or "borrowed parts," but this is unrealistic in view of its forty structural components.

The video also discusses DNA replication. The information contained within is contrasted with the SETI search for signal patterns from space. Fascinating graphics and animation are used throughout the presentation. Dr. Dean Kenyon explains his realization, after many years of research, that chemical evolution could never originate life. Others interviewed include Jonathan Wells, Jed Macosko, and Scott Minnich, all sympathetic to intelligent design. The video is an excellent tool for students, skeptics, and intelligent design enthusiasts. It does not mention Scripture or the age of the earth.

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Three paper copies and a computer file shall be submitted to the editor of the *Quarterly*. Each copy should have a title page with only the title, author contact information, and a list of key words for subjects covered in their articles. The second page should have the title, no author information, and the rest of the article to allow anonymous reviewing.

Authors must realize that the editors will subject their papers to changes as necessary, in order to make them more suitable for the broad spectrum of CRSQ readers. If the revisions of the editor and referees are extensive, the changes will be sent to the author to be incorporated in the final draft. If the changes are not acceptable to the author, he may withdraw his request for publication, or he may request that the changes be examined by another editor, whose decision will be final.

All submitted articles will be reviewed by at least two technical referees. The editor may or may not follow the advice of these reviewers, and the author may defend his position against referee opinion. After the peer review is finished and all changes have been made to the article, a final paper copy and computer file will be requested. Authors who provide either an email address or fax number will receive a copy of their article just prior to publication. Materials will not be returned to authors unless accompanied by a self-addressed, stamped envelope.

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Although it is nicer to be positive, there seem to be a lot of important negatives:

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- Do not use all capital letters for *anything* (titles, etc.).
- Do not use bold type in the paragraphs; use italics to call attention to words.

- Do not use multiple spaces for tables and similar material. Use tabs instead.
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All figures and drawings must be of high quality, therefore, no sloppy drawings or lettering will be accepted. Use patterns, rather than shading, in line drawings. Unacceptable illustrations will result in rejection of the manuscript for publication. Do not embed pictures in text files.

References and Book Reviews

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CRSQ: *Creation Research Society Quarterly*. [for multiple *Quarterly* references]

Cockman, Joneen. 1988. Collecting plants for the Creation Research Society Herbarium. CRSQ 24:187–193.

Margulis, Lynn. 1971a. The origin of plant and animal cells. *American Scientist* 59:230–235.

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Book review headings, like references, have a particular style which should be followed. This issue of the *Quarterly* will provide examples.

Length

Manuscripts containing more than 25 pages are discouraged. If a topic cannot be covered to the author's satisfaction in this number of pages, the author should divide his material into separate papers that can be serialized in the *Quarterly*. Book reviews should be limited to 1000 words.

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Creation Research Society

History—The Creation Research Society was 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 need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The *Creation Research Society Quarterly* has been gradually enlarged and improved and now is recognized as the outstanding publication in the field. In 1996 the CRSQ was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

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. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, 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. 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 humans, 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 a historical event worldwide in its extent and effect.

4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act 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 Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.